GRADE 12 PHYSICAL SCIENCE

BOOST EXAM PREP

CAPS-ALIGNED SUMMARY SERIES

COMPILED BY STEM IN ACTION

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A message from the STEM in ACTION Team

Grade 12's, welcome to STEM in ACTION's Physical Science Boost Series. This product was conceptualised together with your educators, during our Physical Science Community of Practice online sessions in 2020. It serves to support you and your Physical Science educators in preparing you for your Matric Physical Science NSC examination. You will recognise our laboratories and team, as we bring the STEM in ACTION laboratories into your classroom and highlight all the topics in your Grade 12 Physical Science curriculum, according to the Examination Guidelines. Have fun, go for it and realise that we believe in you and know that you can do it!

Your Boost Prep Pack contains the Physical Science examination guidelines and exam papers with memoranda from 2018 to 2023. Work through the Boost Summary and Experiment Series on YouTube (scan QR code below) with your educator in class or at home. This summarises the work according to the exam guidelines and CAPS and gives you handles on how to approach and tackle exam questions.

STEM in ACTION is a community engagement entity within the Engineering, Built Environment and Technology (EBET) Faculty at Nelson Mandela University. It supports learners, educators and parents across the educational phases, through a hands-on brains-on approach within the teaching and learning of Physical Science. This constructivist approach together with a dynamic and enthusiastic STEM in ACTON team, aim to get learners motivated about the subject and to consider possible STEM careers.

EXAMINATION GUIDELINES

3. ELABORATION OF THE CONTENT FOR GRADE 12 (CAPS)

The final examination in Physical Sciences will cover the topics outlined below.

3.1 PAPER 1: PHYSICS

Newton's Laws and Application of Newton's Laws (Grade 11)
(This section must be read in conjunction with the CAPS, p. 62–66.)

Different kinds of forces: weight, normal force, frictional force, applied force (push, pull), tension (strings or cables)

- Define normal force, N.
- Define frictional force, *f*.

Force diagrams, free-body diagrams

- Draw force diagrams.
- Draw free-body diagrams.
- Resolve two-dimensional forces (such as the weight of an object with respect to the inclined plane) into its parallel (x) and perpendicular (y) components.
- Determine the resultant or net force of two or more forces.

Newton's first, second and third laws

- State Newton's first law: A body will remain in its state of motion (at rest or moving at constant velocity) until a net force acts on it.
- Discuss why it is important to wear seatbelts using Newton's first law.
- State Newton's second law: When a net force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object.
- Draw force diagrams and free-body diagrams for objects that are in equilibrium or accelerating.
- Apply Newton's laws to a variety of equilibrium and non-equilibrium problems including:
  - o A single object:
    - Moving on a horizontal plane with or without friction
    - Moving on an inclined plane with and without friction
    - Moving in the vertical plane (lifts, rockets, etc.)
  - o Two-body systems (joined by a light inextensible string):
    - Both on a flat horizontal plane with and without friction
    - One on a horizontal plane with and without friction, and a second hanging vertically from a string over a frictionless pulley
    - Both on an inclined plane with or without friction
    - Both hanging vertically from a string over a frictionless pulley
- State Newton's third law: When one body exerts a force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.
- Identify action-reaction pairs.
- List the properties of action-reaction pairs.

Newton's Law of Universal Gravitation

- State Newton's Law of Universal Gravitation: Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.
- Solve problems using $F = \frac{Gm_1m_2}{r^2}$.

- Describe weight as the gravitational force the Earth exerts on any object on or near its surface.
- Calculate weight using the expression w = mg.
- Calculate the weight of an object on other planets with different values of gravitational acceleration.
- Distinguish between mass and weight.
- Explain weightlessness.

Momentum and Impulse
(This section must be read in conjunction with the CAPS, p. 99–101.)

Momentum

- Define momentum as the product of an object's mass and its velocity.
- Describe linear momentum as a vector quantity with the same direction as the velocity of the object.
- Calculate the momentum of a moving object using p = mv.
- Describe the vector nature of momentum and illustrate it with some simple examples.
- Draw vector diagrams to illustrate the relationship between the initial momentum, the final momentum and the change in momentum for each of the cases above.

Newton's second law in terms of momentum

- State Newton's second law of motion in terms of momentum: The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force.
- Express Newton's second law in symbols: $F_{net} = \frac{\Delta p}{\Delta t}$
- Calculate the change in momentum when a resultant force acts on an object and its velocity:
  - o Increases in the direction of motion, e.g. 2nd stage rocket engine fires
  - o Decreases, e.g. brakes are applied
  - o Reverses its direction of motion, e.g. a soccer ball kicked back in the direction it came from

Impulse

- Define impulse as the product of the net force acting on an object and the time the net force acts on the object.
- Deduce the impulse-momentum theorem: $F_{net}\Delta t = m\Delta v$
- Use the impulse-momentum theorem to calculate the force exerted, the time for which the force is applied and the change in momentum for a variety of situations involving the motion of an object in one dimension.
- Explain how the concept of impulse applies to safety considerations in everyday life, e.g. airbags, seatbelts and arrestor beds.

Conservation of momentum and elastic and inelastic collisions

- Explain what is meant by:
  - o An isolated system (in Physics): An isolated system is one on which the net external force acting on the system is zero.
  - o Internal and external forces
- State the principle of conservation of linear momentum: The total linear momentum of an isolated system remains constant (is conserved).
- Apply the conservation of momentum to the collision of two objects moving in one dimension (along a straight line) with the aid of an appropriate sign convention.
- Distinguish between elastic collisions and inelastic collisions by calculation.

Vertical Projectile Motion in One Dimension (1D)
(This section must be read in conjunction with the CAPS, p. 102–103.)

- Explain what is meant by a projectile, i.e. an object upon which the only force acting is the force of gravity.
- Use equations of motion to determine the position, velocity and displacement of a projectile at any given time.
- Sketch position versus time (x vs. t), velocity versus time (v vs. t) and acceleration versus time (a vs. t) graphs for:
  - A free-falling object
  - An object thrown vertically upwards
  - An object thrown vertically downwards
  - Bouncing objects (restricted to balls)
- For a given x vs. t, v vs. t or a vs. t graph, determine:
  - Position
  - Displacement
  - Velocity or acceleration at any time t
- For a given x vs. t, v vs. t or a vs. t graph, describe the motion of the object:
  - Bouncing
  - Thrown vertically upwards
  - Thrown vertically downward

Work, Energy and Power
(This section must be read in conjunction with the CAPS, p. 117–120.)

Work

- Define the work done on an object by a constant force F as $F\Delta x\cos\theta$, where F is the magnitude of the force, Δx the magnitude of the displacement and θ the angle between the force and the displacement. (Work is done by a force – the use of the term 'work is done against a force', e.g. work done against friction, must be avoided.)
- Draw a force diagram and free-body diagrams.
- Calculate the net work done on an object.
- Distinguish between positive net work done and negative net work done on the system.

Work-energy theorem

- State the work-energy theorem: The work done on an object by a net force is equal to the change in the object's kinetic energy:
  $W_{net} = \Delta K = K_f - K_i$
- Apply the work-energy theorem to objects on horizontal, vertical and inclined planes (for both frictionless and rough surfaces).

Conservation of energy with non-conservative forces present

- Define a conservative force as a force for which the work done in moving an object between two points is independent of the path taken. Examples are gravitational force, the elastic force in a spring and coulombic force.
- Define a non-conservative force as a force for which the work done in moving an object between two points depends on the path taken. Examples are frictional force, air resistance, tension in a chord, etc.
- State the principle of conservation of mechanical energy: The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant. A system is isolated when the net external force (excluding the gravitational force) acting on the system is zero.)
- Solve conservation of energy problems using the equation: $W_{nc} = \Delta E_k + \Delta E_p$
- Use the relationship above to show that in the absence of non-conservative forces, mechanical energy is conserved.

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Power

- Define *power* as the rate at which work is done or energy is expended.
  In symbols: $P = \frac{W}{\Delta t}$
- Calculate the power involved when work is done.
- Perform calculations using $P_{ave} = Fv_{ave}$ when an object moves at a constant speed along a rough horizontal surface or a rough inclined plane.
- Calculate the power output for a pump lifting a mass (e.g. lifting water through a height at constant speed).

Doppler Effect (relative motion between source and observer)
(This section must be read in conjunction with the CAPS, p. 121–122.)

With sound and ultrasound

- State the Doppler effect as the change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.
- Explain (using appropriate illustrations) the change in pitch observed when a source moves toward or away from a listener.
- Solve problems using the equation $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ when EITHER the source OR the listener is moving.
- State applications of the Doppler effect.

With light – red shifts in the universe (evidence for the expanding universe)

- Explain red shifts.
- Use the Doppler effect to explain why we conclude that the universe is expanding.

Electrostatics (Grade 11)

Coulomb's law

- State Coulomb's law: The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the magnitudes of the charges and inversely proportional to the square of the distance (r) between them:
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in one dimension (1D) (restrict to three charges).
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in two dimensions (2D) – for three charges in a right-angled formation (limit to charges at the 'vertices of a right-angled triangle').

Electric field

- Describe an electric field as a region of space in which an electric charge experiences a force. The direction of the electric field at a point is the direction that a positive test charge would move if placed at that point.
- Draw electric field patterns for:
  - A single point charge
  - Two point charges
  - A charged sphere
- Define the electric field at a point: The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point.
  In symbols: $E = \frac{F}{q}$

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- Solve problems using the equation $E = \frac{F}{q}$.
- Calculate the electric field at a point due to a number of point charges, using the equation $E = \frac{kQ}{r^2}$ to determine the contribution to the field due to each charge. Restrict to three charges in a straight line.

Electric Circuits
(This section must be read in conjunction with the CAPS, p. 88–89 & 121.)

Ohm's law (Grade 11)
- State Ohm's law in words: The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
- Determine the relationship between current, voltage and resistance at constant temperature using a simple circuit.
- State the difference between ohmic conductors and non-ohmic conductors and give an example of each.
- Solve problems using $R = \frac{V}{I}$ for series and parallel circuits (maximum four resistors).

Power, energy (Grade 11)
- Define power as the rate at which work is done.
- Solve problems using $P = \frac{W}{\Delta t}$.
- Solve problems using $P = VI$, $P = I^2R$ or $P = \frac{V^2}{R}$.
- Solve circuit problems involving the concepts of power and electrical energy.
- Deduce that the kilowatt hour (kWh) refers to the use of 1 kilowatt of electricity for 1 hour.
- Calculate the cost of electricity usage given the power specifications of the appliances used as well as the duration if the cost of 1 kWh is given.

Internal resistance, series and parallel networks
- Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel (maximum four resistors).
- Explain the term internal resistance.
- Solve circuit problems using $\varepsilon = V_{load} + V_{internal\ resistance}$ or $\varepsilon = IR_{ext} + Ir$.
- Solve circuit problems, with internal resistance, involving series-parallel networks of resistors (maximum four resistors).

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Electrodynamics
(This section must be read in conjunction with the CAPS, p. 130–131.)

Electrical machines (generators, motors)
- State the energy conversion in generators.
- Use the principle of electromagnetic induction to explain how a generator works.
- Explain the functions of the components of an AC and a DC generator.
- State examples of the uses of AC and DC generators.
- State the energy conversion in motors.
- Use the motor effect to explain how a motor works.
- Explain the functions of the components of a motor.
- State examples of the use of motors.

Alternating current
- State the advantages of alternating current over direct current.
- Sketch graphs of voltage vs. time and current vs. time for an AC circuit.
- Define the term rms for an alternating voltage/current. The rms value of AC is the direct current/voltage, which dissipates the same amount of energy as AC.
- Solve problems using $I_{rms} = \frac{I_{max}}{\sqrt{2}}$, $V_{rms} = \frac{V_{max}}{\sqrt{2}}$.
- Solve problems using $P_{ave} = I_{rms}V_{rms} = \frac{1}{2} I_{max}V_{max}$ (for a purely resistive circuit), $P_{ave} = I^2_{rms}R$ and $P_{ave} = \frac{V^2_{rms}}{R}$.

Optical Phenomena and Properties of Materials
(This section must be read in conjunction with the CAPS, p. 132–133.)

Photo-electric effect
- Describe the photoelectric effect as the process whereby electrons are ejected from a metal surface when light of suitable frequency is incident on that surface.
- State the significance of the photoelectric effect.
- Define threshold frequency, f_o, as the minimum frequency of light needed to emit electrons from a certain metal surface.
- Define work function, W_o: The work function of a metal is the minimum energy that an electron in the metal needs to be emitted from the metal surface.
- Perform calculations using the photoelectric equation:
  $E = W_o + E_{kmax}$, where $E = hf$ and $W_o = hf_o$ and $E_{kmax} = \frac{1}{2} m(v_{max})^2$
- Explain the effect of intensity and frequency on the photoelectric effect.

Emission and absorption spectra
- Explain the formation of atomic spectra by referring to energy transition.
- Explain the difference between atomic absorption and emission spectra.

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3.2 PAPER 2: CHEMISTRY

Representing Chemical Change (Grade 10)
(This section must be read in conjunction with the CAPS, p. 37.)

Balanced chemical equations

- Write and balance chemical equations.
- Interpret balanced reaction equations in terms of:
  - o Conservation of atoms
  - o Conservation of mass (use relative atomic masses)

Quantitative Aspects of Chemical Change (Grade 11)
(This section must be read in conjunction with the CAPS, p. 82.)

Molar volume of gases

- 1 mole of any gas occupies 22,4 dm^3 at 0 °C (273 K) and 1 atmosphere (101,3 kPa).

Volume relationships in gaseous reactions

- Interpret balanced equations in terms of volume relationships for gases, i.e. under the same conditions of temperature and pressure, equal number of moles of all gases occupy the same volume.

Concentration of solutions

- Calculate the molar concentration of a solution.

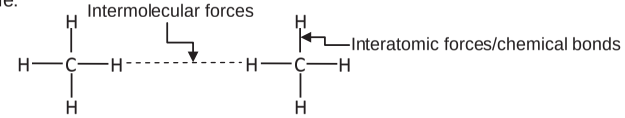
More complex stoichiometric calculations

- Determine the empirical formula and molecular formula of compounds.
- Determine the percentage yield of a chemical reaction.
- Determine percentage purity or percentage composition, e.g. the percentage $CaCO_3$ in an impure sample of seashells.
- Perform stoichiometric calculations based on balanced equations.
- Perform stoichiometric calculations based on balanced equations that may include limiting reagents.

Intermolecular Forces (Grade 11)
(This section must be read in conjunction with the CAPS, p. 71–73.)

Intermolecular and interatomic forces (chemical bonds)

- Name and explain the different intermolecular forces (Van der Waal's forces):
  - (i) Dipole-dipole forces:
    Forces between two polar molecules
  - (ii) Induced dipole forces or London forces:
    Forces between non-polar molecules
  - (iii) Hydrogen bonding:
    Forces between molecules in which hydrogen is covalently bonded to nitrogen, oxygen or fluorine – a special case of dipole-dipole forces
- Describe the difference between intermolecular forces and interatomic forces using a diagram of a group of small molecules; and in words.
  Example:



- State the relationship between intermolecular forces and molecular size. For non-polar molecules, the strength of induced dipole forces increases with molecular size.

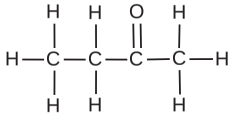
- Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.
  Boiling point:
  The temperature at which the vapour pressure equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
  Melting point:
  The temperature at which the solid and liquid phases of a substance are at equilibrium. The stronger the intermolecular forces, the higher the melting point.
  Vapour pressure:
  The pressure exerted by a vapour at equilibrium with its liquid in a closed system. The stronger the intermolecular forces, the lower the vapour pressure.

Organic Molecules
(This section must be read in conjunction with the CAPS, p. 104–116.)

- Define organic molecules as molecules containing carbon atoms.

Organic molecular structures – functional groups, saturated and unsaturated structures, isomers

- Write down condensed structural formulae, structural formulae and molecular formulae (up to 8 carbon atoms, one functional group per molecule) for:
  - o Alkanes (no ring structures)
  - o Alkenes (no ring structures)
  - o Alkynes
  - o Halo-alkanes (primary, secondary and tertiary haloalkanes; no ring structures)
  - o Alcohols (primary, secondary and tertiary alcohols)
  - o Carboxylic acids
  - o Esters
  - o Aldehydes
  - o Ketones
- Know the following definitions/terms:
  - o Molecular formula: A chemical formula that indicates the type of atoms and the correct number of each in a molecule.
    Example: C_4H_8O
  - o Structural formula: A structural formula of a compound shows which atoms are attached to which within the molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold the atoms together.

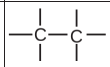
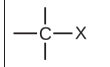
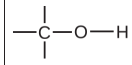
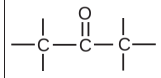
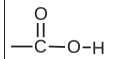
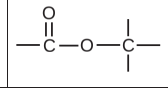


  - o Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.



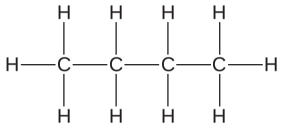
  - o Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.
  - o Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH_2 group
  - o Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains

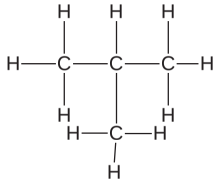
- Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains
- Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds

Homologous series	Structure of functional group	
	Structure	Name
Alkanes		Only C-H and C-C single bonds
Alkenes		Carbon-carbon double bond
Alkynes		Carbon-carbon triple bond
Haloalkanes	 (X = F, Cℓ, Br, I)	-
Alcohols		Hydroxyl group
Aldehydes		Formyl group
Ketones		Carbonyl group
Carboxylic acids		Carboxyl group
Esters		-

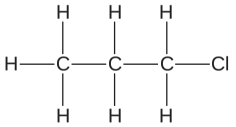
- Structural isomer: Organic molecules with the same molecular formula, but different structural formulae

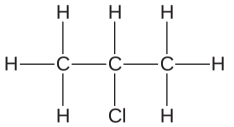
- Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.
- Restrict structural isomers to chain isomers, positional isomers and functional isomers.
  - Chain isomers: Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane

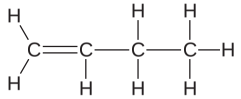

Butane

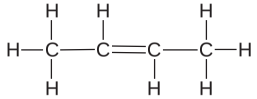

2-methylpropane

- Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene

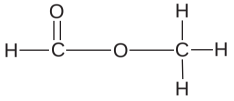

1-chloropropane

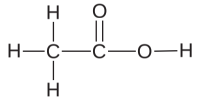

2-chloropropane


but-1-ene


but-2-ene

- Functional isomers: Same molecular formula, but different functional groups, e.g. methyl methanoate and ethanoic acid


methyl methanoate


ethanoic acid

IUPAC naming and formulae

- Write down the IUPAC name when given the structural formula or condensed structural formula for compounds from the homologous series above, restricted to one functional group per compound, except for haloalkanes. For haloalkanes, maximum two functional groups per molecule.
- Write down the structural formula when given the IUPAC name for the above homologous series.
- Identify alkyl substituents (methyl- and ethyl-) in a chain to a maximum of THREE alkyl substituents on the parent chain.
- When naming haloalkanes, the halogen atoms do not get preference over alkyl groups – numbering should start from the end nearest to the first substituent, either the alkyl group or the halogen. In haloalkanes, where e.g. a Br and a Cℓ have the same number when numbered from different ends of chain, Br gets alphabetical preference. When an alkyl group is a substituent in a molecule, it should be treated as a substituent.
- When writing IUPAC names, substituents appear as prefixes written alphabetically (bromo, chloro, ethyl, methyl), ignoring the prefixes di- and tri.

Structure and physical properties (boiling point, melting point, vapour pressure) relationships

- For a given example (from the above functional groups), explain the relationship between physical properties and:
  - Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
  - Type of functional groups
  - Chain length
  - Branched chains

Oxidation of alkanes
- State the use of alkanes as fuels.
- Write down an equation for the combustion of an alkane in excess oxygen.

Esterification
- Write down an equation, using structural formulae, for the formation of an ester.
- Name the alcohol and carboxylic acid used and the ester formed.
- Write down reaction conditions for esterification.

Substitution, addition and elimination reactions
- Identify reactions as elimination, substitution or addition.
- Write down, using structural formulae, equations and reaction conditions for the following addition reactions of alkenes:
  - Hydrohalogenation:
    The addition of a hydrogen halide to an alkene
  - Halogenation:
    The reaction of a halogen (Br_2, $C\ell_2$) with a compound
  - Hydration:
    The addition of water to a compound
  - Hydrogenation:
    The addition of hydrogen to an alkene
- Write down, using structural formulae, equations and reaction conditions for the following elimination reactions:
  - Dehydrohalogenation of haloalkanes:
    The elimination of hydrogen and a halogen from a haloalkane
  - Dehydration of alcohols:
    Elimination of water from an alcohol
  - Cracking of alkanes:
    The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules.
- Write down, using structural formulae, equations and reaction conditions for the following substitution reactions:
  - Hydrolysis of haloalkanes
    Hydrolysis: The reaction of a compound with water
  - Reactions of HX (X = Cℓ, Br) with alcohols to produce haloalkanes
  - Halogenation of alkanes
    The reaction of a halogen (Br_2, $C\ell_2$) with a compound

Plastics and polymers (ONLY BASIC POLYMERISATION as application of organic chemistry)
- Describe the following terms:
  Macromolecule: A molecule that consists of a large number of atoms
  Polymer: A large molecule composed of smaller monomer units covalently bonded to each other in a repeating pattern
  Monomer: Small organic molecules that can be covalently bonded to each other in a repeating pattern
  Polymerisation: A chemical reaction in which monomer molecules join to form a polymer
- Distinguish between addition polymerisation and condensation polymerisation:
  Addition polymerisation: A reaction in which small molecules join to form very large molecules by adding on at double bonds
  Addition polymer: A polymer formed when monomers (usually containing a double bond) combine through an addition reaction
  Condensation polymerisation: Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water

  Condensation polymer: A polymer formed by monomers with two functional groups that are linked together in a condensation reaction in which a small molecule, usually water, is lost
- Identify monomers from given addition polymers.
- Write down an equation for the polymerisation of ethene to produce polythene.
- State the industrial uses of polythene.

Energy and Change
(This section must be read in conjunction with the CAPS, p. 90–91.)

Energy changes in reactions related to bond energy changes
- Define heat of reaction (ΔH) as the energy absorbed or released in a chemical reaction.
- Define exothermic reactions as reactions that release energy.
- Define endothermic reactions as reactions that absorb energy.
- Classify (with reason) reactions as exothermic or endothermic.

Exothermic and endothermic reactions
- State that $\Delta H > 0$ for endothermic reactions, i.e. reactions in which energy is absorbed.
- State that $\Delta H < 0$ for exothermic reactions, i.e. reactions in which energy is released.

Activation energy
- Define activation energy as the minimum energy needed for a reaction to take place.
- Define an activated complex as the unstable transition state from reactants to products.
- Draw or interpret fully labelled sketch graphs (potential energy vs. course of reaction) of catalysed and uncatalysed endothermic and exothermic reactions.

Rate and Extent of Reaction
(This section must be read in conjunction with the CAPS, p. 123–124.)

Rates of reaction and factors affecting rate
- Define reaction rate as the change in concentration of reactants or products per unit time.
- Calculate reaction rate from given data.
  $\text{Rate} = \frac{\Delta c}{\Delta t}$ (Unit: $mol \cdot dm^{-3} \cdot s^{-1}$)
  Questions may also include calculations of rate in terms of change in mass/volume/moles/per time.
- List the factors that affect the rate of chemical reactions, i.e. nature of reacting substances, surface area, concentration, pressure for gases, temperature and the presence of a catalyst.
- Explain in terms of the collision theory how the various factors affect the rate of chemical reactions. The collision theory is a model that explains reaction rate as the result of particles colliding with a certain minimum energy to form products.

Measuring rates of reaction
- Answer questions and interpret data (tables or graphs) on different experimental techniques for measuring the rate of a given reaction.

Mechanism of reaction and of catalysis
- Define the term (positive) catalyst as a substance that increases the rate of a chemical reaction without itself undergoing a permanent change.

- Interpret graphs of distribution of molecular energies (number of particles against their kinetic energy also known as Maxwell-Boltzmann curves) to explain how a catalyst, temperature and concentration affect rate.
- Explain that a catalyst increases the rate of a reaction by providing an alternative path of lower activation energy. It therefore decreases the net activation energy.
- Use a graph showing the distribution of molecular energies (number of particles against their kinetic energy) to explain why only some molecules have enough energy to react, and hence how adding a catalyst and heating the reactants affects the rate.

Chemical Equilibrium
(This section must be read in conjunction with the CAPS, p. 125–126.)

Chemical equilibrium and factors affecting equilibrium

- Explain what is meant by:
  - Open and closed systems: An open system continuously interacts with its environment, while a closed system is isolated from its surroundings.
  - A reversible reaction: A reaction is reversible when products can be converted back to reactants.
  - Chemical equilibrium: It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction.
- List the factors that influence the position of an equilibrium, i.e. pressure (gases only), concentration and temperature.

Equilibrium constant

- List the factors that influence the value of the equilibrium constant, K_c.
- Write down an expression for the equilibrium constant, having been given the equation for the reaction.
- Perform calculations based on K_c values.
- Explain the significance of high and low values of the equilibrium constant.

Application of equilibrium principles

- State Le Chatelier's principle: When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance.
- Use Le Chatelier's principle to explain changes in equilibria qualitatively.
- Interpret graphs of equilibrium, e.g. concentration/rate/number of moles/mass/volume versus time.
- Explain the use of rate and equilibrium principles in the Haber process and the contact process.

Acids and Bases
(This section must be read in conjunction with the CAPS, p. 127–128.)

Acid-base reactions

- Define acids and bases according to Arrhenius and Lowry-Brønsted theories:
  Arrhenius theory: An acid is a substance that produces hydrogen ions (H^+) in water. A base produces hydroxide ions (OH^-) in water.
  Lowry-Brønsted theory: An acid is a proton (H^+ ion) donor. A base is a proton (H^+ ion) acceptor.
- Distinguish between strong acids/bases and weak acids/bases with examples.
  Strong acids ionise completely in water to form a high concentration of H_3O^+ ions. Examples of strong acids are hydrochloric acid, sulphuric acid and nitric acid.
  Weak acids ionise incompletely in water to form a low concentration of H_3O^+ ions. Examples of weak acids are ethanoic acid and oxalic acid.
  Strong bases dissociate completely in water.
  Examples of strong bases are sodium hydroxide and potassium hydroxide.
  Weak bases dissociate/ionise incompletely in water to form a low concentration of OH^- ions.

Examples of weak bases are ammonia, calcium carbonate, potassium carbonate, calcium carbonate and sodium hydrogen carbonate.

- Distinguish between concentrated acids/bases and dilute acids/bases.
  Concentrated acids/bases contain a large amount (number of moles) of acid/base in proportion to the volume of water.
  Dilute acids/bases contain a small amount (number of moles) of acid/base in proportion to the volume of water.
- Write down the reaction equations of aqueous solutions of acids and bases.
  Examples: $HC\ell(g) + H_2O(\ell) \rightarrow H_3O^+(aq) + C\ell^-(aq)$ ($HC\ell$ is a monoprotic acid.)
  $NH_3(g) + H_2O(\ell) \rightarrow NH_4^+(aq) + OH^-(aq)$
  $H_2SO_4(aq) + 2H_2O(\ell) \rightarrow 2H_3O^+(aq) + SO_4^{2-}(aq)$ (H_2SO_4 is a diprotic acid.)
- Identify conjugate acid-base pairs for given compounds. When the acid, HA, loses a proton, its conjugate base, A^-, is formed. When the base, A^-, accepts a proton, its conjugate acid, HA, is formed. These two are a conjugate acid-base pair.
- Describe a substance that can act as either acid or base as amphiprotic. Water is a good example of an amphoteric substance. Write equations to show how an amphoteric substance can act as acid or base.
- Write down neutralisation reactions of common laboratory acids and bases.
  Examples: $HC\ell(aq) + NaOH(aq)/KOH(aq) \rightarrow NaC\ell(aq)/KC\ell(aq) + H_2O(\ell)$
  $HC\ell(aq) + Na_2CO_3(aq) \rightarrow NaC\ell(aq) + H_2O(\ell) + CO_2(g)$
  $HNO_3(aq) + NaOH(aq) \rightarrow NaNO_3(aq) + H_2O(\ell)$
  $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$
  $(COOH)_2(aq) + NaOH(aq) \rightarrow (COO)_2Na_2(aq) + H_2O(\ell)$
  $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$
  NOTE: The above are examples of equations that learners will be expected to write from given information. However, any other neutralisation reaction can be given in a question paper and used to assess, e.g. stoichiometry calculations.
- Determine the approximate pH (equal to, smaller than or larger than 7) of salts in salt hydrolysis. Define hydrolysis as the reaction of a salt with water.
  - Hydrolysis of the salt of a weak acid and a strong base results in an alkaline solution, i.e. the pH > 7. Examples of such salts are sodium ethanoate, sodium oxalate and sodium carbonate.
  - Hydrolysis of the salt of a strong acid and a weak base results in an acidic solution, i.e. the pH < 7. An example of such a salt is ammonium chloride.
  - The salt of a strong acid and a strong base does not undergo hydrolysis and the solution of the salt will be neutral, i.e. pH = 7.
- Motivate the choice of a specific indicator in a titration. Choose from methyl orange, phenolphthalein and bromothymol blue. Define the equivalence point of a titration as the point at which the acid/base has completely reacted with the base/acid.
  Define the endpoint of a titration as the point where the indicator changes colour.
- Perform stoichiometric calculations based on titrations of a strong acid with a strong base, a strong acid with a weak base and a weak acid with a strong base. Calculations may include percentage purity.
- For a titration, e.g. the titration of oxalic acid with sodium hydroxide:
  - List the apparatus needed or identify the apparatus from a diagram.
  - Describe the procedure to prepare a standard oxalic acid solution.
  - Describe the procedure to conduct the titration.
  - Describe safety precautions.
  - Describe measures that need to be in place to ensure reliable results.
  - Interpret given results to determine the unknown concentration.
- Explain the pH scale as a scale of numbers from 0 to 14 used to express the hydrogen ion concentration.
- Calculate pH values of strong acids and strong bases.
- Define the concept of K_w as the equilibrium constant for the ionisation of water – the ionic product of water (ionisation constant of water).

- Explain the auto-ionisation of water, i.e. the reaction of water with itself to form H_3O^+ ions and OH^- ions.
- Interpret K_a values of acids to determine the relative strength of given acids. Interpret K_b values of bases to determine the relative strength of given bases.
- Compare strong and weak acids by looking at:
  - pH (monoprotic and diprotic acids)
  - Conductivity
  - Reaction rate

Electrochemical Reactions
(This section must be read in conjunction with the CAPS, p. 134–137.)

Electrolytic cells and galvanic cells

- Define the galvanic cell as a cell in which chemical energy is converted into electrical energy. A galvanic (voltaic) cell has self-sustaining electrode reactions.
- Define the electrolytic cell as a cell in which electrical energy is converted into chemical energy.
- Define oxidation and reduction in terms of electron (e^-) transfer:
  Oxidation is a loss of electrons. Reduction is a gain of electrons.
- Define oxidation and reduction in terms of oxidation numbers:
  Oxidation: An increase in oxidation number
  Reduction: A decrease in oxidation number
- Define an oxidising agent and a reducing agent in terms of oxidation and reduction:
  Oxidising agent: A substance that is reduced/gains electrons.
  Reducing agent: A substance that is oxidised/loses electrons.
- Define an anode and a cathode in terms of oxidation and reduction:
  Anode: the electrode where oxidation takes place
  Cathode: the electrode where reduction takes place
- Define an electrolyte as a substance of which the aqueous solution contains ions OR a substance that dissolves in water to give a solution that conducts electricity.
- Electrolysis: The chemical process in which electrical energy is converted to chemical energy OR the use of electrical energy to produce a chemical change.

Relation of current and potential difference to rate and equilibrium

- Give and explain the relationship between current in an electrolytic cell and the rate of the reaction.
- State that the potential difference of a galvanic cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium.
- State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction, namely V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which the $V_{cell} = 0$ (the cell is 'flat'). (Qualitative only. Nernst equation is NOT required.)

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Understanding of the processes and redox reactions taking place in galvanic cells

- Describe the movement of ions in the solutions.
- State the direction of electron flow in the external circuit.
- Write down the half-reactions that occur at the electrodes.
- State the function of the salt bridge.

  Use cell notation or diagrams to represent a galvanic cell.
  When writing cell notation, the following convention should be used:
  - The $H_2|H^+$ half-cell is treated just like any other half-cell.
  - Cell terminals (electrodes) are written on the outside of the cell notation.
  - Active electrodes:
    reducing agent | oxidised species || oxidising agent | reduced species
  - Inert electrodes (usually Pt or C):
    Pt | reducing agent | oxidised species || oxidising agent | reduced species | Pt
    Example: Pt | $C\ell^-(aq)$ |$C\ell_2(g)$ || $F_2(g)$ | $F^-(aq)$ | Pt
- Predict the half-cell in which oxidation will take place when two half-cells are connected.
- Predict the half-cell in which reduction will take place when connected to another half-cell.
- Write down the overall cell reaction by combining two half-reactions.
- Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell.
- Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions.

Standard electrode potentials

- Write down the standard conditions under which standard electrode potentials are determined.
- Describe the standard hydrogen electrode and explain its role as the reference electrode.
- Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values.

Understanding the processes and redox reactions taking place in electrolytic cells

- Describe the movement of ions in the solution.
- State the direction of electron flow in the external circuit.
- Write equations for the half-reactions taking place at the anode and cathode.
- Write down the overall cell reaction by combining two half-reactions.
- Describe, using half-reactions and the equation for the overall cell reaction as well as the layout of the particular cell using a schematic diagram, the following electrolytic processes:
  - The decomposition of copper(II) chloride
  - Electroplating, e.g. the electroplating of an iron spoon with silver/nickel
  - Refining copper
  - The electrolysis of a concentrated solution of sodium chloride and its use in the chlor-alkali industry
  - The recovery of aluminium metal from bauxite (South Africa uses bauxite from Australia.)
- Describe risks to the environment of the following electrolytic processes used industrially:
  - The production of chlorine (the chemical reactions of the chloro-alkali industry)
  - The recovery of aluminium metal from bauxite

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Chemical Industry
(This section must be read in conjunction with the CAPS, p. 138–140.)

The fertiliser industry (N, P, K)

- List, for plants:
  - Three non-mineral nutrients C, H and O and their sources, i.e. the atmosphere (CO_2) and rain (H_2O)
  - Three primary nutrients N, P and K and their sources
- Explain why fertilisers are needed.
- Explain the function of N, P and K in plants.
- Interpret the N : P : K fertiliser ratio and perform calculations based on the ratio.
- Describe/Explain/Write balanced equations and interpret flow diagrams of the following processes in the industrial manufacture of fertilisers:
  - N_2 – fractional distillation of air
  - H_2 – at SASOL from coal and steam
  - NH_3 – Haber process
  - HNO_3 – Ostwald process
  - H_2SO_4 – Contact process
  - NH_4NO_3; $(NH_4)_2SO_4$
- Evaluate the use of inorganic fertilisers on humans and the environment.
- Define eutrophication as the process by which an ecosystem, e.g. a river or dam, becomes enriched with inorganic plant nutrients, especially phosphorus and nitrogen, resulting in excessive plant (algae) growth. As plant growth becomes excessive, the amount of dead and decaying plant material increases rapidly.
- Discuss alternatives to inorganic fertilisers as used by some communities.

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5. MARKING GUIDELINES: PAPER 1

5.1 CALCULATIONS

5.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.
5.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.
5.1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
5.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.
5.1.5 **No penalisation if zero substitutions are omitted** in calculations where **correct formula/principle is given correctly**.
5.1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
5.1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
5.1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
5.1.9 Final answers to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
5.1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
5.1.11 Questions in which a series of calculations have to be made (e.g. a circuit-diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded, provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.

5.2 UNITS

5.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
5.2.2 Units are only required in the final answer to a calculation.
5.2.3 Marks are only awarded for an answer, and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

5.2.4 SI units must be used, except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this.

5.3 GENERAL

5.3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
5.3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.
5.3.3 Separate compound units with a multiplication dot, not a full stop, e.g. $m \cdot s^{-1}$. For marking purposes, $m.s^{-1}$ and m/s will also be accepted.

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5.4 POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

5.4.1 **Subquestion to subquestion:** When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (3.2 or 3.3), **full marks** are to be awarded for the subsequent subquestions.

5.4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

5.5 NEGATIVE MARKING

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for, for example, QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 should be considered.

6. MARKING GUIDELINES: PAPER 2

6.1 CALCULATIONS

6.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.

6.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

6.1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

6.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.
Example: No K_c expression, correct substitution:

$K_c = \frac{(2)^2}{(2)(1)^3}$ ✓ $= 2$ ✓ $(\frac{2}{3})$

6.1.5 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer has been given.

6.1.6 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

6.1.7 The final answer to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.

6.1.8 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

6.1.9 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.

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Example:

CORRECT	ANSWER (1)	POSSIBLE	ANSWER (2)	POSSIBLE
$n=\frac{m}{M}$ ✓ $0,01$✓ $= \frac{m}{52}$ ✓ $m = 0,52$ g ✓ (4)	$n=\frac{m}{M}$ ✓ $0,01$ ✓$= \frac{52}{m}$ × $m = 5\ 200$ g × (2)	$m=\frac{n}{M}$ × $= \frac{0,01}{52}$ $= 0,002$ g (0)	$n=\frac{m}{M}$ ✓ $m=\frac{M}{n}$ × $=\frac{52}{0,01}$ ✓ $= 5\ 200$ g× (3)	$n=\frac{m}{M}$ ✓ $= 0,52$ g ✓ (2)

6.2 UNITS

6.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.

6.2.2 Units are only required in the final answer to a calculation.

6.2.3 Marks are only awarded for an answer and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

6.2.4 Separate compound units with a multiplication dot, not a full stop, for example $mol \cdot dm^{-3}$. Accept $mol.dm^{-3}$ (or mol/dm^3) for marking purposes.

6.3 GENERAL

6.3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

6.3.2 When a chemical **FORMULA** is asked, and the **NAME** is given as answer, the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA** is given.

6.3.3 When redox half-reactions are to be written, the correct arrow should be used.
If the equation

$H_2S \rightarrow S + 2H^+ + 2e^-$ $(\frac{2}{2})$

is the correct answer, the marks must be given as follows:

$H_2S \rightleftharpoons S + 2H^+ + 2e^-$ $(\frac{1}{2})$

$H_2S \leftarrow S + 2H^+ + 2e^-$ $(\frac{0}{2})$

$S + 2H^+ + 2e^- \leftarrow H_2S$ $(\frac{2}{2})$

$S + 2H^+ + 2e^- \rightleftharpoons H_2S$ $(\frac{0}{2})$

6.3.4 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, do not accept the following:
- Stating the position of a substance on Table 4 only (e.g. Cu is above Mg).
- Using relative reactivity only (e.g. Mg is more reactive than Cu).
- The correct answer would be for instance: Mg is a stronger reducing agent than Cu, and therefore Mg will be able to reduce Cu^{2+} ions to Cu. The answer can also be given in terms of the relative strength as electron acceptors and donors.

6.3.5 One mark is forfeited when the charge of an ion is omitted per equation (not for the charge on an electron).

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6.3.6 The error-carrying principle does not apply to chemical equations or half-reactions. For example, if a learner writes the wrong oxidation/reduction half-reaction in the subquestion and carries the answer to another subquestion (balancing of equations or calculation of E^{θ}_{cell}), then the learner will not be credited for this substitution.

6.3.7 In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks will be deducted if hydrogen atoms are omitted.

6.3.8 When a structural formula is required, marks will be deducted if the candidate writes the condensed formula.

6.3.9 When a IUPAC name is asked and the candidate omits the hyphen (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks will be forfeited.

6.3.10 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.
If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or product(s). If only a reactant(s) or only a product(s) is/are written, without an arrow, no marks are awarded for the reactant(s) or product(s).

Examples:

$N_2 + 3H_2$ ✓$\rightarrow 2NH_3$ ✓ bal. ✓	$\frac{3}{3}$
$N_2 + H_2 \rightarrow$✓	$\frac{1}{3}$
$\rightarrow NH_3$ ✓	$\frac{1}{3}$
$N_2 + H_2$	$\frac{0}{3}$
NH_3	$\frac{0}{3}$

6.4 POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

6.4.1 **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. QUESTION 3.1) and needs to be substituted in another (QUESTION 3.2 or QUESTION 3.3), e.g. if the answer for QUESTION 3.1 is incorrect and is substituted correctly in QUESTION 3.2 or QUESTION 3.3, **full marks** are to be awarded for the subsequent subquestions.

6.4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

6.5 NEGATIVE MARKING

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for e.g. QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 could be considered.

7. CONCLUSION

This Examination Guidelines document is meant to articulate the assessment aspirations espoused in the CAPS document. It is therefore not a substitute for the CAPS document which teachers should teach to.

Qualitative curriculum coverage as enunciated in the CAPS cannot be over-emphasised.

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PHYSICS DATA SHEETS

Conventions (e.g. signs, symbols, terminology and nomenclature)
The syllabus and question papers will conform to generally accepted international practices.

NOTE:
1. For marking purposes, alternative symbols will also be accepted.
2. Separate compound units with a multiplication dot, not a full stop, e.g. $m \cdot s^{-1}$.
   For marking purposes, $m.s^{-1}$ will also be accepted.
3. Use the equal sign only when it is mathematically correct, e.g.
   Incorrect: 1 cm = 1 m (on a scale drawing)
   Correct: 1 cm = 10^{-2} m 1 cm represents 1 m (on a scale drawing)

4.2 INFORMATION SHEETS – PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant	h	6,63 x 10^{-34} J·s
Coulomb's constant	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron	e	-1,6 x 10^{-19} C
Electron mass	m_e	9,11 x 10^{-31} kg

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ OR $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = E_P = mgh$
$K = E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ OR $E = h\frac{c}{\lambda}$
$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$R_s = R_1 + R_2 + \ldots$	emf (ε) = I(R + r)
Q = IΔt	W = Vq = VIΔt = $I^2R\Delta t = \frac{V^2\Delta t}{R}$
$P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$	

ALTERNATING CURRENT

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms} = I_{rms}^2R = \frac{V_{rms}^2}{R}$

PHYSICS PAPER 1 PRACTICE

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2023

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following quantities is the tendency of an object to resist a change to its state of motion?

A Inertia

B Impulse

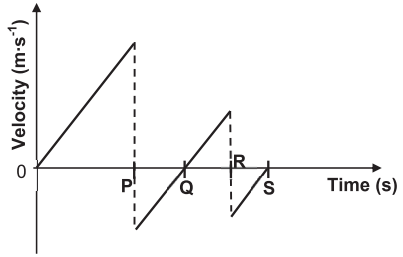
C Momentum

D Acceleration (2)

1.2 A ball is dropped from rest at a height above a concrete floor. The ball strikes the floor and bounces vertically up and down on the same spot on the floor.

The velocity-time graph for the bouncing ball is shown below, with points **P**, **Q**, **R** and **S** representing different times during the motion.

Ignore the effects of air resistance.



At which time does the ball reach its maximum height after the first upward bounce?

A **P**

B **Q**

C **R**

D **S** (2)

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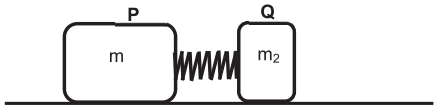
.3 Two blocks, **P** and **Q**, of masses m and m_2 respectively, are held at rest on a frictionless horizontal floor with a compressed spring between them, as shown below.



When the blocks are released and the spring drops to the floor, block **Q** moves to the right with velocity **v**.

Which ONE of the following represents the momentum of block **P** after the blocks are released?

A m **v** to the right

B m_2**v** to the right

C m **v** to the left

D m_2**v** to the left (2)

.4 The magnitude of the gravitational force that spheres **X** and **Y** exert on each other is **F**.

The mass of sphere **X** is now doubled while the mass of sphere **Y** and the distance between the centres of the spheres remain the same.

Which ONE of the following combinations is CORRECT for the magnitude of the forces that the spheres now exert on each other?

	FORCE THAT X EXERTS ON Y	FORCE THAT Y EXERTS ON X
A	**F**	**F**
B	**F**	2**F**
C	2**F**	**F**
D	2**F**	2**F**

(2)

1.5 A hot-air balloon is moving vertically downwards at a CONSTANT SPEED. Assume that the mass of the hot-air balloon remains constant.

Which ONE of the following physical quantities associated with the hot-air balloon changes during the motion?

A Weight

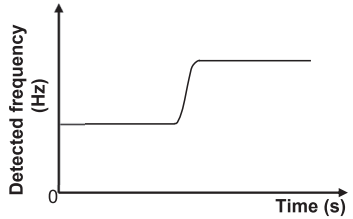
B Momentum

C Kinetic energy

D Potential energy (2)

1.6 A learner standing at a roadside records the frequency of sound waves produced by the siren of an ambulance. The ambulance is moving at constant velocity along a straight horizontal road.

The frequency-time graph for the detected sound is shown below.



Which ONE of the following statements concerning the motion of the ambulance is CORRECT?

The ambulance …

A approaches the learner and then passes the learner.

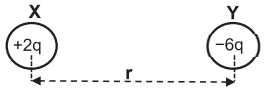
B moves away from the learner, then turns and approaches the learner.

C approaches the learner, then turns and moves away from the learner.

D moves away from the learner and then stops. (2)

1.7 Two identically charged spheres, **X** and **Y**, carry charges of +2q and −6q respectively.

Sphere **X** experiences an electrostatic force **F** to the right when the distance between their centres is **r**.



The spheres are brought into contact and are then returned to their original positions.

Which ONE of the following represents the magnitude of the electrostatic force that sphere **X** experiences now?

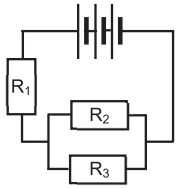
A $\frac{1}{4}$**F**

B $\frac{1}{3}$**F**

C 4 **F**

D 12 **F** (2)

1.8 In the circuit diagram below, R_1, R_2 and R_3 are identical resistors. The battery has negligible internal resistance.



The power dissipated by R_1 is **P**.

Which ONE of the following is the power dissipated by R_2?

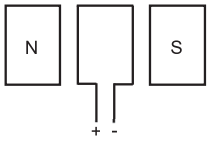
A $\frac{1}{4}$**P**

B $\frac{1}{2}$**P**

C 2 **P**

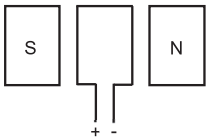
D 4 **P** (2)

1.9 The simplified diagram below represents a DC motor.

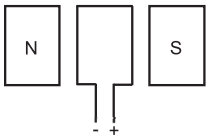


The diagrams below indicate some changes made to the above motor.

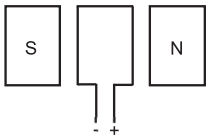
(i)



(ii)



(iii)



Which of the changes to the motor above will change the original direction of rotation of the coil?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (iii) only (2)

1.10 An atom has a ground state energy of **x**. When the atom moves to a higher energy state **y**, a line spectrum is observed.

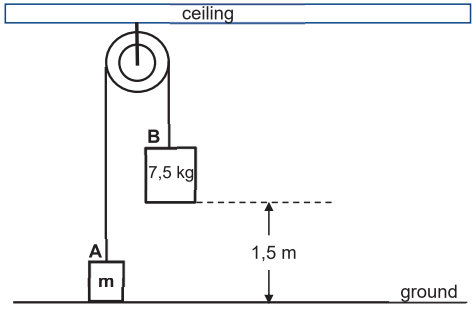
Which ONE of the following combinations is CORRECT for the ENERGY CHANGE of the atom and the TYPE OF LINE SPECTRUM observed during the transition?

	ENERGY CHANGE	TYPE OF LINE SPECTRUM
A	**y – x**	Emission
B	**x – y**	Emission
C	**x – y**	Absorption
D	**y – x**	Absorption

(2)
[20]

QUESTION 2 (Start on a new page.)

Block **A** of mass **m** is connected to block **B** of mass 7,5 kg by a light inextensible rope passing over a frictionless pulley. Block **B** is initially held at a height of 1,5 m above the ground, while block **A** is initially stationary on the ground, as shown in the diagram below.



When block **B** is released, it moves vertically downwards and strikes the ground with a velocity of 3,41 $m \cdot s^{-1}$.

Ignore the effects of friction.

2.1 Show, by means of a calculation, that the magnitude of the acceleration of block **B** was 3,88 $m \cdot s^{-2}$ while the block was moving vertically downwards. (3)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on block **B** immediately after it was released. (2)

2.3 State Newton's Second Law of Motion in words. (2)

2.4 Calculate the value of **m** by applying Newton's Second Law to EACH BLOCK while they are in motion. (5)

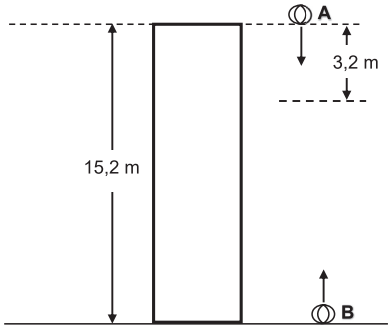
2.5 Calculate the maximum height above the ground reached by block **A**. (5)
[17]

QUESTION 3 (Start on a new page.)

Ball **A** is dropped from rest from the top of a building 15,2 m high.

After ball **A** has fallen 3,2 m, a second ball **B** is projected vertically upwards from the ground. After a while, the two balls strike the ground at the SAME time.

Ignore the effects of air resistance.



3.1 Define the term *free fall.* (2)

3.2 Calculate the:

3.2.1 Time taken for ball **A** to strike the ground (3)

3.2.2 Magnitude of the velocity with which ball **B** was projected from the ground (5)

3.3 On the same system of axes, draw position-time graphs to show the motions of both ball **A** and ball **B** from the instant ball **A** is dropped until the time it reaches the ground.

Take the ground as the zero position.

Label the graphs **A** and **B**.

Clearly indicate the following on the graphs:

- The starting time for each ball
- The initial position of each ball
- The time when the balls strike the ground (5)

[15]

QUESTION 4 (Start on a new page.)

Trolley **A** of mass 7,2 kg moves to the right at 0,4 $m \cdot s^{-1}$ in a straight line on a horizontal floor. It collides with a stationary trolley **B** of mass 5,3 kg.

After the collision, the trolleys lock together and move to the right, as shown in the diagram below.

Ignore any frictional effects.



4.1 State the *principle of conservation of linear momentum* in words. (2)

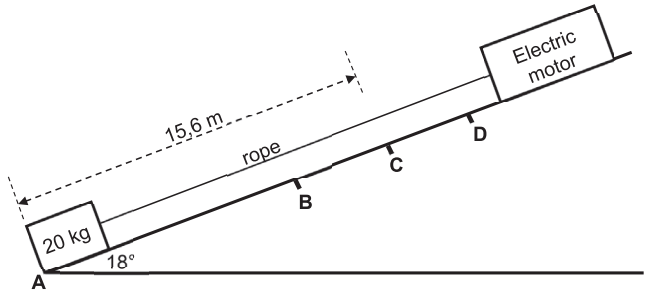
4.2 Calculate the magnitude of the:

4.2.1 Velocity of the trolleys immediately after the collision (3)

4.2.2 Average net force exerted by trolley **A** on trolley **B** during the collision, if the collision time is 0,02 s (3)
[8]

QUESTION 5 (Start on a new page.)

An electric motor pulls a 20 kg crate from rest at point **A** up an inclined plane by means of a light inextensible rope. The inclined plane makes an angle of 18° with the horizontal. **B**, **C** and **D** are points on the inclined plane and the distance between points **A** and **C** is 15,6 m, as shown in the diagram below.



The motor exerts a constant force of 96,8 N parallel to the inclined plane on the rope.

A constant frictional force of 13,5 N acts on the crate as it is moves on the inclined plane.

5.1 Define a *non-conservative force*. (2)

5.2 Use ENERGY PRINCIPLES to calculate the speed of the crate when it reaches point **C**. (5)

5.3 Calculate the minimum average power dissipated by the electric motor to pull the crate from point **A** to point **C**. (3)

When the crate reaches point **C**, the rope breaks. The crate continues moving up the inclined plane, comes to a stop at point **D**, and then slides down the plane past point **B**.

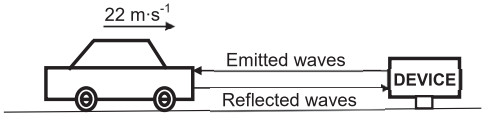
5.4 Draw a labelled free-body diagram for the crate as it slides down the plane past point **B**. (3)

5.5 Draw a velocity-time graph for the entire motion of the crate starting from point **A** until it passes point **B** again on its motion down the inclined plane. (4)
[17]

QUESTION 6 (Start on a new page.)

6.1 A car moves at a constant velocity of 22 $m \cdot s^{-1}$ on a straight horizontal road TOWARDS a stationary device, which can both emit and detect sound waves.

The device emits sound waves with a frequency of 24 000 Hz. These sound waves are reflected off the car and the reflected sound waves are then detected by the device, as shown in the diagram below.



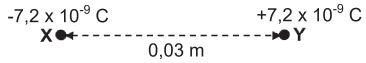
6.1.1 State the *Doppler effect* in words. (2)

6.1.2 If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the frequency of the reflected sound waves detected by the device. (6)

6.2 The spectral lines observed for a distant star show that the star is moving away from Earth. Explain, by referring to frequency, how one can deduce that the star is moving away from Earth. (2)
[10]

QUESTION 7 (Start on a new page.)

Two point charges, **X** and **Y**, are held 0,03 m apart, as shown in the diagram below. The charge of **X** is -7,2 x 10^{-9} C, while the charge of **Y** is +7,2 x 10^{-9} C.

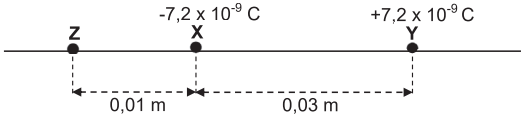


7.1 State Coulomb's law in words. (2)

7.2 Draw the net electric field pattern due to the two point charges. (3)

7.3 Calculate the magnitude of the electrostatic force that **Y** exerts on **X**. (3)

A third point charge, **Z**, of unknown positive charge, is positioned 0,01 m to the left of point charge **X** on the line joining point charges **X** and **Y**, as shown in the diagram below.



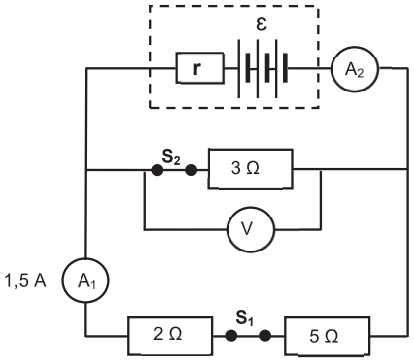
7.4 Draw a labelled vector diagram to show the directions of the electric fields at the point where **X** is positioned. (2)

7.5 The magnitude of the resultant electric field at the point where **X** is positioned is 4,91 x 10^{5} $N \cdot C^{-1}$.

Calculate the magnitude of charge **Z**. (5)
[15]

QUESTION 8 (Start on a new page.)

A battery with unknown emf (**ε**) and unknown internal resistance (**r**) is connected to three resistors, a high-resistance voltmeter, two switches and two ammeters of negligible resistance, as shown below.



8.1 State Ohm's law in words. (2)

Both switch **S_1** and switch **S_2** are CLOSED. The reading on ammeter **A_1** is 1,5 A.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

8.2.2 Reading on ammeter **A_2** (4)

8.2.3 Power dissipated in the 3 Ω resistor (3)

Switch **S_1** is now OPENED, while switch **S_2** remains CLOSED. The reading on ammeter **A_2** is now 3,64 A.

8.3 Calculate the emf of the battery. (5)

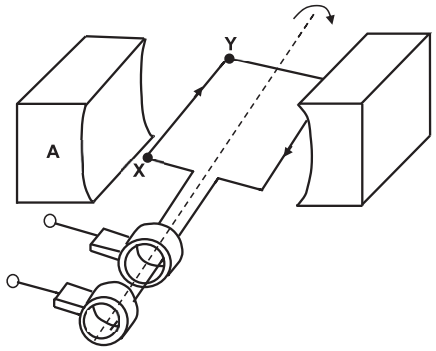
Switch **S_2** is now OPENED, while switch **S_1** is CLOSED.

8.4 How does the voltmeter reading change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer. (4)
[21]

QUESTION 9 (Start on a new page.)

9.1 The simplified sketch below represents an AC generator with the coil initially horizontal between the poles of a magnet. **X** and **Y** are two points on the coil, while **A** is one of the poles of the magnet.



When the coil of the generator rotates clockwise between the two poles of the magnet, the direction of the induced current is from **X** to **Y**, as shown above.

9.1.1 Is **A** the NORTH POLE or the SOUTH POLE of the magnet? (1)

9.1.2 The coil is now rotated through 180°.

Will the direction of the current be from **X** to **Y** or from **Y** to **X**? (1)

9.1.3 Sketch an emf-time graph for TWO complete rotations of the coil, starting from the position of the coil as shown in the diagram above. (3)

9.2 An electrical device is connected to an AC generator. The rms potential difference across the device is 200 V and the maximum current passing through the device is 6 A.

Calculate the:

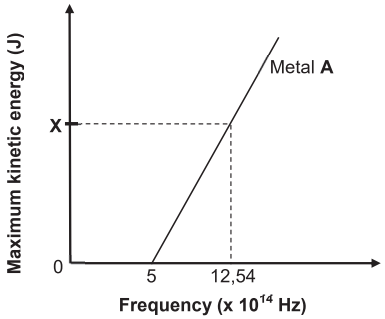
9.2.1 Resistance of the device (4)

9.2.2 Energy consumed by the device in two hours (4)
[13]

Q ESTION 10 (Start on a new page.)

In a photoelectric investigation, light of different frequencies was radiated on each of two metals, **A** and **B**. The graph of maximum kinetic energy of the ejected electrons from metal **A** and the frequency of the incident photons is shown below.

Point **X** on the graph represents an unknown maximum kinetic energy.



10.1 Write down the numerical value of the gradient of the graph. (1)

10.2 Define the term *work function*. (2)

10.3 Calculate the:

10.3.1 Work function of metal **A** (3)

10.3.2 Value of **X** shown on the graph (4)

10.4 How will EACH of the following be affected if light of frequency 12,54 x 10^{14} Hz, but of higher intensity, is used?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The value of **X** (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

Metal **B** has a larger work function than metal **A**.

10.5 Redraw the graph above in your ANSWER BOOK. (Do NOT include values on the axes.) Label this graph as **A**.

On the SAME set of axes, sketch the graph for metal **B**. Label this graph as **B**. (2)
[14]

TOTAL: 150

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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 3 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following combinations consists of only SCALAR quantities?

A Velocity, speed and time

B Time, distance and speed

C Acceleration, speed and distance

D Displacement, velocity and acceleration (2)

1.2 The acceleration due to gravity on Earth is g.

Which ONE of the following represents the acceleration due to gravity on a planet that has TWICE the mass and HALF the radius of the Earth?

A $\frac{1}{2}g$

B $2g$

C $4g$

D $8g$ (2)

1.3 A ball is projected vertically upwards from the ground and reaches its maximum height after a while.

Ignore the effects of air friction.

How will the ACCELERATION and TOTAL MECHANICAL ENERGY of the ball at its maximum height compare to that immediately after it was projected?

	ACCELERATION	TOTAL MECHANICAL ENERGY
A	Equal to	Equal to
B	Greater than	Smaller than
C	Equal to	Greater than
D	Smaller than	Equal to

(2)

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1.4 A car travels at CONSTANT VELOCITY along a horizontal road. A constant frictional force acts on the car during its motion.

Which ONE of the following statements about the power dissipated by the engine of the car during the motion is CORRECT?

The power …

A is zero.

B increases.

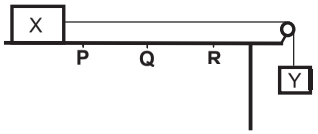
C decreases.

D remains constant. (2)

1.5 Block X is placed on a horizontal table and is connected to block Y by a light inextensible string passing over a frictionless pulley, as shown below.

A constant frictional force acts on block X while it moves to the right.

P, **Q** and **R** are points on the table such that the distance from **P** to **Q** is equal to that from **Q** to **R**.



When block X reaches point **Q**, the string is cut and block X continues to move towards point **R**. Ignore the effect of air friction.

Consider the following statements:

(i) The work done by the frictional force acting on block X is greater when the block moves from point **P** to point **Q** than when the block moves from point **Q** to point **R**.

(ii) Both the momentum and kinetic energy of block X decrease when the block moves from point **Q** to point **R**.

(iii) The total mechanical energy of block X remains constant when the block moves from point **Q** to point **R**.

Which of the statements above is/are CORRECT as block X moves from point **Q** to point **R**?

A (i) only

B (ii) only

C (i) and (ii) only

D (ii) and (iii) only (2)

1.6 Light emitted from a distant star contains a spectral line X of frequency *f*. The spectral lines of this star when observed on Earth are red shifted.

Which ONE of the following combinations of the OBSERVED FREQUENCY of spectral line X and the MOTION OF THE STAR is CORRECT?

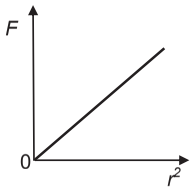
	OBSERVED FREQUENCY	**MOTION OF THE STAR**
A	Greater than *f*	Away from Earth
B	Greater than *f*	Towards Earth
C	Smaller than *f*	Away from Earth
D	Smaller than *f*	Towards Earth

(2)

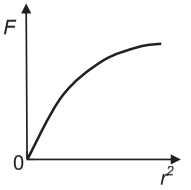
1.7 A proton and an electron are a distance r apart. The magnitude of the electrostatic force that they exert on each other is F.

Which ONE of the following graphs shows the relationship between F and r^2 as the proton and the electron approach each other?

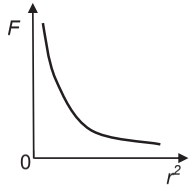
A



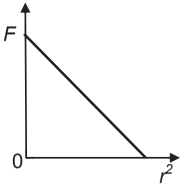
B



C

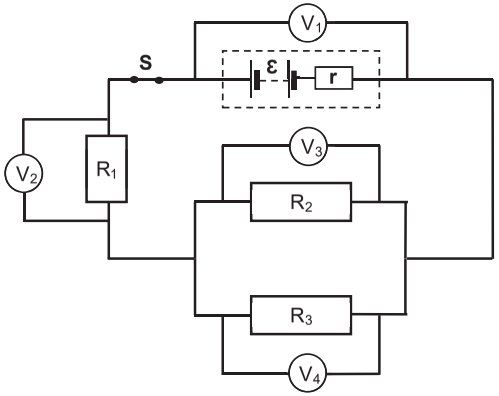


D



(2)

1.8 The emf of a battery is **ε** and its internal resistance is **r**. The battery is connected to three resistors and four voltmeters, as shown below. The resistance of the conducting wires is negligible, while the voltmeters have very high resistances.



Which ONE of the following equations represents the reading on voltmeter V_1 in terms of the readings on the other voltmeters?

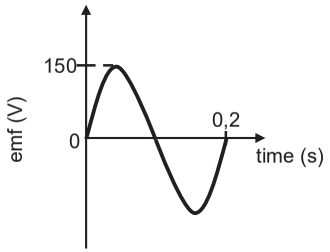
A $V_1 = V_2 + V_3$

B $V_1 = V_2 + \frac{1}{2}V_3$

C $V_1 = V_2 + V_3 + V_4$

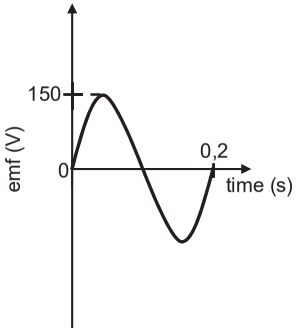
D $V_1 = V_2 + 2V_3$ (2)

1.9 An AC generator consists of a coil which is rotated in a magnetic field. The emf time graph for one complete rotation of the coil is shown below.

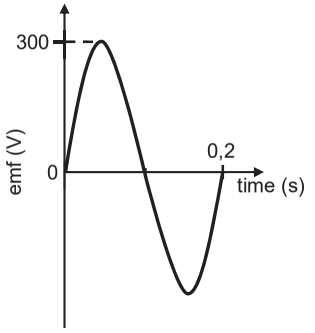


If the speed of rotation of the coil is now DOUBLED, which ONE of the following graphs is CORRECT for one complete rotation of the coil?

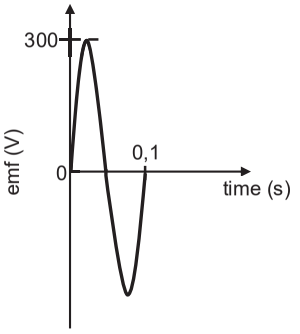
A



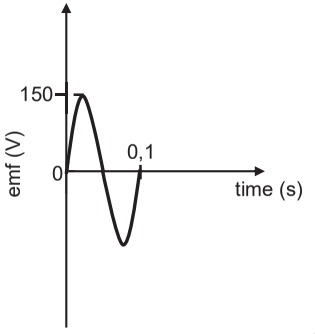
B



C

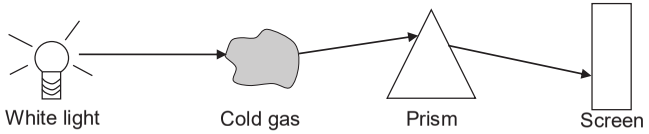


D



(2)

1.10 White light is passed through a cold gas and then through a prism, as shown below. A line spectrum is observed on the screen.



Which ONE of the following correctly describes the ENERGY TRANSITION of the atoms of the gas and the TYPE OF LINE SPECTRUM observed on the screen?

	ENERGY TRANSITION	TYPE OF LINE SPECTRUM
A	Higher to lower energy level	Emission
B	Lower to higher energy level	Emission
C	Higher to lower energy level	Absorption
D	Lower to higher energy level	Absorption

(2)
[20]

QUESTION 2 (Start on a new page.)

Crate **P** of mass 1,25 kg is connected to another crate, **Q**, of mass 2 kg by a light inextensible string. The two crates are placed on a rough horizontal surface. A constant force **F** of magnitude 7,5 N, acting at angle θ to the horizontal, is applied on crate **Q**, as shown in the diagram below.

The crates accelerate at 0,1 $m \cdot s^{-2}$ to the right.



Crate **P** experiences a constant frictional force of 1,8 N and crate **Q** experiences a constant frictional force of 2,2 N.

2.1 State Newton's Second Law of Motion in words. (2)

2.2 Draw a labelled free-body diagram for crate **P**. (4)

2.3 Calculate the magnitude of:

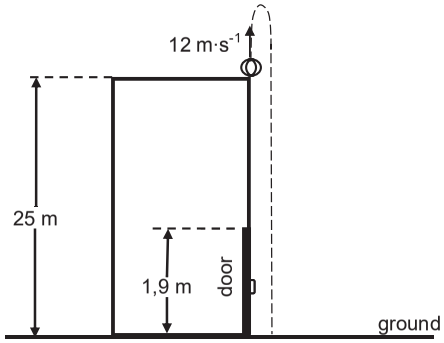
2.3.1 The tension in the string (4)

2.3.2 Angle θ (3)
[13]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards from the top of a building of height 25 m with a velocity of 12 m·s^{-1}. On its way down, the ball passes a door which has a height of 1,9 m and then strikes the ground, as shown in the diagram below.

Ignore the effects of air friction.



3.1 Define the term *free fall*. (2)

3.2 Calculate the:

3.2.1 Time taken for the ball to reach its maximum height (3)

3.2.2 Velocity with which the ball strikes the ground (4)

3.2.3 Time it took the ball to move from the top of the door to the ground (4)

3.3 Draw a velocity versus time graph for the motion of the ball from the moment that the ball is thrown upwards until it strikes the ground. Use the ground as zero reference.

Clearly indicate the following on your graph:

- The velocity with which the ball was thrown upwards
- Time taken by the ball to reach its maximum height
- The velocity with which the ball strikes the ground (3)

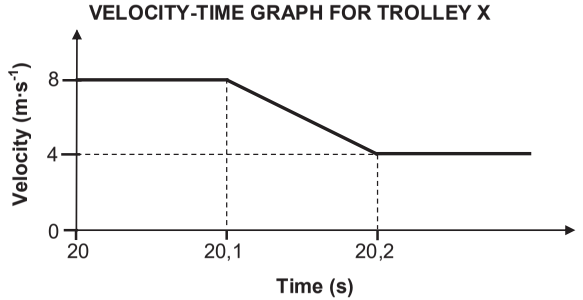
[16]

QUESTION 4 (Start on a new page.)

Trolley X of mass 1,2 kg travels at 8 m·s^{-1} east and collides with trolley Y of mass 0,5 kg which is initially at rest.

Ignore all frictional effects.

The velocity-time graph below shows the velocity of trolley X before, during and after the collision with trolley Y.



4.1 State the *principle of conservation of linear momentum*. (2)

4.2 Calculate the magnitude of the:

4.2.1 Velocity of trolley Y immediately after the collision (4)

4.2.2 Average net force that trolley X exerts on trolley Y during the collision (3)

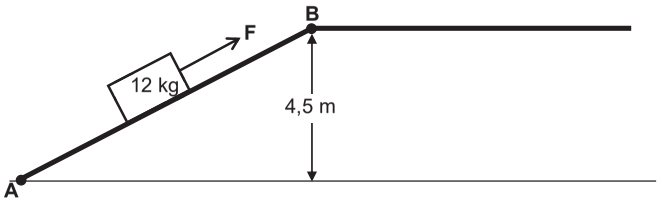
4.3 Is the collision ELASTIC or INELASTIC?

Explain the answer by means of suitable calculations. (5)

[14]

QUESTION 5 (Start on a new page.)

A 12 kg block is initially at rest at point **A** at the bottom of a ROUGH inclined plane. The block is pulled up the incline by a constant force **F** acting parallel to the incline. The block reaches point **B**, which is at a vertical height of 4,5 m above the horizontal, with a speed of 2,25 $m \cdot s^{-1}$. See the diagram below.

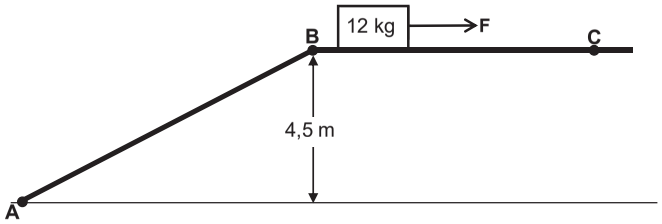


5.1 Define the term *non-conservative force.* (2)

5.2 Draw a labelled free-body diagram for the block when it is pulled up the inclined plane. (4)

5.3 Calculate the total work done on the block by the NON-CONSERVATIVE forces when the block moved from point **A** to point **B**. (4)

The same constant force **F** now moves the block at a CONSTANT VELOCITY across a rough horizontal surface from point **B** to point **C**, as shown below. Force **F** acts parallel to the horizontal surface.



The magnitude of the constant frictional force acting on the block while moving from point **B** to point **C** is 42 N LARGER than the magnitude of the constant frictional force acting on the block when it moves from point **A** to point **B**.

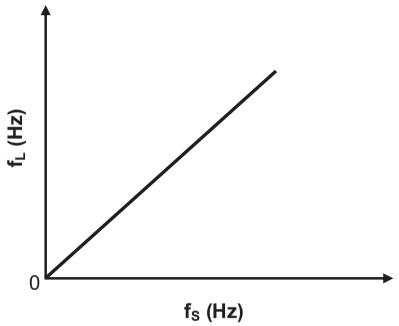
5.4 Calculate the distance from point **A** to point **B**. (5)
[15]

QUESTION 6 (Start on a new page.)

A learner investigates the relationship between the observed frequency and the frequency of sound waves emitted by a stationary source.

The learner moves towards the source at a constant velocity and records the observed frequency (f_L) for a given source frequency (f_S) . This process is repeated for different frequencies of the source, with the learner moving at the same constant velocity each time.

The graph below shows how the observed frequency changes as the frequency of sound waves emitted by the source changes.



6.1 Name the phenomenon illustrated by the graph. (1)

6.2 Name ONE application in the medical field of the phenomenon in QUESTION 6.1. (1)

6.3 Write down the type of proportionality that exists between f_L and f_S, as illustrated by the graph. (1)

6.4 The gradient of the graph obtained is found to be 1,06.

If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the magnitude of the velocity at which the learner approaches the source. (5)

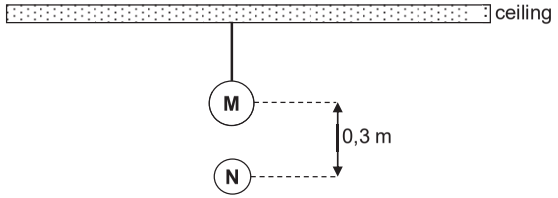
The investigation is now repeated with the learner moving at a HIGHER constant velocity towards the sound source.

6.5 Copy the graph above in your ANSWER BOOK and label it as **A**. On the same set of axes, sketch the graph that will be obtained when the learner is moving at the HIGHER velocity. Label this graph as **B**. (2)
[10]

QUESTION 7 (Start on a new page.)

A charged sphere **M** is suspended from a ceiling by a light inextensible, insulated string.

Another charged sphere **N**, of mass 2,04 x 10^{-3} kg and carrying a charge of + 8,6 x 10^{-8} C, hangs STATIONARY vertically below sphere **M**. The centres of the spheres are 0,3 m apart, as shown in the diagram below.



7.1 State Coulomb's law in words. (2)

7.2 State whether the charge on sphere **M** is POSITIVE or NEGATIVE. (1)

7.3 Draw a labelled free-body diagram for sphere **N**. (2)

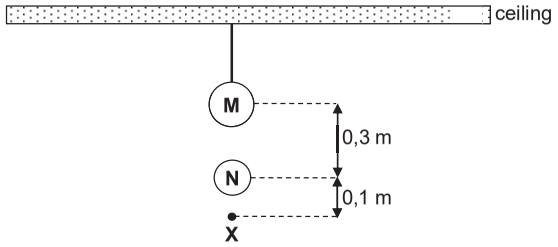
7.4 Calculate the magnitude of the charge on sphere **M**. (5)

7.5 How does the electrostatic force that sphere **M** exerts on sphere **N** compare to that exerted by sphere **N** on sphere **M** with respect to:

7.5.1 Magnitude (1)

7.5.2 Direction (1)

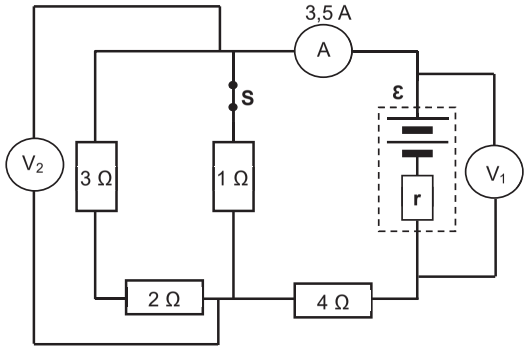
Point **X** is 0,1 m vertically below the centre of sphere **N**, as shown below.



7.6 Calculate the net electric field at point **X**. (5)
[17]

QUESTION 8 (Start on a new page.)

The circuit diagram below shows four resistors connected to a battery of emf **ε** and internal resistance **r**. The resistances of the ammeter and the connecting wires are negligible, while the voltmeters have very high resistances.



8.1 State Ohm's law in words. (2)

Switch **S** is CLOSED.

8.2 The reading on the ammeter is 3,5 A.

8.2.1 Calculate the total external resistance of the circuit. (4)

8.2.2 Calculate the reading on voltmeter V_1. (3)

8.2.3 How does the reading on voltmeter V_2 compare to the reading on voltmeter V_1? Choose from SMALLER THAN, EQUAL TO or GREATER THAN. (1)

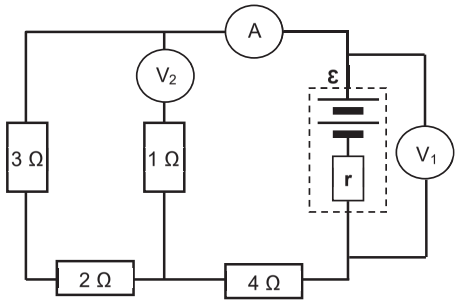
8.3 A learner concludes that the emf of the battery is equal to the reading on voltmeter V_1.

8.3.1 Define the term *emf*. (2)

8.3.2 Is the learner's conclusion CORRECT? Choose from YES or NO. (1)

8.3.3 Give a reason for the answer to QUESTION 8.3.2. (1)

Switch **S** is now removed and replaced by voltmeter V_2, as shown in the circuit diagram below.



8.4 How will EACH of the following change?

(Choose from INCREASES, DECREASES or REMAINS THE SAME.)

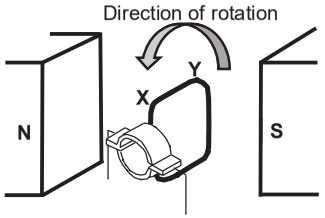
8.4.1 The power dissipated by the 4 Ω resistor (1)

8.4.2 The reading on voltmeter V_1 (1)

8.5 Explain the answer to QUESTION 8.4.2. (4)
[20]

QUESTION 9 (Start on a new page.)

9.1 The diagram below shows the initial position of the coil in a simple DC generator. The coil is rotated in an anticlockwise direction, as shown.



9.1.1 Name the component in this generator that ensures that the induced current in the external circuit is in one direction only. (1)

9.1.2 Is the direction of the induced current from **X to Y** or from **Y to X**? (1)

A maximum voltage of 90 V is generated when the coil is rotating at a frequency of 20 Hz.

9.1.3 Write down the time taken for the coil to complete ONE rotation. (1)

9.1.4 The coil starts rotating from the initial position, as shown in the diagram above.

Sketch a graph of output voltage versus time for one complete rotation of the coil. Indicate the maximum voltage and the relevant time values on the graph. (4)

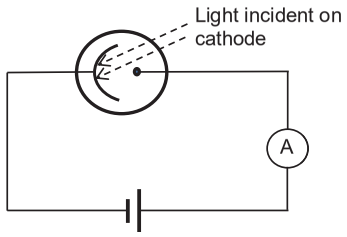
9.2 Wall sockets supply rms voltage and current.

A 220 V AC voltage is supplied from a wall socket to an electric kettle having a resistance of 32 Ω.

Calculate the average energy dissipated by the kettle in TWO minutes. (4)
[11]

QUESTION 10 (Start on a new page.)

Light is incident on the cathode of a photoelectric cell connected to a battery and a sensitive ammeter, as shown below.



10.1 What conclusive evidence about the nature of light is provided by the photoelectric effect? (1)

The cathode has a work function of $3,42 \times 10^{-19}$ J.

10.2 Define the term *work function*. (2)

Light of frequency $5,96 \times 10^{14}$ Hz is shone onto the cathode.

10.3 Calculate the maximum kinetic energy of an electron ejected from the cathode. (4)

10.4 The ammeter registers a constant current of 0,012 A.

Calculate the minimum number of photons of light that strike the cathode in a 10 s period. (4)

10.5 The intensity of the incident light is now INCREASED. How will this change affect the reading on the ammeter?

Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)
[14]

TOTAL: 150

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Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2022

PHYSICAL SCIENCES P1 (PHYSICS)

MARKS: **150**

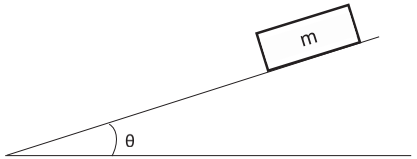
TIME: **3 hours**

This question paper consists of 19 pages, including 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the correct answer and write only the letter of the correct answer (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 An object of mass **m** moves down an incline at a constant velocity as shown in the diagram below.



Which ONE of the following expressions represents the magnitude of frictional force acting on the object?

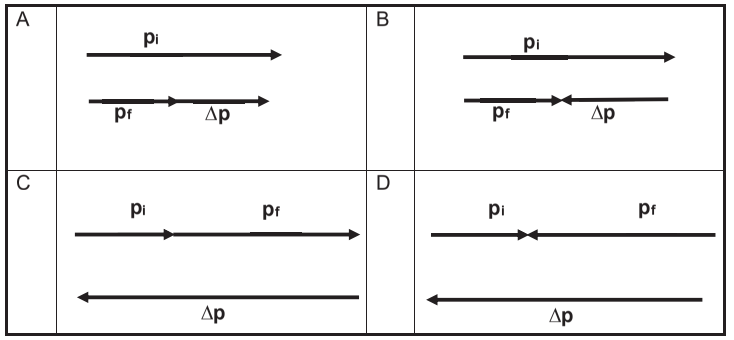
A mg cos θ

B mg sin θ

C mg tan θ

D tan θ (2)

1.2 A car of mass **m** is travelling at a constant velocity and has a momentum **p**. The driver notices an object ahead of him and applies the brakes so that the momentum of the car changes to ½**p**. Which ONE of the diagrams below correctly shows the relationship between $\mathbf{p}_i$, $\mathbf{p}_f$ and $\Delta\mathbf{p}$?



(2)

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1.3 A hot air balloon is moving upwards at a constant velocity **v**. A stone is dropped from the hot air balloon. What is the velocity of the stone at the instant it is dropped from the balloon?

A Zero

B **v** downwards

C **v** upwards

D 2**v** downwards (2)

1.4 An object is thrown vertically upwards from **R**, passes point **Q** and reaches a maximum height at point **P**. Ignore the effects of air friction.



Which ONE of the following is correct as the object moves from point **R** to point **Q**?

A Total mechanical energy has increased.

B The total kinetic energy at point **P** is zero.

C The decrease in kinetic energy is equal to the increase in potential energy.

D The average work done on the object is equal to zero. (2)

1.5 The net work done by a constant force **F** that acts on an object to increase its velocity from **0** to **v** is **W**.

The net work done by the same force on the object to increase its velocity from **v** to **2v** is …

A ⅓ W.

B ½ W.

C 2 W.

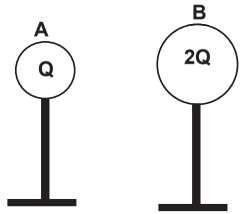
D 3 W. (2)

1.6 Astronomers observed that a light from distant star undergoes a red shift. Which ONE of the following combinations regarding the observed wavelength and frequency correctly explains this shift?

	OBSERVED WAVELENGTH	OBSERVED FREQUENCY
A	Increases	Decreases
B	Decreases	Decreases
C	Decreases	Increases
D	Increases	Increases

(2)

1.7 Two charged spheres, **A** and **B**, carrying charges **Q** and **2Q** respectively, are placed on insulating stands as shown in the diagram below. Sphere **A** exerts a force of **F** on sphere **B**. What is the magnitude of the force exerted by sphere **B** on sphere **A**?



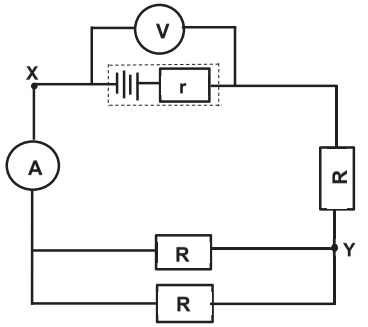
A 4**F**

B 2**F**

C **F**

D ½**F** (2)

1.8 A battery with internal resistance **r** is connected into a circuit as shown in the diagram below.

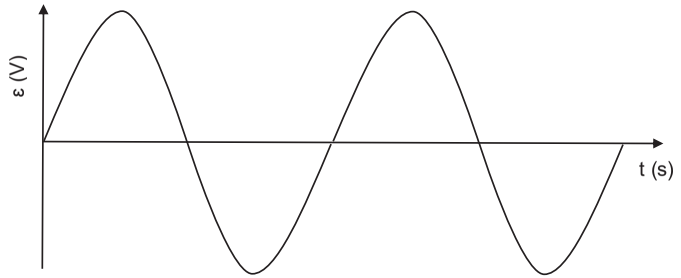


A conducting wire of negligible resistance is now connected into the circuit across points **X** and **Y**. Which combinations below correctly shows the changes to the readings on the voltmeter and ammeter?

	VOLTMETER READING	AMMETER READING
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Decreases	Increases

(2)

1.9 The graph below represents the emf generated versus time for an alternating current (ac) generator.



The speed of rotation of the generator's coil is now DOUBLED. What happens to the emf and the period of one cycle?

	EMF	PERIOD
A	Doubles	Doubles
B	Doubles	Halves
C	Halves	Doubles
D	Halves	Halves

(2)

1.10 The photoelectric effect provides evidence of the fact that:

A Positive charges can be emitted from metal surfaces.

B Light is an electromagnetic wave.

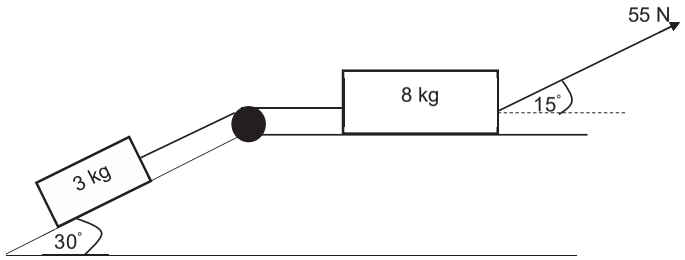
C Light has a wave nature.

D Light has a particle nature. (2)

[20]

QUESTION 2 (Start on a new page.)

Two blocks of masses 3 kg and 8 kg respectively are connected by means of a light, inextensible string as shown in the diagram below. The string moves over a frictionless pulley and the 3 kg block is placed on a plane that is inclined at an angle of 30° to the horizontal.
A force of 55 N, which makes an angle of 15° with the horizontal, is applied to the 8 kg block to move the system of blocks to the right.
The 3 kg block experiences a constant frictional force of 5 N. The coefficient of kinetic friction between the 8 kg block and the surface is 0,16.



2.1 State Newton's Second Law of motion in words. (2)

2.2 Draw a labelled free-body diagram of all forces acting on the 8 kg block. (5)

2.3 Calculate the:

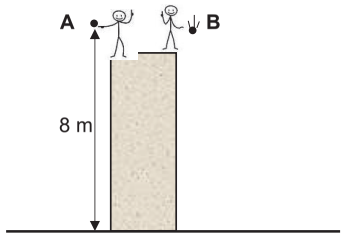
2.3.1 Kinetic frictional force that the 8 kg block experiences (4)

2.3.2 Tension in the string connecting the two blocks (6)

[17]

QUESTION 3 (Start on a new page.)

A learner drops a ball **A** from a height of 8 m. After 0,6 s, another learner throws a second ball **B** downwards from the same height. Both balls **A** and **B**, hit the ground at the same time. Ignore the effects of friction.



3.1 Define the term *free fall*. (2)

3.2 Calculate the speed at which:

3.2.1 Ball **A** hits the ground (3)

3.2.2 Ball **B** was thrown downwards (5)

Ball **A** bounces off the ground to a maximum height of 6,5 m above the ground.

3.3 Calculate the velocity of ball **A** as it bounces off the ground. (4)

3.4 Sketch a velocity versus time graph for the motion of ball **A** from the moment it was dropped until it reaches its maximum height after the bounce.

Indicate the following on the graph:

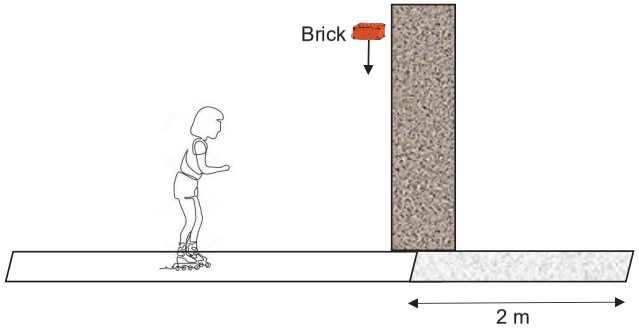
- The velocity with which ball **A** hits the ground
- The velocity with which the ball bounces off the ground (3)

[17]

QUESTION 4 (Start on a new page.)

A girl on roller skates, of combined mass 52 kg, moves horizontally at a certain constant velocity. She catches a brick of mass 5 kg which is thrown vertically downwards from the top of a high wall. The girl continues to move in a straight line at a speed of 2,4 $m \cdot s^{-1}$ after catching the brick.

Ignore the effects of friction.



4.1 Write down the horizontal speed of the brick just before the girl catches it. (1)

4.2 Calculate the girl's speed just before she catches the brick. (4)

The girl-brick combination, moving at 2,4 $m \cdot s^{-1}$ moves onto a rough surface. She comes to rest after moving 2 m along the rough surface.

4.3 Write down a pair of action-reaction forces acting while the girl catches the brick. (2)

4.4 Calculate the magnitude of the net force exerted by the rough surface to bring the girl-brick combination to a stop after 2 m. (5)

[12]

QUESTION 5 (Start on a new page.)

A rescue helicopter lifts a man of mass 75 kg, initially at rest, vertically upwards by means of a light inextensible massless cable as shown in the diagram below. While the man is lifted to a height of 12 m, the average tension in the cable is 3 600 N. A constant downward air resistance of 1 540 N is exerted on the man while he is being lifted.



5.1 State the work-energy theorem in words. (2)

5.2 Draw a free body diagram of all forces acting on the man as he is lifted upwards. (3)

5.3 Name a non-conservative force acting on the man while he is being lifted. (1)

5.4 Calculate the work done on the man by the gravitational force while he is being lifted. (3)

5.5 Use ONLY energy principles to calculate the speed of the man at 12 m above the ground. (5)
[14]

QUESTION 6 (Start on a new page.)

An ambulance, with its siren emitting sound of a certain constant frequency, approaches an accident scene at a constant velocity. A stationary sound detector at the accident scene records a frequency that is 2% higher than the actual frequency of the siren.

6.1 State the Doppler effect in words. (2)

6.2 Explain why the detector records a higher frequency. (2)

6.3 Calculate the speed of the ambulance.

Take velocity of sound as 343 $m.s^{-1}$. (5)

6.4 The frequency of the sound emitted by the siren is 720 Hz. Calculate the wavelength of the siren's sound. (3)

6.5 State ONE use of a Doppler flowmeter. (1)
[13]

QUESTION 7 (Start on a new page.)

7.1 Define the *electric field at a point* in words. (2)

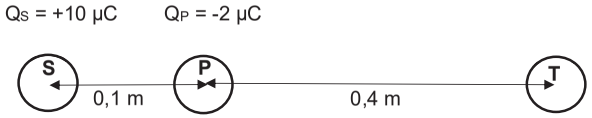
7.2 Draw the resultant electric field pattern due to two-point charges with identical positive charges. (3)

Two identical spheres, **S** and **T,** are placed with their centres 0,5 m apart. Point **A** is 0,1 m to the right of sphere **S**, as shown in the diagram below. The charge on sphere **S** is +10 µC while sphere **T** carries an unknown positive charge of similar magnitude.



7.3 The net electric field strength at point **A** is 4,70 x 10^6 N.C^{-1} to the left. Calculate the unknown charge on sphere **T**. (6)

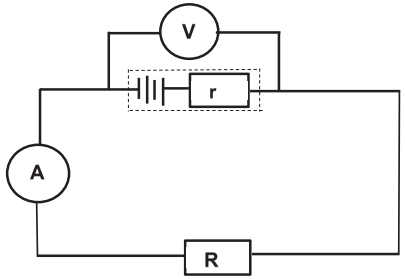
A third sphere **P** carrying a charge of -2 µC is now placed at point **A** as shown in the diagram below.



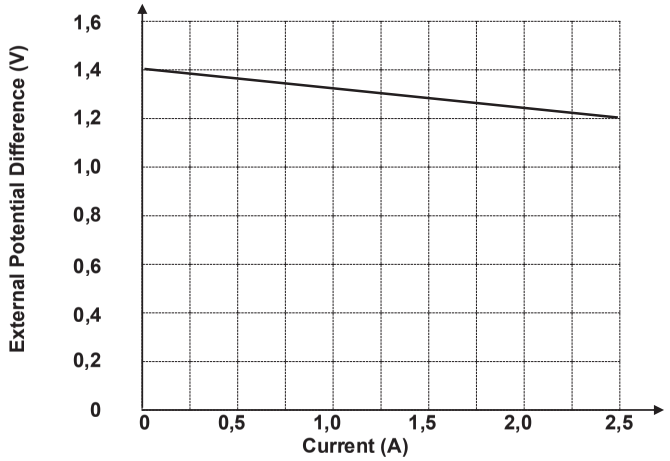
7.4 Calculate the NET electrostatic force exerted on sphere **P** due to charged spheres **S** and **T**. (4)
[15]

QUESTION 8 (Start on a new page.)

8.1 A learner sets up a circuit to determine the emf and internal resistance of a battery.



She uses the results obtained to plot the graph shown below.



8.1 Define the term *emf* of a battery. (2)

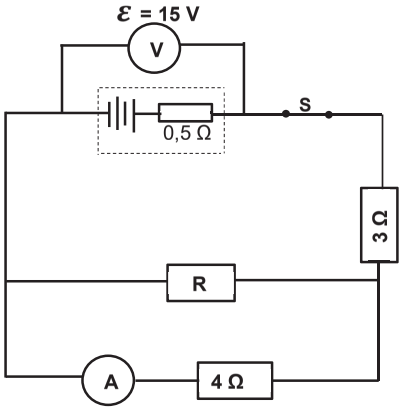
8.2 Use the graph to:

8.2.1 Determine the emf of the battery (1)

8.2.2 Calculate the internal resistance of the battery (3)

8.3 A circuit is connected as shown below. The resistance of **R**, which is connected in parallel with the 4 Ω resistor, is unknown. The battery has an emf of 15 V and an internal resistance of 0,5 Ω.

When switch **S** is closed the voltmeter reads 13,5 V.



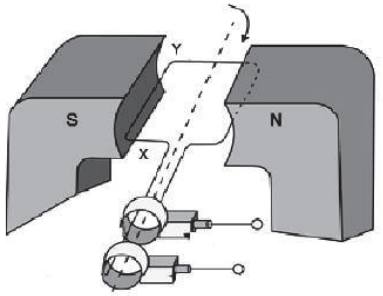
Calculate the:

8.3.1 Reading on ammeter **A** (6)

8.3.2 Resistance of resistor **R** (3)
[15]

QUESTION 9 (Start on a new page.)

9.1 The diagram of a simplified generator is shown below. The coil is rotated clockwise in a uniform magnetic field.



9.1.1 What type of generator is illustrated in the diagram?
Give a reason for your answer. (2)

9.1.2 Determine the direction of the current in segment XY when the coil is in the position shown above.

Only write down **X to Y** OR **Y to X**. (2)

9.2 Eskom supplies electricity to homes at rms voltage of 220 V. A certain electrical appliance dissipates 1 200 W of power when it is plugged in at a home.

9.2.1 Define the term *rms potential difference.* (2)

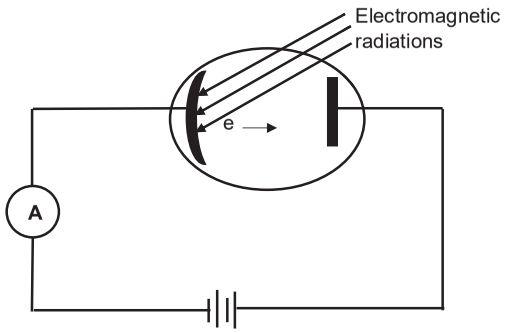
Calculate the:

9.2.2 Resistance of the appliance (3)

9.2.3 Peak (maximum) current that passes through the appliance (5)
[14]

QUESTION 10 (Start on a new page.)

The diagram below shows a photocell that emits electrons when a certain frequency of electromagnetic radiation is incident on the metal plate.



10.1 Describe the *photoelectric effect*. (2)

10.2 Define the term *work function of a metal.* (2)

When radiation of wavelength 555 nm is incident on the metal plate, electrons are released with zero kinetic energy.

10.3 Calculate the work function of this metal. (3)

10.4 The intensity of the incident light is now increased. State how this increase in intensity will affect the reading on the ammeter.

Write down only INCREASES, DECREASES or REMAINS THE SAME.
Give a reason for your answer. (2)

10.5 Another light source shines light onto the same metal and the emitted electron moves away from the metal surface with a velocity of 5×10^6 $m.s^{-1}$.

Calculate the frequency of this light source. (4)
[13]

TOTAL: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2022

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 A bucket is at rest on a table.

Which ONE of the following is the reaction force to the weight of the bucket, as described by Newton's Third Law?

A Force of the table on Earth

B Force of the bucket on Earth

C Force of the bucket on the table

D Force of the table on the bucket (2)

1.2 A ball is dropped from a small height above the ground.

Ignore air resistance.

The following pairs show physical quantities associated with the ball while it is falling to the ground.

In which ONE of these pairs will BOTH quantities change while the ball is falling?

A Mechanical energy and weight

B Kinetic energy and momentum

C Gravitational acceleration and kinetic energy

D Gravitational potential energy and gravitational force (2)

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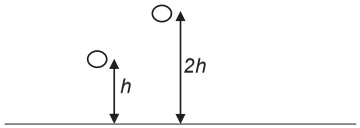
1.3 A ball is dropped from height *h* and strikes the floor with momentum **p**.

Ignore air resistance.

The ball is NOW dropped from height *2h*.



Which ONE of the following represents the momentum with which the ball NOW strikes the floor?

A **p**

B $\sqrt{2}\,\mathbf{p}$

C $2\sqrt{\mathbf{p}}$

D $2\mathbf{p}$ (2)

1.4 Object X exerts a gravitational force **F** on object Y when the distance between the centres of the objects is **r**.

The distance **r** is now DOUBLED.

Which ONE of the following represents the gravitational force that X now exerts on Y?

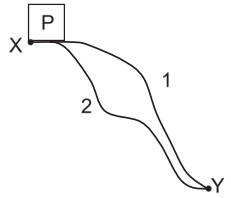
A $\frac{1}{4}\mathbf{F}$

B $\frac{1}{2}\mathbf{F}$

C $2\mathbf{F}$

D $4\mathbf{F}$ (2)

1.5 A force **F** moves an object P from point X to point Y along two different paths, 1 and 2, as shown below.



The work done by **F** in moving the object is the same for both paths. Which ONE of the following can be used to describe force **F**?

A Normal force

B Tension force

C Frictional force

D Gravitational force (2)

1.6 Which ONE of the following can be explained by the Doppler effect?

A A stethoscope is used to listen to a person's heartbeat.

B An echo is heard when sound waves are reflected off a cliff.

C The spectrum of light from an approaching star is shifted towards shorter wavelengths.

D Sound intensity decreases when the sound source moves away from a stationary listener. (2)

1.7 Two oppositely charged point charges move towards each other.

Which ONE of the following is CORRECT?

The point charges move at …

A constant velocity.

B decreasing velocity.

C constant acceleration.

D increasing acceleration. (2)

1.8 Which ONE of the following phrases describes the emf of a battery?

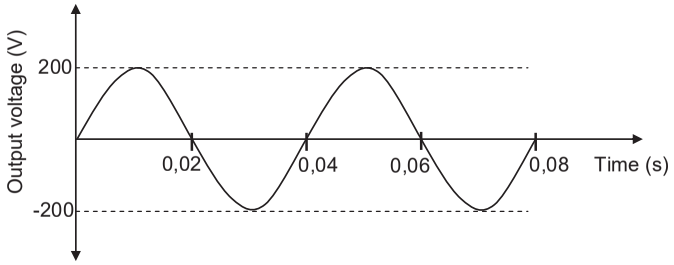
A Energy supplied per unit time

B Charge transferred per unit time

C Current supplied per unit charge

D Maximum energy supplied per unit charge (2)

1.9 The graph below represents the output voltage versus time for an AC generator.



The speed of rotation of the generator's coil is now DOUBLED.

Which ONE of the combinations below shows the CORRECT new peak output voltage and the time for ONE rotation?

	PEAK OUTPUT VOLTAGE (V)	TIME FOR ONE ROTATION (S)
A	400	0,02
B	200	0,02
C	200	0,04
D	100	0,04

(2)

1.10 A photon of light of energy $2X$ joules is shone onto a metal surface with work function X joules.

Which ONE of the following represents the maximum kinetic energy (in joules) of the electron ejected from the metal by this photon?

A Zero

B $\frac{1}{2}X$

C X

D $2X$ (2)

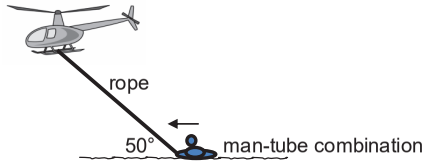
[20]

QUESTION 2 (Start on a new page.)

A man faces difficulty while swimming in a dam. During the rescue operation, an inflated tube attached to a helicopter by a rope is dropped from the helicopter.

The man, of mass 70 kg, holds onto the inflated tube of mass 4 kg, while the helicopter is flying horizontally at a CONSTANT speed. An average frictional force of 300 N is exerted on the man-tube combination while they are dragged horizontally along the surface of the water by the helicopter. The rope makes an angle of 50° with the surface of the water, as shown in the diagram below.

Assume that the rope is inextensible and massless, and the water of the dam does not flow.



2.1 State Newton's First Law of Motion in words. (2)

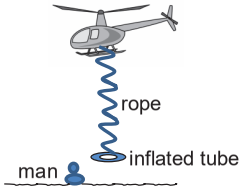
2.2 Draw a free-body diagram of the man-tube combination while they are being dragged. (4)

2.3 Calculate the tension in the rope. (4)

2.4 How will the answer to QUESTION 2.3 change if the helicopter ACCELERATES while dragging the man? The frictional force and the angle between the rope and the surface of the water remain the same.

Choose from INCREASES, DECREASES or NO CHANGE. Give a reason for the answer. (2)

In another rescue operation, the inflated tube of mass 4 kg is dropped from the stationary helicopter and it strikes the water at a speed of 16 $m \cdot s^{-1}$. The tube sinks vertically downwards into the water to a depth of 0,8 m and then rises to the surface. The rope hangs loosely.



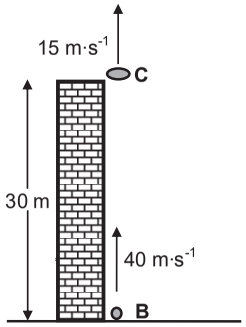
2.5 Calculate the magnitude of the average upward force exerted on the inflated tube while it is sinking. Assume that the average upward force is constant for the motion. (5)

[17]

QUESTION 3 (Start on a new page.)

A small disc, **C**, is thrown vertically upwards at a speed of 15 m·s^{-1} from the edge of the roof of a building of height 30 m. AFTER 0,5 s, a small ball **B** is shot vertically upwards from the foot of the building at a speed of 40 m·s^{-1} in order to hit disc **C**.

Ignore the effects of air resistance.



3.1 Explain the term *projectile*. (2)

3.2 Calculate the:

3.2.1 Time taken by disc **C** to reach its maximum height (3)

3.2.2 Maximum height above the ground reached by disc **C** (4)

3.3 Calculate the time from the moment that disc **C** was thrown upwards until the time ball **B** hits the disc. (6)

3.4 On the same set of axes, sketch graphs of velocity versus time for disk **C** and ball **B** from the moment that disc **C** was thrown upwards until ball **B** hits disc **C**.

Label the graph for ball **B** as B and the graph for disc **C** as C.

Clearly indicate the following on the graphs:

- The initial velocities of ball **B** and disc **C**
- The time at which ball **B** was shot upward
- The time at which disc **C** reaches its maximum height
- The time at which ball **B** hits disc **C**

(5)
[20]

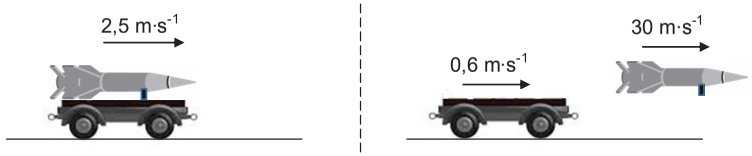
QUESTION 4 (Start on a new page.)

4.1 What is meant by an *isolated system* in physics? (2)

During an experiment, a rocket of unknown mass is mounted on a toy cart of mass 20 kg. The cart-rocket combination moves at a constant speed of 2,5 m·s^{-1} along a horizontal floor.

At a certain instant, the rocket is fired horizontally in the direction of motion at a speed of 30 m·s^{-1}. As a result, the cart slows down to a speed of 0,6 m·s^{-1}, as shown in the diagram below.

Ignore frictional effects.



Before rocket is fired After rocket is fired

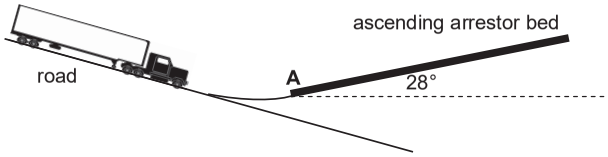
4.2 Use relevant physics principles to explain why the firing of the rocket will slow down the cart. (2)

4.3 Calculate the mass of the rocket at the instant the rocket was fired from the toy cart. (5)
[9]

QUESTION 5 (Start on a new page.)

Arrestor beds are used to help moving trucks to come to a stop when their brakes fail.

The driver of a 30 000 kg truck driving down a steep road drives onto an ASCENDING arrestor bed inclined at 28° to the horizontal, as shown in the diagram below.



5.1 State the work-energy theorem in words. (2)

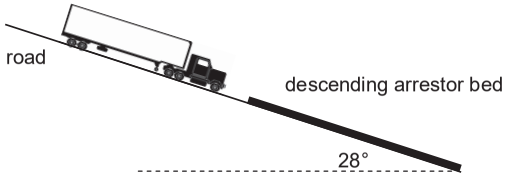
The truck with failed brakes passes point **A** at the beginning of the arrestor bed at a speed of 33 $m \cdot s^{-1}$. The average frictional force on the truck is 31 000 N while the truck moves up the arrestor bed.

Ignore the rotational effects of the wheels.

5.2 Give a reason why the net work done on the truck, while moving on the arrestor bed, is negative. (1)

5.3 Use ENERGY PRINCIPLES to calculate the minimum length of the arrestor bed needed to bring the truck to a stop. (5)

The diagram below shows the same truck entering a DESCENDING arrestor bed inclined at 28° to the horizontal. The initial speed of the truck and the average frictional force on the truck are 33 $m \cdot s^{-1}$ and 31 000 N respectively.



5.4 Which arrestor bed, ASCENDING or DESCENDING, will be able to stop the truck in a shorter distance?

Explain the answer in terms of the forces acting on the truck. (3)

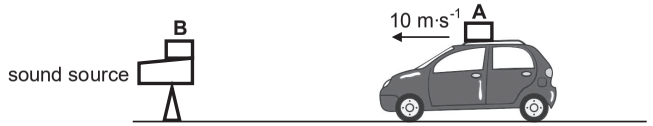
[11]

QUESTION 6 (Start on a new page.)

A car moves at a constant speed of 10 $m \cdot s^{-1}$ TOWARDS a stationary sound source. The sound source emits sound waves of frequency 880 Hz.

A sound detector **A** is attached to the car and another sound detector **B** is attached to the sound source. Detector **B** detects the sound waves reflected from the car.

The speed of sound in air is 340 $m \cdot s^{-1}$.

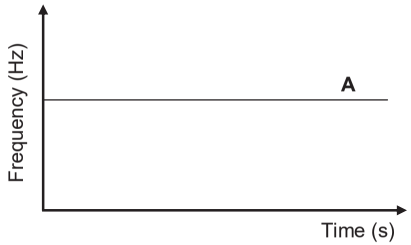


6.1 State the Doppler effect in words. (2)

6.2 Calculate the wavelength of the sound waves emitted by the source. (3)

6.3 Calculate the frequency of the sound waves detected by detector **A**. (4)

The sketch graph below shows the frequency recorded by detector **A**.

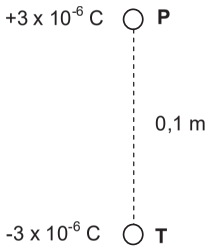


6.4 Redraw the graph above for detector **A** in your ANSWER BOOK. On the same set of axes, sketch the graph of the frequency recorded by detector **B**. Label this graph as B. (2)

[11]

QUESTION 7 (Start on a new page.)

7.1 Two small, identical spheres, **P** and **T**, are placed a distance of 0,1 m apart, as shown in the diagram below. **P** carries a charge of +3 x 10^{-6} C and **T** carries a charge of -3 x 10^{-6} C.

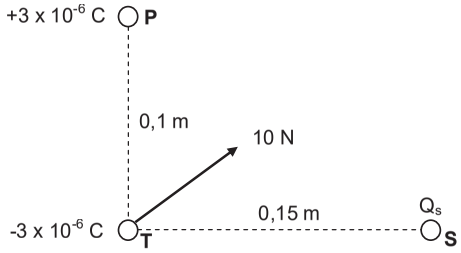


7.1.1 State Coulomb's law in words. (2)

7.1.2 Draw the resultant electric field pattern due to the charges on **P** and **T**. (3)

A third charged sphere **S** of unknown charge Q_s is placed a distance of 0,15 m from sphere **T** such that the three charged spheres are at the vertices of a right-angled triangle.

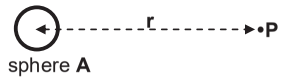
The net electrostatic force on sphere **T** due to the other two charged spheres has a magnitude of 10 N, as shown in the diagram below.



7.1.3 Is charge Q_s POSITIVE or NEGATIVE? (1)

7.1.4 Calculate the number of electrons added to or removed from sphere **S** to give it a charge of Q_s. (6)

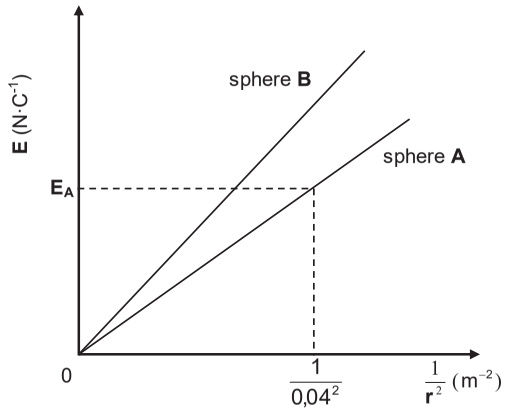
7.2 **P** is a variable point in the electric field of charged sphere **A** and **r** is the distance between point **P** and the centre of sphere **A**. See the diagram below.



A learner determines the magnitude of the electric field (**E**) at point **P** for different values of **r**.

Sphere **A** is then replaced by another sphere, **B**, of a different charge. Another set of results are obtained.

The graphs below are obtained from the results for sphere **A** and sphere **B**. E_A is the magnitude of the electric field at a distance of 0,04 m from the centre of charged sphere **A**.



Use the graphs to answer the following questions.

7.2.1 State the proportionality between the magnitude of electric field **E** at a point and $\frac{1}{r^2}$. (1)

7.2.2 Calculate E_A if the numerical value of the gradient of the graph for sphere **A** is 680. (4)

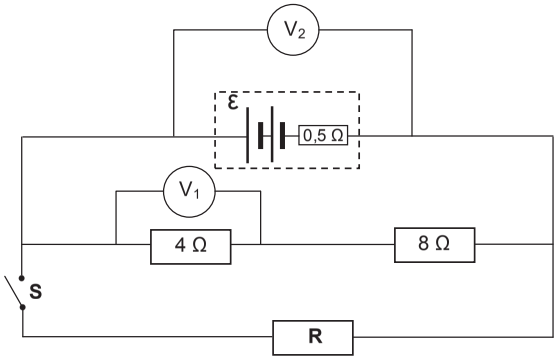
7.2.3 How does the magnitude of the charge on sphere **B** compare to the magnitude of the charge on sphere **A**?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (3)
[20]

QUESTION 8 (Start on a new page.)

In the circuit below a battery of UNKNOWN emf and an internal resistance of 0,5 Ω is connected to two resistors of 4 Ω and 8 Ω each, and a resistor **R** of unknown resistance.

Ignore the resistance of the connecting wires.



8.1 The three external resistors are ohmic conductors.

Explain the meaning of the term *ohmic conductor*. (2)

8.2 When switch **S** is OPEN, voltmeter V_1 reads 3,2 V.

Calculate the:

8.2.1 Current through the battery (3)

8.2.2 Emf of the battery (4)

8.3 When switch **S** is CLOSED, voltmeter V_2 reads 8,8 V.

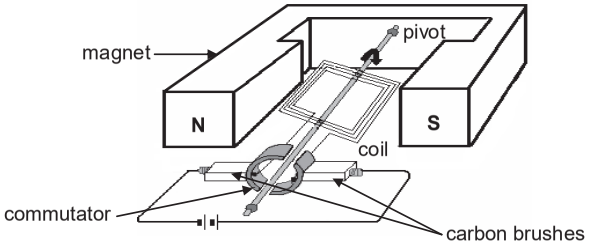
8.3.1 Calculate the resistance of resistor **R**. (5)

8.3.2 The battery becomes heated when voltmeter V_2 is replaced by a connecting wire. Explain this observation. (3)

[17]

QUESTION 9 (Start on a new page.)

9.1 The simplified sketch of an electric motor is shown below.

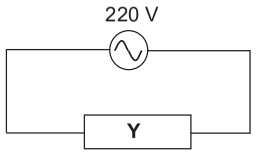


9.1.1 Write down the energy conversion that takes place in this motor. (1)

9.1.2 Is the motor above an AC motor or a DC motor? (1)

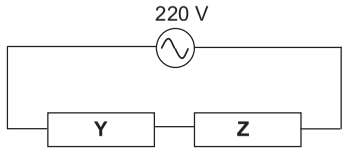
9.1.3 What is the function of the commutator in this motor? (1)

9.2 A resistor **Y** is rated 220 V, 100 W and is connected to a 220 V AC source, as shown in the circuit below.



9.2.1 Calculate the resistance of resistor **Y**. (3)

Another resistor **Z** with a rating 220 V, *X* W, is now connected in series to resistor **Y** and to the same AC source. See the diagram below.



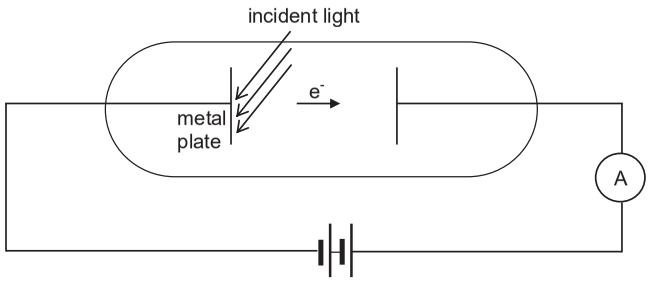
The power dissipated by resistor **Y** changes to 80 W, while its resistance remains constant.

9.2.2 Calculate the power rating *X* of resistor **Z**, assuming that resistor **Z** has constant resistance. (6)

[12]

QUESTION 10 (Start on a new page.)

10.1 The apparatus illustrated in the simplified diagram below is used to demonstrate the photoelectric effect.



10.1.1 Define the term *photoelectric effect*. (2)

Incident light of frequency 1,2 x 10^{15} Hz is shone onto the metal plate and electrons are emitted.

Calculate the:

10.1.2 Number of photoelectrons emitted in one second if the total energy transferred by the light to the metal plate per second is 1,75 x 10^{-9} J (4)

10.1.3 Maximum speed of a photoelectron if the threshold frequency of the metal plate is 9,09 x 10^{14} Hz (5)

10.2 Briefly explain how an emission spectrum is formed in terms of energy transitions. (2)
[13]

TOTAL: 150

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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Consider the statement below.

The perpendicular force exerted by a surface on an object in contact with the surface.

Which ONE of the following forces is defined by the statement above?

A Normal force

B Resultant force

C Frictional force

D Gravitational force (2)

1.2 Two balls of masses m and 2m are dropped simultaneously from the same height above the ground. Ignore air resistance.

When the balls strike the ground, which ONE of the following physical quantities will be the same for both balls?

A Weight

B Velocity

C Momentum

D Kinetic energy (2)

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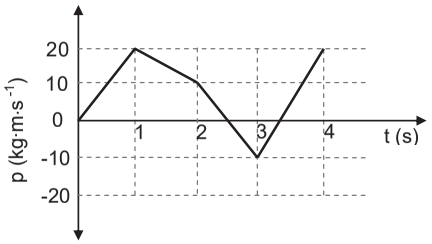
1.3 The graph below shows how the momentum (p) of an object changes with time (t).



During which ONE of the following time intervals, measured in seconds, is the magnitude of the net force acting on the object the greatest?

A 0 to 1

B 1 to 2

C 2 to 3

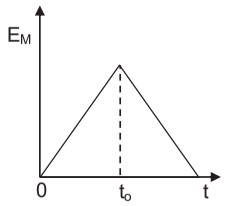
D 3 to 4 (2)

1.4 A ball is dropped from a height above a floor. The ball makes an elastic collision with the floor at time t_o and bounces vertically upwards.

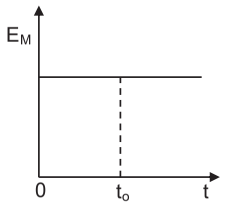
Ignore air resistance.

Which ONE of the following graphs shows how the total mechanical energy (E_M) of the ball changes with time?

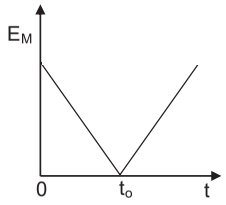
A



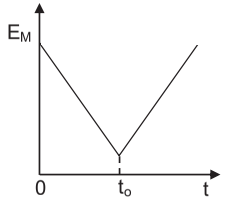
B



C



D



(2)

1.5 Consider the two spectrum diagrams below.

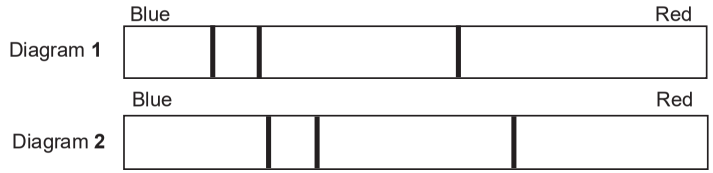


Diagram **1** represents the spectrum of an element in a laboratory on Earth.

Diagram **2** represents the spectrum of the same element from a distant star as observed from Earth.

Which ONE of the following can be deduced from the spectra above?

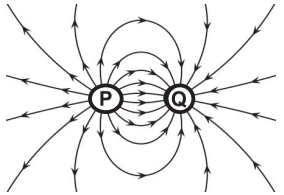
A The star is moving towards Earth.

B The star is at rest relative to Earth.

C The star is moving away from Earth.

D Both the star and Earth are moving towards each other. (2)

1.6 The diagram below shows the field lines for the combined electric field due to two small charged spheres **P** and **Q**.



Which ONE of the combinations below correctly shows the polarity of spheres **P** and **Q**?

	SPHERE P	**SPHERE Q**
A	Negative	Positive
B	Negative	Negative
C	Positive	Positive
D	Positive	Negative

(2)

1.7 Two identical spheres, **P** and **Q**, carry charges of +q and –2q respectively. Sphere **P** exerts an electrostatic force of magnitude F on sphere **Q**.

Which ONE of the following represents the magnitude of the electrostatic force exerted on sphere **P** by sphere **Q**?

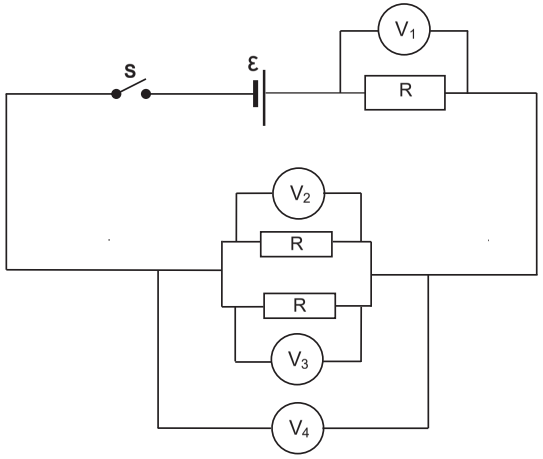
A $\frac{1}{2}F$

B F

C 2F

D 4F (2)

1.8 In the circuit diagram shown below all the resistors are IDENTICAL. Ignore the internal resistance of the cell.



Which voltmeter will have the HIGHEST reading when switch **S** is closed?

A V_1

B V_2

C V_3

D V_4 (2)

1.9 In which ONE of the following electrical machines is electrical energy converted to mechanical energy?

A AC generator

B DC generator

C AC dynamo

D DC motor (2)

1.10 Which ONE of the following combinations correctly links an emission spectrum and an absorption spectrum to the energy transitions of an electron in an atom?

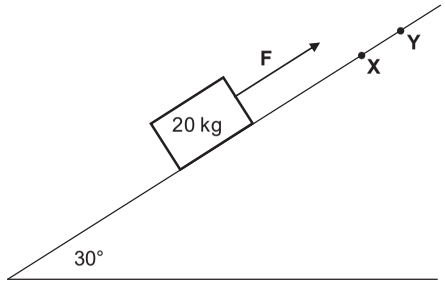
	EMISSION SPECTRUM	ABSORPTION SPECTRUM
A	From low to high energy levels	From high to low energy levels
B	From low to high energy levels	From low to high energy levels
C	From high to low energy levels	From high to low energy levels
D	From high to low energy levels	From low to high energy levels

(2)
[20]

QUESTION 2 (Start on a new page.)

A 20 kg block is placed on a rough surface inclined at 30° to the horizontal. A constant force **F**, acting parallel to the surface, is applied on the block so that the block moves up the incline at a CONSTANT VELOCITY of 2 m·s^{-1}. Refer to the diagram below.

A constant kinetic frictional force of 18 N acts on the block.



2.1 State *Newton's First Law* in words. (2)

2.2 Draw a labelled free-body diagram for the block. (4)

2.3 Calculate the magnitude of force **F**. (4)

Force **F** is removed when the block reaches point **X** on the surface. The block continues to move up the surface and comes to rest momentarily at point **Y**.

Assume that the kinetic frictional force acting on the block remains at 18 N as it moves from point **X** to point **Y**.

2.4 Write down the net force acting on the block as it moves from **X** to **Y**. (2)

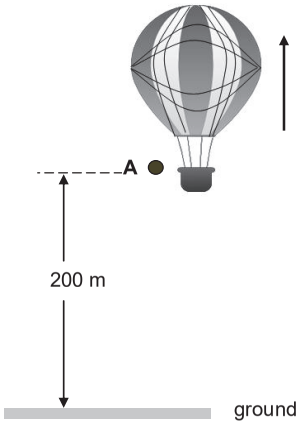
2.5 Calculate the distance between points **X** and **Y**. (4)
[16]

QUESTION 3 (Start on a new page.)

A hot-air balloon is moving upwards at a CONSTANT UNKNOWN speed.

3.1 Is the hot air balloon in free fall? Choose from YES or NO.

Give a reason for the answer. (2)



When the balloon is 200 m above the ground, a small stone **A** is dropped from the balloon. See the diagram above. Another small stone **B** is dropped 5 s later from the balloon while the balloon is still moving upwards at constant velocity.

Stone **A** strikes the ground at a speed of 62,68 m·s^{-1}.

Ignore air resistance.

3.2 Calculate the:

3.2.1 Speed of the hot air balloon (3)

3.2.2 Time it takes stone **A** to strike the ground (3)

3.2.3 Distance between the hot-air balloon and stone **B** at the instant when stone **A** strikes the ground (6)

3.3 On the same set of axes, draw position-time graphs for both the hot-air balloon and stone **A** from the moment the stone is dropped until it strikes the ground.

Use the ground as zero reference.

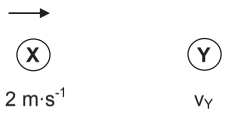
Label your graphs **BALLOON** and **A**. (4)
[18]

QUESTION 4 (Start on a new page.)

A ball **X**, of mass 10 kg, is moving eastwards with a velocity of 2 m·s^{-1}. It collides ELASTICALLY with another ball, **Y**, of mass 2 kg which was moving with an unknown velocity v_Y (Diagram **A**). Immediately after the collision, ball **X** comes to rest and ball **Y** moves eastwards with a kinetic energy of 36 J (Diagram **B**).

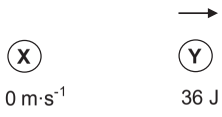
Ignore friction.

DIAGRAM A

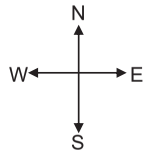


Before collision

DIAGRAM B



After collision



4.1 Explain the meaning of the term *elastic collision*. (2)

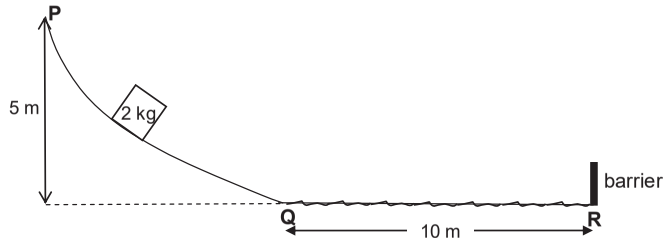
4.2 Calculate velocity v_Y. (5)

The balls were in contact with each other for 0,1 s during the collision.

4.3 Calculate the magnitude of the force that ball **X** exerted on ball **Y** during the collision. (3)
[10]

QUESTION 5 (Start on a new page.)

A 2 kg box is released from rest at point **P**, 5 m above the ground. It slides down a smooth frictionless curved track **PQ**. See the diagram below.



5.1 State the *principle of conservation of mechanical energy* in words. (2)

5.2 Use the PRINCIPLE OF CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the box when it reaches point **Q**. (3)

The box passes point **Q** and moves 10 m on a rough horizontal surface before striking a barrier at point **R** at a speed of 4 m·s^{-1}.

5.3 Use ENERGY PRINCIPLES to calculate the magnitude of the average frictional force acting on the box as it moves from **Q** to **R**. (4)

The barrier exerts an impulse of 14 N·s to the LEFT on the box when the box strikes the barrier.

5.4 Calculate the change in kinetic energy of the box after striking the barrier. (5)
[14]

QUESTION 6 (Start on a new page.)

The siren of a stationary ambulance emits sound waves at a constant frequency of 680 Hz. A man is standing with a detector that records the wavelength of the sound emitted by the siren, as shown in the diagram below.



The speed of sound in air is 340 $m \cdot s^{-1}$.

6.1 Calculate the wavelength of the detected sound. (3)

The ambulance now moves at a constant speed along the road TOWARDS the man. The detector now records the wavelength of the sound, which differs from the previous reading by 0,05 m.

6.2 State the Doppler effect. (2)

6.3 How would EACH of the following have changed when the ambulance approached the detector compared to when the ambulance was stationary?

Choose from INCREASED, DECREASED or NO CHANGE.

6.3.1 Distance between the wave fronts (1)

6.3.2 Frequency of the detected waves (1)

6.4 Calculate the speed of the ambulance. (5)
[12]

QUESTION 7 (Start on a new page.)

7.1 A small neutral sphere acquires a charge of $-1,95 \times 10^{-6}$ C.

7.1.1 Were electrons ADDED TO or REMOVED FROM the sphere? (1)

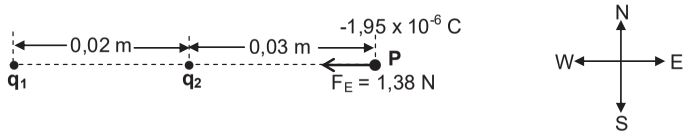
7.1.2 Calculate the number of electrons which were added or removed. (3)

7.1.3 Define the term *electric field at a point*. (2)

7.1.4 Calculate the magnitude of the electric field at a point 0,5 m from the centre of the charged sphere. (3)

7.2 Two point charges, $\mathbf{q_1}$ and $\mathbf{q_2}$, are fixed 0,02 m apart. The magnitude of charges $\mathbf{q_1}$ and $\mathbf{q_2}$ is the same and $\mathbf{q_1}$ is NEGATIVELY charged.

The small charged sphere with the charge of $-1,95 \times 10^{-6}$ C is placed at point **P**, 0,03 m east of charge $\mathbf{q_2}$, as shown in the diagram below. The sphere at point **P** experiences a net electrostatic force of 1,38 N west.

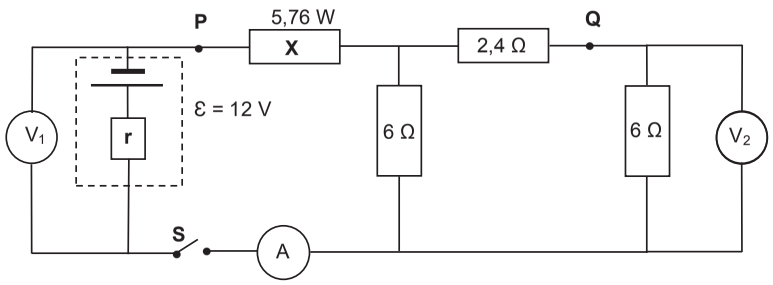


Calculate the magnitude of the charge on $\mathbf{q_2}$. (5)
[14]

QUESTION 8 (Start on a new page.)

The battery in the circuit shown below has an emf of 12 V and an unknown internal resistance **r**.

The resistance of the connecting wires and the ammeter is negligible.



Switch **S** is OPEN.

8.1 Write down the reading on:

8.1.1 Voltmeter V_1 (1)

8.1.2 Voltmeter V_2 (1)

Switch **S** is now CLOSED.

The reading on the ammeter is 1,2 A and the power dissipated in resistor **X** is 5,76 W.

8.2 Define the term *power.* (2)

Calculate the:

8.3 Resistance of resistor **X** (3)

8.4 Total EXTERNAL resistance of the circuit (3)

8.5 Reading on voltmeter V_2 (5)

A length of wire of negligible resistance is used to connect point **P** to point **Q** in the circuit.

8.6 How will the reading on voltmeter V_1 be affected?

Choose from INCREASES, DECREASES or NO EFFECT.

Explain the answer. (4)

[19]

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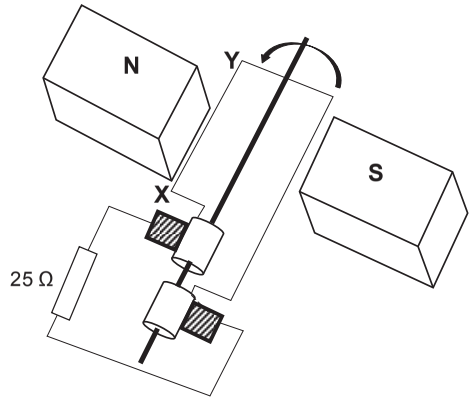
QUESTION 9 (Start on a new page.)

A simplified diagram of an AC generator connected to a 25 Ω resistor is shown below. The coil rotates anticlockwise.

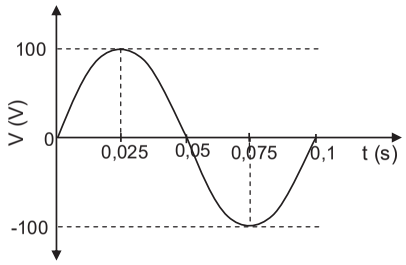


9.1 Name the component that distinguishes this generator from a DC generator. (1)

9.2 In which direction will the induced current flow in section **XY** of the coil?

Choose from **X to Y** OR **Y to X**. (2)

The graph below shows the output voltage of the generator for one cycle of rotation of the coil.



9.3 Define the term *rms potential difference*. (2)

9.4 Calculate the rms current in the circuit. (4)

9.5 Calculate the average power dissipated in the 25 Ω resistor. (3)

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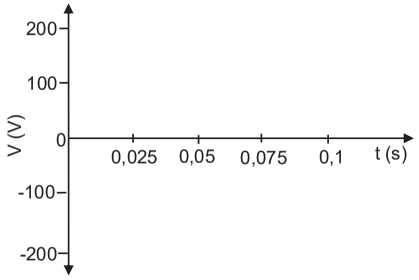
The speed of rotation of the coil in the generator is now DOUBLED.

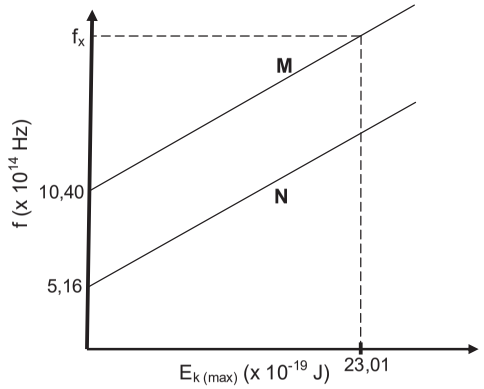
9.6 Copy the set of axes below in your ANSWER BOOK and sketch the graph of output voltage versus time for 0,1 s.



(3)
[15]

QUESTION 10 (Start on a new page.)

The relationship between frequency (f) and maximum kinetic energy ($E_{k(max)}$) of photoelectrons emitted from two cathodes, **M** and **N**, of different photoelectric cells is investigated. The graphs below have been obtained from the results.



10.1 Define the term *threshold frequency*. (2)

10.2 How does the maximum kinetic energy of photoelectrons emitted from cathode **N** compare to the maximum kinetic energy of those emitted from cathode **M** when light of a frequency greater than 10,40 x 10^{14} Hz is shone on each of the cathodes?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (2)

10.3 Calculate the value of frequency f_x indicated on the graph. (5)

10.4 The experiment is now repeated for cathode **M** using light of frequency f_x, but of higher intensity. How will EACH of the following be affected?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The y-intercept of the graph (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

10.4.3 The maximum kinetic energy of the emitted photoelectrons (1)
[12]

TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2021

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

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KWAZULU-NATAL

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 A constant net force acts on an object moving in a straight line. Which ONE of the following quantities associated with the object will remain constant during the motion?

A Velocity

B Momentum

C Acceleration

D Kinetic energy (2)

1.2 The weight of an object on the surface of the Earth is **w**. What will be the weight of the object on the surface of another planet of the SAME mass as that of the Earth, but TWICE the radius of the Earth?

A $\frac{1}{4}\mathbf{w}$

B $\frac{1}{2}\mathbf{w}$

C $2\mathbf{w}$

D $4\mathbf{w}$ (2)

1.3 The diagram below shows a cricket player moving his hands downwards from position **1** to **2** to **3** while catching a ball.



Which ONE of the following statements CORRECTLY explains why the cricket player moves his hands downwards?

A The impulse on the ball is decreased.

B The change in momentum of the ball is increased.

C The change in momentum of the ball is decreased.

D The time it takes to change the momentum of the ball is increased. (2)

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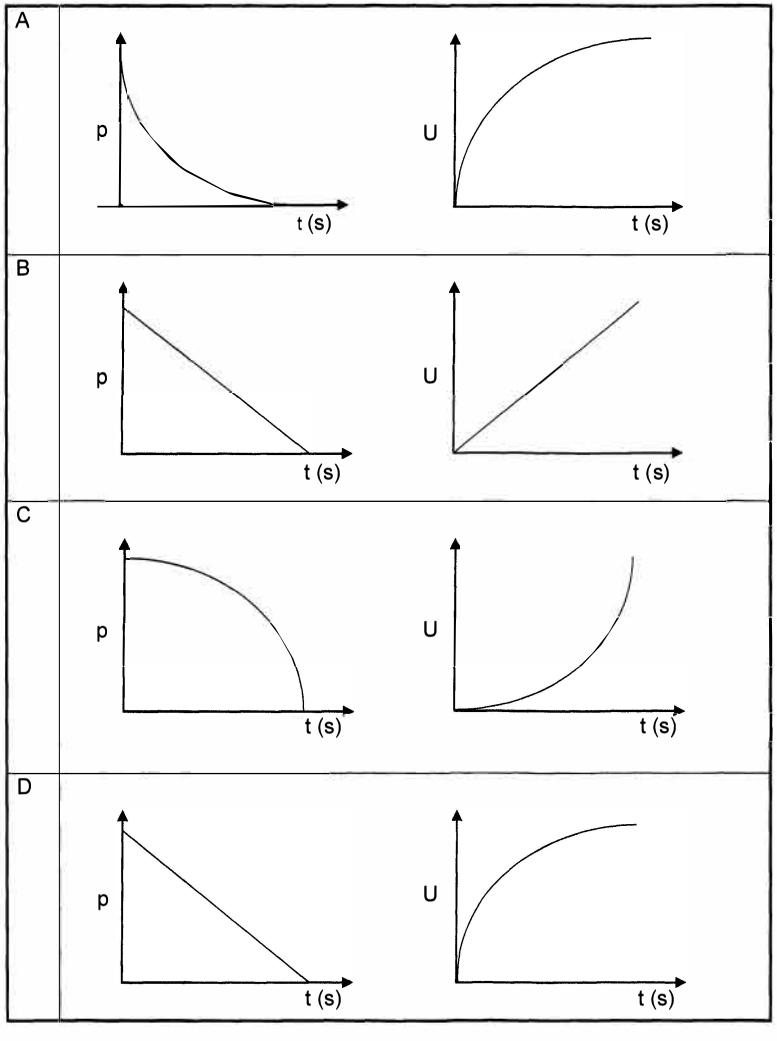
1.4 Consider the motion of a small stone thrown vertically upwards until it reaches its maximum height.

Ignore the effects of friction.

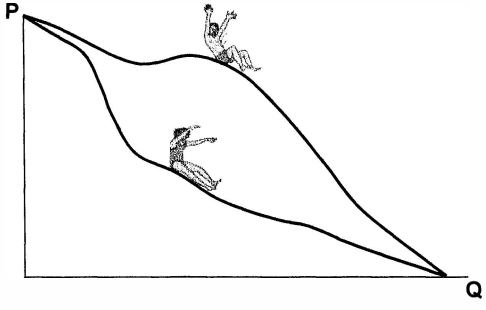
Which ONE of the following combinations of graphs CORRECTLY shows how the momentum **p** and the gravitational potential energy **U** of the stone change with time?



(2)

1.5 A boy and a girl, having DIFFERENT masses, are initially at rest at point **P**. They slide down different paths of a water slide, as shown in the diagram below.

Ignore the effects of friction.



Consider the statements below regarding the boy and the girl:

I Only conservative forces act on both the boy and the girl while they are sliding downwards.

II The boy and the girl each have the same gravitational potential energy at point **P**.

III On reaching point **Q**, the speed of the girl is equal to that of the boy.

Which of the above statements is/are CORRECT?

A I only

B I and III only

C II and III only

D I, II and III (2)

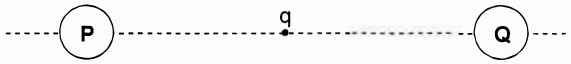
1.6 An astronomer observes that the light spectrum of a star has been blue shifted.

How have the observed frequency of light from the star and the distance between the star and Earth changed?

	OBSERVED FREQUENCY OF LIGHT	DISTANCE BETWEEN THE STAR AND EARTH
A	Increased	Increased
B	Increased	Decreased
C	Decreased	Increased
D	Decreased	Decreased

(2)

1.7 A small negative point charge (q) is situated halfway between two identical spheres, **P** and **Q**, carrying IDENTICAL charges, as shown below.



Sphere **P** exerts an electrostatic force of magnitude **F** on sphere **Q**. What is the magnitude of the net electrostatic force experienced by the point charge?

A Zero

B $\frac{1}{2}$F

C F

D 2F

(2)

1.8 Consider the statements below regarding AC power and DC power:

I AC voltage can be changed during AC power transmission.

II DC power transmission requires transformers.

III AC power transmission is more energy efficient.

Which of the above statement(s) is/are CORRECT?

A I only

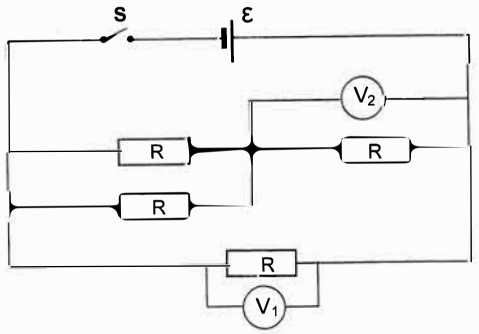
B II only

C I and III only

D II and III only

(2)

1.9 In the circuit diagram below, all resistors are IDENTICAL. Ignore the internal resistance of the cell and the resistance of the connecting wires.



When switch **S** is CLOSED, the reading on voltmeter V_1 is 3 V.

What will be the reading on voltmeter V_2?

A 1 V

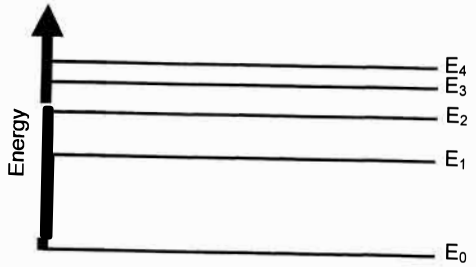
B 1,5 V

C 2 V

D 3 V

(2)

1.10 Some of the energy levels of an atom are represented in the diagram below.



E_0 represents the ground state energy.

Which ONE of the energy transitions below represents the absorption of light of the lowest frequency by the atom?

A E_0 to E_4

B E_1 to E_3

C E_3 to E_4

D E_0 to E_3

(2)
[20]

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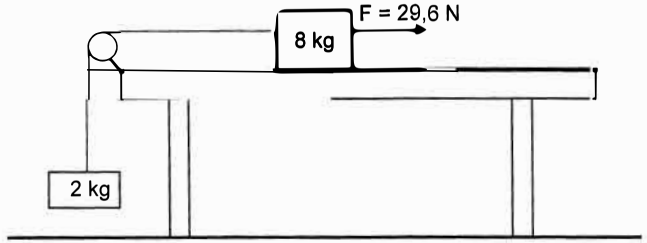
QUESTION 2 (Start on a new page.)

An 8-kg block, on a rough horizontal surface, is connected to a 2-kg block by a light inextensible string passing over a frictionless pulley, as shown below. The 8-kg block moves at a **constant speed** when pulled by a 29,6 N horizontal force to the right. The frictional force acting on the 8-kg block is 10 N.



2.1 State *Newton's Second Law of Motion* in words. (2)

2.2 Draw a labelled free-body diagram for the 8-kg block. (5)

2.3 Calculate the tension in the string. (3)

The 29,6 N horizontal force is now increased to 50 N.

2.4 Apply Newton's Second Law to EACH block and calculate the:

2.4.1 Magnitude of the acceleration of the 8-kg block (5)

2.4.2 Tension in the string (2)
[17]

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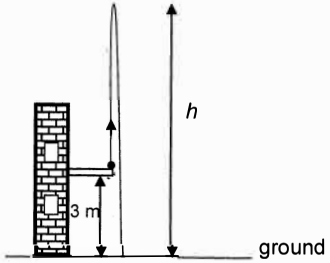
QUESTION 3 (Start on a new page.)

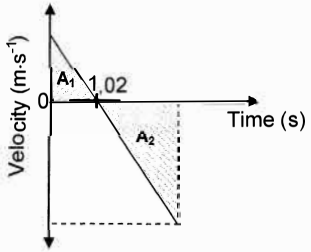
A ball, of mass 0,06 kg, is thrown vertically upwards from the balcony of a building, 3 m above the ground. The ball reaches a maximum height *h* above the ground, as shown in the diagram below.

Ignore the effects of air resistance.



3.1 Name the force acting on the ball while it is in free fall. (1)

The velocity-time graph below represents the motion of the ball from the instant it is thrown upwards until it hits the ground.



3.2 Write down the acceleration of the ball at time t = 1,02 s. (2)

3.3 Consider the areas A_1 and A_2 shown in the graph above. Write down the numerical value represented by the DIFFERENCE in areas A_1 and A_2. (1)

3.4 Calculate the:

3.4.1 Speed at which the ball is thrown upwards (3)

3.4.2 Height *h* (4)

After hitting the ground, the ball bounces vertically upwards and reaches a new maximum height in 1,1 s.

3.5 Calculate the work done by the ground on the ball while the ball is in contact with the ground. (6)
[17]

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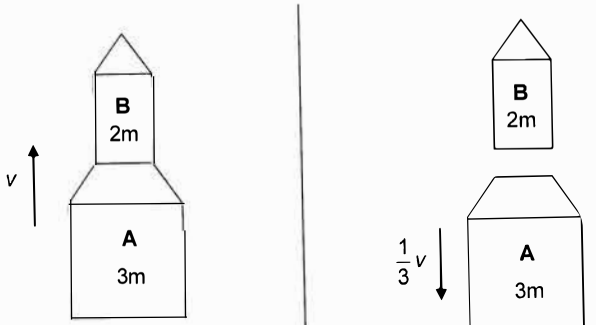
QUESTION 4 (Start on a new page.)

A simple rocket system consists of two parts, **A** of mass 3m, and **B** of mass 2m, as shown in the diagram below. **B** is stacked on top of **A**.



BEFORE EXPLOSION **AFTER EXPLOSION**

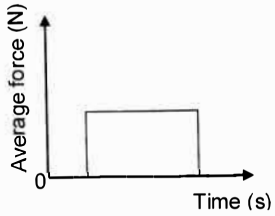
4.1 State the *principle of conservation of momentum* in words. (2)

The rocket is travelling vertically upwards at a constant speed *v* when an internal explosion causes **A** to move DOWNWARDS at a speed $\frac{1}{3}v$.

Ignore ALL external forces on the rocket.

4.2 Calculate the velocity of **B** in terms of *v* immediately after the internal explosion. (5)

The graph below shows the average force exerted by **A** on **B** during the internal explosion as a function of time.



4.3 Name the physical quantity represented by the area under the graph. (1)

4.4 Redraw the graph in your ANSWER BOOK. On the same set of axes, sketch the graph of the average force that **B** exerts on **A** as a function of time. (2)
[10]

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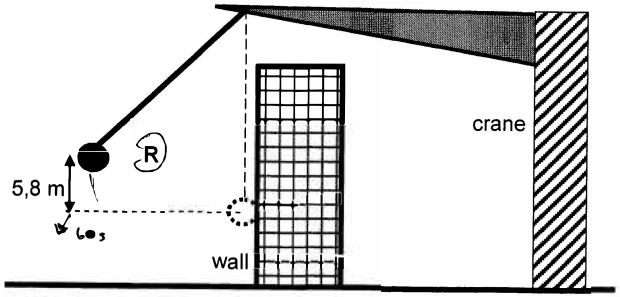
QUESTION 5 (Start on a new page.)

A demolition ball is used by a crane to break the wall of a building.

The demolition ball, of mass 1 250 kg, is lifted by the crane to a point **R** at a height of 5,8 m above its lowest position in 60 s.

Ignore air friction.



5.1 Define the term *power* in words. (2)

5.2 Calculate the average power dissipated by the crane in lifting the demolition ball to point **R**. (3)

The demolition ball is released from point **R** and strikes the wall at the lowest point of its swing. The ball then moves 0,25 m HORIZONTALLY into the wall before coming to rest.

5.3 Define the term *conservative force.* (2)

5.4 Is the force which the wall exerts on the ball a CONSERVATIVE or a NON-CONSERVATIVE force? (1)

5.5 State the energy conversion that takes place during the downward swing of the demolition ball. (1)

5.6 Using *energy principles*, calculate the magnitude of the average force exerted on the ball while it moves into the wall. (5)
[14]

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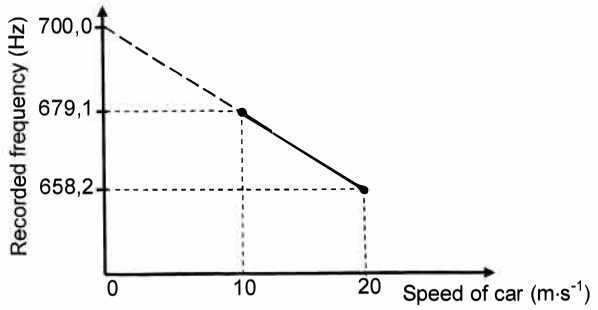
QUESTION 6 (Start on a new page.)

A learner in a car, moving at a constant speed of 10 $m \cdot s^{-1}$ along a straight horizontal road, records the frequency of sound emitted by a distant stationary source.

The learner then repeats the recording of the frequency of the sound when the car travels at a new constant speed of 20 $m \cdot s^{-1}$.

The graph below, not drawn to scale, is obtained from the results.



6.1 State the *Doppler effect*. (2)

6.2 Use the graph to answer the following questions.

6.2.1 Write down the frequency of the sound emitted by the stationary source.

Give a reason for the answer. (2)

6.2.2 In which direction is the car moving relative to the source? Choose from TOWARDS or AWAY.

Give a reason for the answer. (2)

6.2.3 Calculate the speed of sound in air. (5)
[11]

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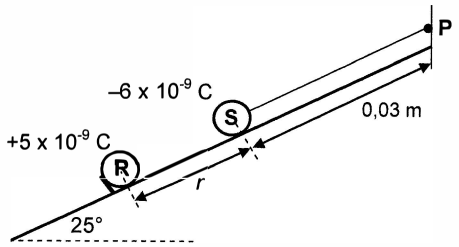
QUESTION 7 (Start on a new page.)

Two charged spheres, **R** and **S**, are both stationary on a smooth, insulated surface inclined at an angle of 25° to the horizontal. Sphere **S**, of mass 0,01 kg and carrying a charge of -6×10^{-9} C, is connected to a 0,03 m long, light inextensible string attached to point **P** at the top of the incline.

Sphere **R**, carrying a charge of $+5 \times 10^{-9}$ C, is held such that the distance between the centres of the spheres is *r*, as shown in the diagram below.

Ignore the effects of friction.



Sphere **R** exerts an electrostatic force of magnitude $1,2 \times 10^{-3}$ N on sphere **S**.

7.1 State Coulomb's law in words. (2)

7.2 Calculate the distance *r* between the spheres. (3)

7.3 Draw a labelled free-body diagram for sphere **S**. (4)

7.4 Calculate the:

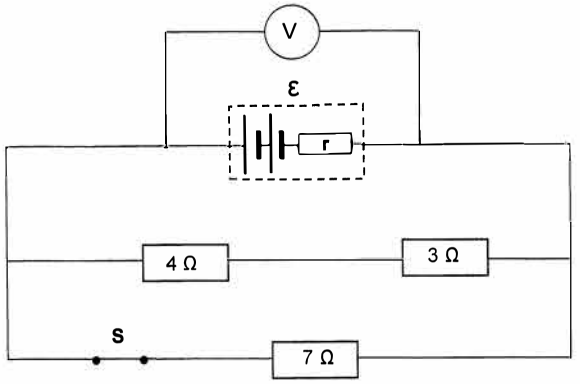
7.4.1 Tension in the string (4)

7.4.2 Net electric field at point **P** (5)
[18]

QUESTION 8 (Start on a new page.)

Three resistors are connected to a battery with an unknown emf and unknown internal resistance **r**, as shown below.

Ignore the resistance of the connecting wires.



8.1 In the definition of the emf of a battery given below, (a) and (b) represent missing words or phrases.

The emf of the battery is the maximum (a) *... supplied by a battery per* (b) *.... passing through it.*

Write down (a) and (b) in your ANSWER BOOK and next to each the missing word or phrase. (2)

With switch **S** CLOSED, the voltmeter reads 2,63 V.

8.2 Calculate the equivalent external resistance of the circuit. (4)

Switch **S** is now OPENED and the voltmeter reads 2,8 V.

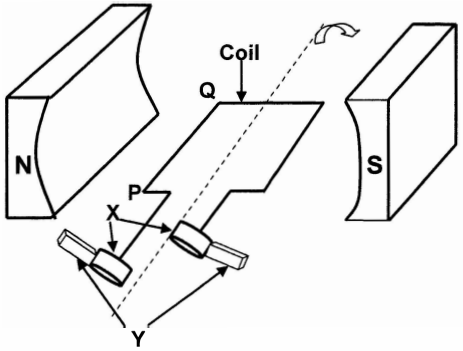
8.3 Calculate:

8.3.1 The internal resistance of the battery (8)

8.3.2 The emf of the battery (2)
[16]

QUESTION 9 (Start on a new page.)

The diagram below is a simplified representation of an AC generator. The coil is rotated in a clockwise direction in the magnetic field.



9.1 Write down the name of component **X**. (1)

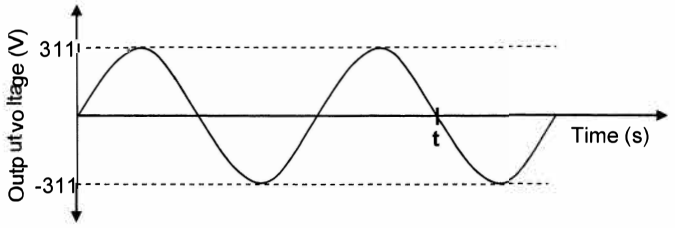
9.2 Write down the function of component **Y**. (1)

9.3 Use the relevant principle to explain why an emf is induced in the coil when the coil is rotated in the magnetic field. (2)

9.4 The coil rotates CLOCKWISE from the position shown in the diagram. In which direction will current be induced in segment **PQ** of the coil?

Choose from '**P to Q**' or '**Q to P**'. (2)

The output voltage versus time graph below was obtained for the above generator.



The output voltage is generated at a frequency of 50 Hz.

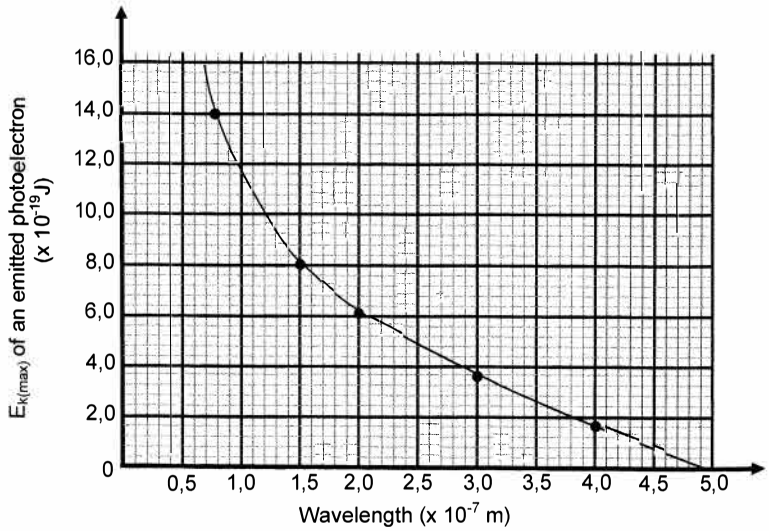
9.5 Calculate the time **t** indicated in the above graph. (3)

9.6 The generator is now connected to an appliance with a resistance of 100 Ω. Calculate the energy dissipated when the appliance is in operation for ONE minute. (5)
[14]

QUESTION 10 (Start on a new page.)

When light of various frequencies is incident on the metal cathode of a photocell, photoelectrons are emitted from the surface of the cathode.

The graph below shows the relationship between the maximum kinetic energy ($E_{k(max)}$) of an emitted photoelectron and the wavelength of the incident light.



10.1 Use the graph to determine the maximum kinetic energy of the emitted photoelectron when the wavelength of the incident light is 1,0 x 10^{-7} m. (1)

10.2 What relationship between the maximum kinetic energy of the emitted photoelectron and the wavelength of the incident light can be deduced from the graph? (2)

10.3 Define the term *work function* in words. (2)

10.4 Use the graph to calculate the work function of the metal used as cathode of this photocell. (4)

10.5 Calculate the maximum kinetic energy of the emitted photoelectron when the wavelength of the incident light is 0,5 x 10^{-7} m. (4)
[13]

TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/ NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2020

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 The rate of change of momentum of an object is equal to the …

A impulse on the object.

B net force acting on the object.

C product of the object's mass and its change in velocity.

D product of the net force acting on the object and its acceleration. (2)

1.2 The gravitational acceleration on the surface of planet **X** with mass M and radius r is g.

The gravitational acceleration on the surface of planet **Y** with mass 2M and radius $\frac{1}{2}r$ is …

A $\frac{1}{2}g$

B g

C $4g$

D $8g$ (2)

1.3 The graph below shows how one of the physical quantities associated with an object in free fall changes with time t. The label on the y-axis is omitted. Ignore air friction.



Which ONE of the following physical quantities can be the label on the y-axis?

A Velocity

B Position

C Weight

D Momentum (2)

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1.4 A ball of mass *m*, falling vertically downwards, hits the floor at a speed *v* and bounces vertically upwards at a speed 0,75*v*.

Which ONE of the following combinations regarding the change in momentum of the ball during the collision is CORRECT?

	MAGNITUDE	DIRECTION
A	0,25*mv*	Upwards
B	0,25*mv*	Downwards
C	1,75*mv*	Upwards
D	1,75*mv*	Downwards

(2)

1.5 The base SI unit of the physical quantity 'work' is …

A $kg \cdot m \cdot s^{-1}$

B $kg \cdot m^2 \cdot s^2$

C $kg \cdot m^2 \cdot s^{-2}$

D $kg \cdot m \cdot s^{-2}$ (2)

1.6 The siren of a police car, moving in front of a truck, emits sound waves of frequency *f*. Both vehicles are travelling at the same constant velocity.

The frequency of the sound heard by the driver of the truck is …

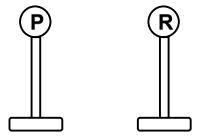
A *f*.

B zero.

C greater than *f*.

D smaller than *f*. (2)

1.7 Two identical metal spheres, **P** and **R**, on insulated stands, carry different charges. The spheres are brought into contact and then separated again.



If the charge on sphere **R** AFTER the separation is *q*, the charge on sphere **P** after the separation is …

A *q*.

B zero.

C less than *q*.

D greater than *q*. (2)

1.8 An AC generator generates a current with a frequency of 50 Hz.

The number of times that the maximum (peak) current is produced in one second is …

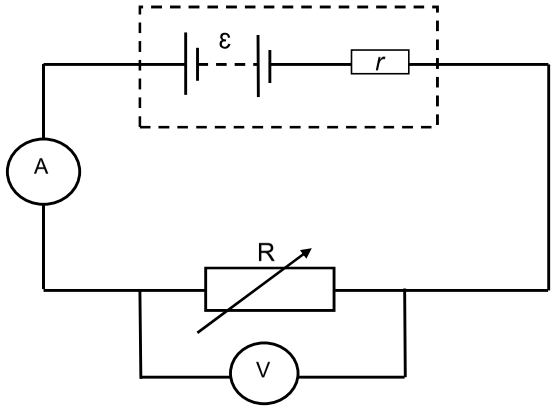
A 25.

B 50.

C 75.

D 100. (2)

1.9 In the circuit below, the battery has an internal resistance *r* and an emf ε. A variable resistor R is connected in the circuit and the ammeter and voltmeter register readings.



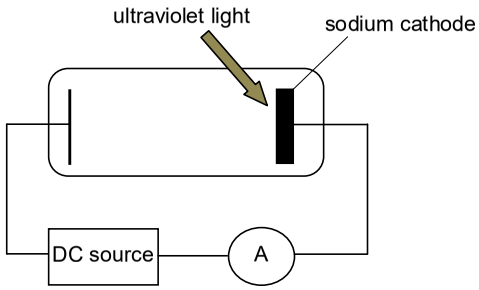
The resistance of the variable resistor R is INCREASED now.

Which ONE of the following combinations is the CORRECT representation of the change in the readings on the ammeter and voltmeter as the resistance of R is increased?

	AMMETER READING	VOLTMETER READING
A	Decreases	Increases
B	Increases	Increases
C	Increases	Decreases
D	Decreases	Decreases

(2)

1.10 The sodium cathode of a photocell is irradiated with ultraviolet light as shown in the diagram below. The ammeter registers a current.



Which ONE of the following changes will INCREASE the ammeter reading?

A Use a thinner sodium cathode.

B Increase the intensity of the ultraviolet light.

C Increase the frequency of the ultraviolet light.

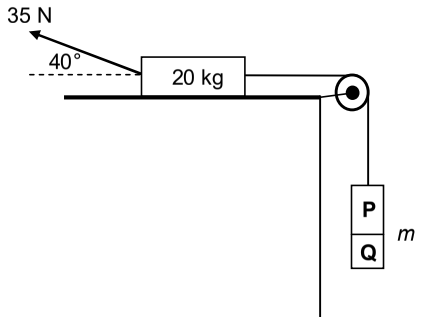
D Replace the sodium cathode with a cathode of lower work function. (2)

[20]

QUESTION 2 (Start on a new page.)

A 20 kg block, resting on a rough horizontal surface, is connected to blocks **P** and **Q** by a light inextensible string moving over a frictionless pulley. Blocks **P** and **Q** are glued together and have a combined mass of *m*.

A force of 35 N is now applied to the 20 kg block at an angle of 40° with the horizontal, as shown below.



The 20 kg block experiences a frictional force of magnitude 5 N as it moves to the RIGHT at a CONSTANT SPEED.

2.1 Define the term *normal force*. (2)

2.2 Draw a labelled free-body diagram of the 20 kg block. (5)

2.3 Calculate the combined mass *m* of the two blocks. (5)

2.4 At a certain stage of the motion, block **Q** breaks off and falls down.

How will EACH of the following be affected when this happens?

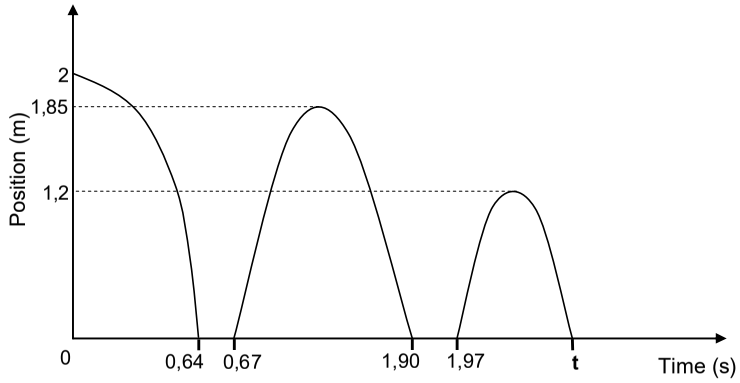
2.4.1 The tension in the string
Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

2.4.2 The velocity of the 20 kg block
Explain the answer. (3)
[16]

QUESTION 3 (Start on a new page.)

A small ball is dropped from a height of 2 m and bounces a few times after landing on a cement floor. Ignore air friction.

The position-time graph below, not drawn to scale, represents the motion of the ball.



3.1 Define the term *free fall*. (2)

3.2 Use the graph and determine:

3.2.1 The time that the ball is in contact with the floor before the first bounce (2)

3.2.2 The time it takes the ball to reach its maximum height after the first bounce (2)

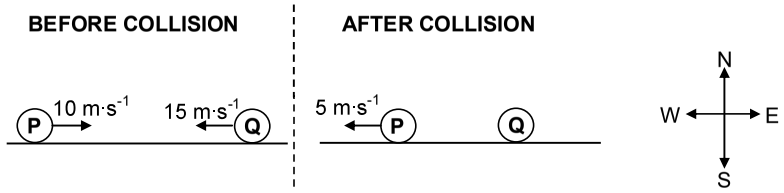
3.2.3 The speed at which the ball leaves the floor at the first bounce (3)

3.2.4 Time **t** indicated on the graph (6)
[15]

QUESTION 4 (Start on a new page.)

Ball **P** of mass 0,16 kg, moving east at a speed of 10 m·s^{-1}, collides head-on with another ball **Q** of mass 0,2 kg, moving west at a speed of 15 m·s^{-1}. After the collision, ball **P** moves west at a speed of 5 m·s^{-1}, as shown in the diagram below.

Ignore the effects of friction and the rotational effects of the balls.



4.1 Define the term *momentum* in words. (2)

4.2 Calculate the:

4.2.1 Velocity of ball **Q** after the collision (5)

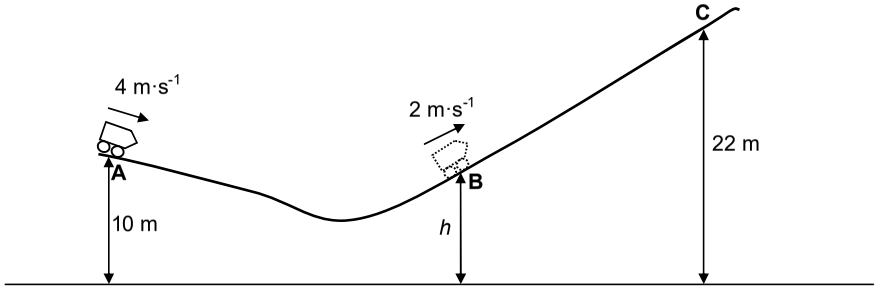
4.2.2 Magnitude of the impulse on ball **P** during the collision (3)
[10]

QUESTION 5 (Start on a new page.)

A roller-coaster car of mass 200 kg, with the engine switched off, travels along track **ABC** which has a rough surface, as shown in the diagram below. At point **A**, which is 10 m above the ground, the speed of the car is 4 m·s^{-1}.

At point **B**, which is at a height *h* above the ground, the speed of the car is 2 m·s^{-1}. During the motion from point **A** to point **B**, 3,40 × 10^3 J of energy is used to overcome friction.

Ignore rotational effects due to the wheels of the car.



5.1 Define the term *non-conservative force*. (2)

5.2 Calculate the change in the kinetic energy of the car after it has travelled from point **A** to point **B**. (3)

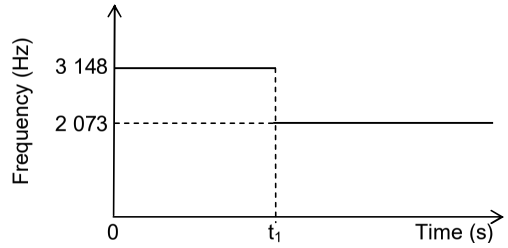
5.3 Use energy principles to calculate the height *h*. (4)

On reaching point **B**, the car's engine is switched on in order to move up the incline to point **C**, which is 22 m above the ground. While moving from point **B** to point **C**, the car travels for 15 s at a constant speed of 2 m·s^{-1}, while an average frictional force of 50 N acts on it.

5.4 Calculate the power delivered by the engine to move the car from point **B** to point **C**. (5)
[14]

QUESTION 6 (Start on a new page.)

The siren of a train, moving at a constant speed along a straight horizontal track, emits sound with a constant frequency. A detector, placed next to the track, records the frequency of the sound waves. The results obtained are as shown in the graph below.



6.1 State the Doppler effect in words. (2)

6.2 Does the detector record the frequency of 3 148 Hz when the train moves TOWARDS the detector or AWAY from the detector? (1)

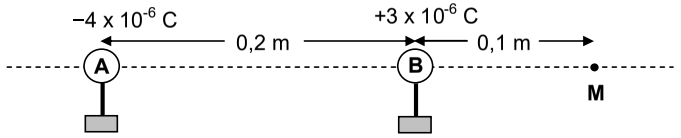
6.3 Calculate the speed of the train. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (6)

6.4 The detector started recording the frequency of the moving train's siren when the train was 350 m away.

Calculate time t_1 indicated on the graph above. (2)
[11]

QUESTION 7 (Start on a new page.)

Two small charged spheres, **A** and **B**, are placed on insulated stands, 0,2 m apart, as shown in the diagram below. They carry charges of -4×10^{-6} C and $+3 \times 10^{-6}$ C respectively.



M is a point that is a distance of 0,1 m to the right of sphere **B**.

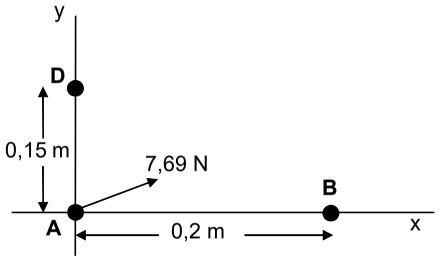
7.1 Calculate the number of electrons in excess on sphere **A**. (3)

7.2 Calculate the magnitude of the electrostatic force exerted by sphere **A** on sphere **B**. (3)

7.3 Describe the term *electric field*. (2)

7.4 Calculate the magnitude of the net electric field at point **M**. (5)

Charged spheres **A** and **B** and another charged sphere **D** are now arranged along a rectangular system of axes, as shown in the diagram below.



The net electrostatic force experienced by sphere **A** is 7,69 N in the direction as shown in the diagram above.

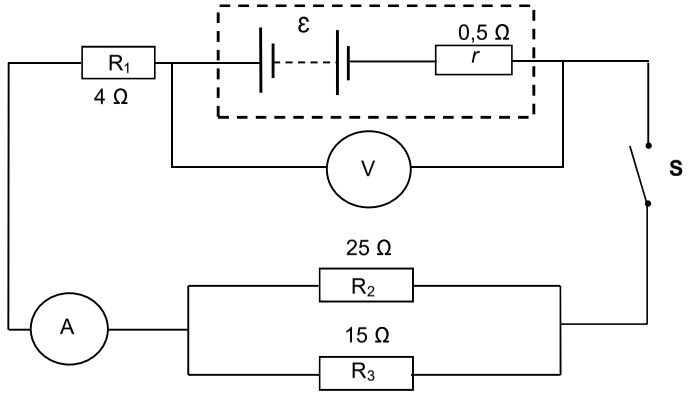
7.5 Is the charge on sphere **D** POSITIVE or NEGATIVE? (1)

7.6 Calculate the magnitude of the charge on sphere **D**. (3)
[17]

QUESTION 8 (Start on a new page.)

A battery with an internal resistance of 0,5 Ω and an unknown emf (ε) is connected to three resistors, a high resistance voltmeter and an ammeter of negligible resistance, as shown in the circuit diagram below.

The resistance of the connecting wires must be ignored.



8.1 Define the term *emf* of a battery. (2)

The reading on the voltmeter DECREASES by 1,5 V when switch **S** is closed.

8.2 Give a reason why the voltmeter reading decreases. (2)

8.3 Calculate the following when switch **S** is closed:

8.3.1 Reading on the ammeter (3)

8.3.2 Total external resistance of the circuit (4)

8.3.3 Emf of the battery (3)

8.4 A learner makes the following statement:

The current through resistor R_3 is larger than the current through resistor R_2.

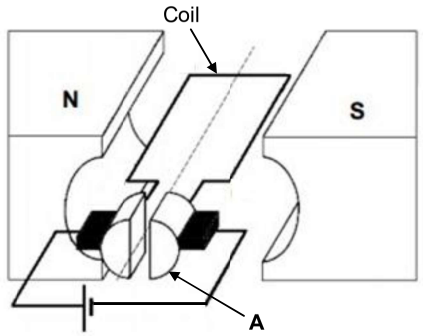
Is this statement CORRECT? Choose from YES or NO. Explain the answer. (3)

8.5 The 4 Ω resistor is now removed from the circuit.

How will this affect the emf of the battery? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
[18]

QUESTION 9 (Start on a new page.)

9.1 A simplified diagram of an electrical machine is shown below.



9.1.1 Is this machine a DC motor or a DC generator? (1)

9.1.2 Write down the energy conversion that takes place while this machine is in operation. (2)

9.1.3 Write down the name of component **A** in the diagram. (1)

9.1.4 In which direction will the coil, shown in the diagram above, rotate? Choose from CLOCKWISE or ANTICLOCKWISE. (2)

9.2 An electrical device is marked 200 W ; 220 V.

9.2.1 Define the term *rms voltage*. (2)

9.2.2 Calculate the resistance of the device. (3)

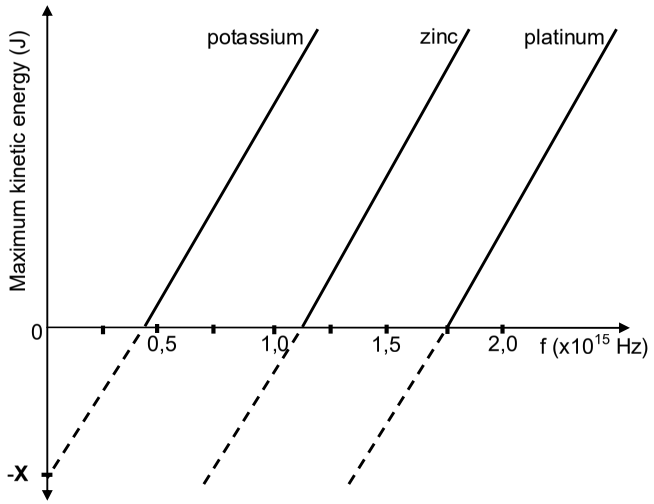
This device is now connected to a 150 V AC source.

9.2.3 Calculate the energy dissipated by the device in 10 minutes. (5)
[16]

QUESTION 10 (Start on a new page.)

An experiment is conducted to investigate the relationship between the frequency of light incident on a metal and the maximum kinetic energy of the emitted electrons from the surface of the metal. This experiment is conducted for three different metals.

The graph below represents the results obtained.



10.1 Name the phenomenon on which this experiment is based. (1)

10.2 Name the physical quantity represented by **X** on the graph. (1)

10.3 Which ONE of the three metals needs incident light with the *largest wavelength* for the emission of electrons?

Give a reason for the answer. (2)

10.4 Define the term *work function* in words. (2)

10.5 Calculate the:

10.5.1 Work function of **platinum** (3)

10.5.2 Frequency of the incident light that will emit electrons from the surface of **platinum** with a maximum velocity of $5,60 \times 10^5$ m·s^{-1} (4)

[13]

TOTAL: 150

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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2020

PHYSICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

This question paper consists of 18 pages, including 2 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Vuyo, the driver of a minibus that is moving at a constant velocity, on a horizontal road, sees that the sliding door of the minibus is open. He suddenly applies his brakes and the door closes. Which ONE of the following Physics laws or principles best explains why Vuyo could close the door?

A Law of conservation of mechanical energy

B Principle of conservation of linear momentum

C Newton's First Law of Motion

D Newton's Second Law of Motion (2)

1.2 A 2 kg mass piece is placed on a 2 kg trolley, which is at rest on a frictionless horizontal surface. When a force **F** is applied on the trolley, it accelerates with an acceleration of **a** as shown in **FIGURE 1**. A 1 kg mass piece is then placed on the trolley with the 2 kg mass piece and the same force **F** is applied on the trolley as shown in **FIGURE 2**.

FIGURE 1

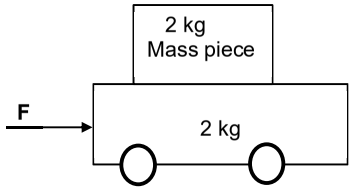
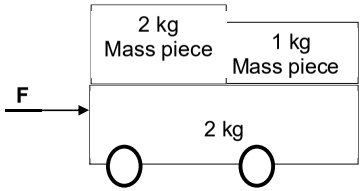


FIGURE 2



What will be the acceleration of the trolley in **FIGURE 2**?

A $\frac{1}{4}$ a

B $\frac{2}{3}$ a

C $\frac{4}{5}$ a

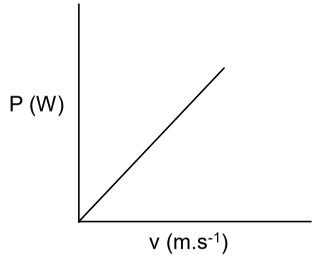
D $\frac{5}{4}$ a (2)

1.3 Two cars are involved in an INELASTIC head-on collision. Which ONE of the following combinations correctly describes the kinetic energy and the momentum of the system?

	TOTAL KINETIC ENERGY	TOTAL MOMENTUM
A	Not conserved	Conserved
B	Conserved	Not conserved
C	Conserved	Conserved
D	Not conserved	Not conserved

(2)

1.4 The graph below shows the relationship between the power delivered by the engine of a car and the average speed of the car.



The gradient of the above graph represents the …

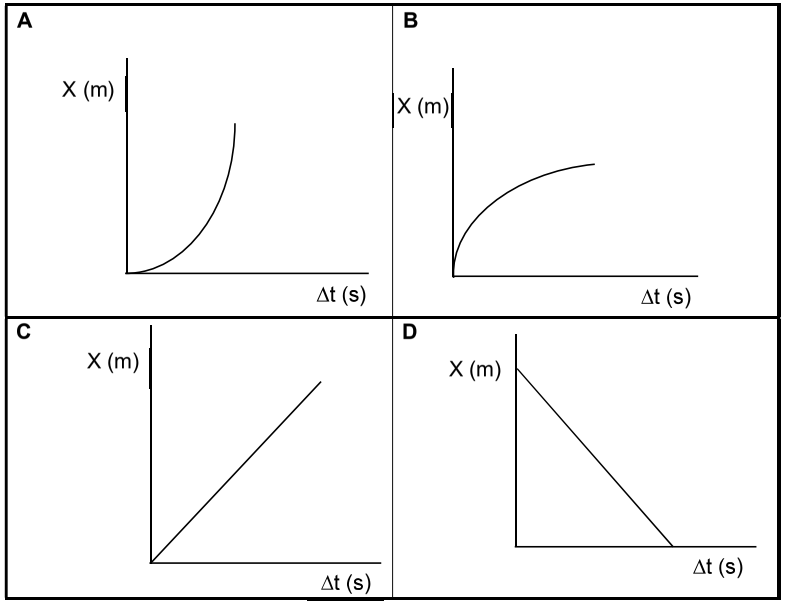
A momentum of the car.

B work done by the engine of the car.

C kinetic energy of the car.

D applied force of the engine on the car. (2)

1.5 A ball is dropped from a certain height. Which ONE of the position versus time graphs below best represents the motion?



(2)

1.6 … is the main principle applied when measuring the rate of blood flow or the heartbeat of a fetus in the womb.

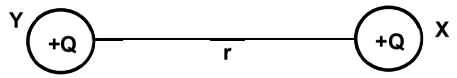
A Photoelectric effect

B Doppler effect

C Huygen's principle

D Diffraction (2)

1.7 The electrostatic force between two point charges that are placed a distance **r** apart in a vacuum is **F**.



The distance between the charges is changed and the electrostatic force between them changes to **16 F**. What is the new distance between the point charges in terms of **r**?

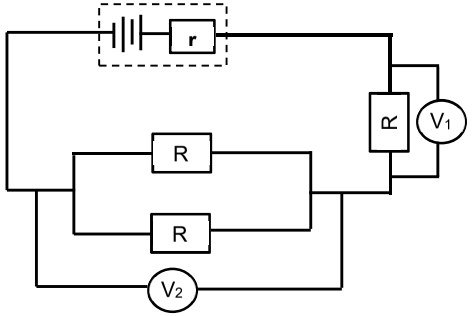
A 8 **r**

B $\frac{1}{8}$ **r**

C 4 **r**

D $\frac{1}{4}$ **r** (2)

1.8 Three identical resistors are connected to a battery as shown on the circuit diagram below. The resistance of the connecting wires can be ignored.



Which ONE of the following best represents the relationship between the readings of the voltmeters?

A $V_1 = ½ V_2$

B $V_1 = 2 V_2$

C $V_1 = V_2$

D $V_1 = ⅓ V_2$ (2)

1.9 The maximum emf of an AC generator can be increased by ...

A changing the polarity of the magnets.

B using larger slip rings.

C using larger brushes.

D increasing the number of turns on the coil. (2)

1.10 In a house, appliances are usually connected in parallel to each other because …

(i) the resistance of each resistor will decrease.
(ii) each appliance can operate independently.
(iii) the current supply to each appliance will be higher.
(iv) each appliance will have maximum voltage.

Which ONE of the following combinations about reasons for connecting appliances in parallel in a house is correct?

A (i) and (ii) only

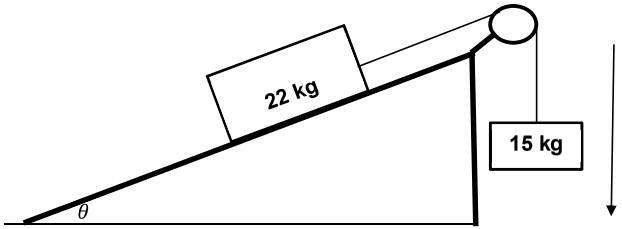
B (i), (ii) and (iii) only

C (ii), (iii) and (iv) only

D (i), (ii), (iii) and (iv) (2)
[20]

QUESTION 2

A block of mass 22 kg is placed on a rough inclined surface and is connected to a 15 kg block which hangs vertically by means of a light inextensible string passing over a frictionless pulley, as shown in the diagram below. When the inclined surface is at an angle θ to the horizontal, the 15 kg block moves downwards *(as shown by the arrow alongside the diagram)* at a CONSTANT VELOCITY.

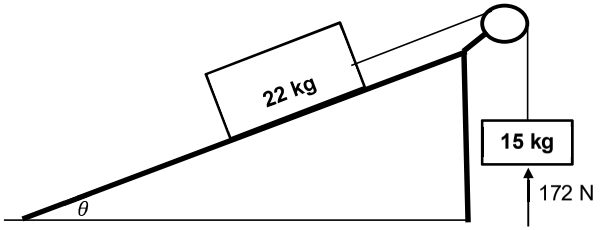


2.1 State Newton's Second Law of motion in words. (2)

2.2 Draw a labelled free-body diagram of all forces acting on the 22 kg block. (4)

2.3 A constant frictional force of 43,86 N acts on the 22 kg block. Calculate the magnitude of the angle θ that will keep the system moving at a constant velocity. (4)

2.4 A force of 172 N is now applied on the 22 kg block and the system of blocks accelerates down the slope. The kinetic frictional force acting on the 22 kg block while it accelerates downward **remains the same**.

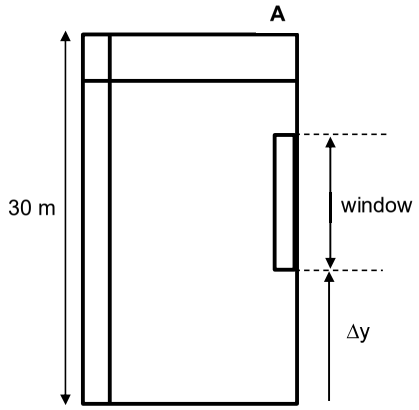


2.4.1 Explain why the kinetic frictional force remains the same even though the system accelerates. (2)

2.4.2 Calculate the acceleration of the system of blocks. (6)
[18]

QUESTION 3

A ball of mass 500 g is thrown vertically downwards with a velocity of 3,28 $m.s^{-1}$ from the top of a 30 m high building, point **A**. After 1,2 s the ball passes the top edge of a window and goes on to hit the ground below. The ground exerts a force of 205 N on the ball and it bounces off to a maximum height Δy, which is at the same level as the lower edge of the window, as shown in the diagram below. The ball is in contact with the ground for 0,1 s. Ignore the effects of air resistance.



Calculate the:

3.1 Velocity of the ball after 1,2 seconds (3)

3.2 Displacement of the ball after 1,2 s of its motion (4)

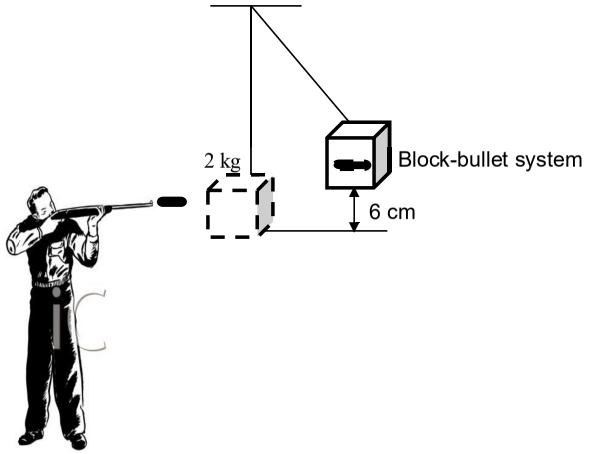
3.3 Magnitude of the velocity with which the ball hits the ground (3)

3.4 Velocity with which the ball bounced off the ground (4)

3.5 Length of the window (5)
[19]

QUESTION 4

During a demonstration to determine the recoil velocity of a certain type of gun, a bullet of mass 5 g is fired from a gun of mass 5 kg. The bullet moves horizontally at a constant velocity into a wooden block of mass 2 kg that hangs vertically from a ceiling by means of a light inextensible string. The block-bullet system swings to a vertical height of 6 cm above its original position as shown in the diagram below. Ignore the effects of air resistance.



4.1 State the principle of conservation of linear momentum in words. (2)

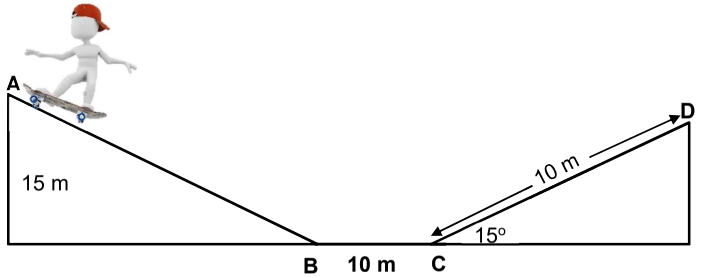
4.2 Suppose that the original position of the wooden block is zero position. Calculate the:

4.2.1 Velocity of the bullet before it entered the wooden block (5)

4.2.2 Recoil velocity of the gun (3)
[10]

QUESTION 5

A skateboarder skates from point **A** of the track, which is at a vertical height of 15 m, and aims to come to rest at point **D** on the other side as shown on the diagram below. Section **AB** is frictionless while **BC** and **CD** are rough. The combined mass of the skateboarder and the skateboard is 55 kg. The skateboarder experiences a frictional force of 15 N while moving from point **C** to point **D**. Ignore the effects of air resistance.



5.1 State the principle of conservation of mechanical energy in words. (2)

5.2 Calculate the kinetic energy of the skateboarder at point **B**. (3)

5.3 State the work-energy theorem in words. (2)

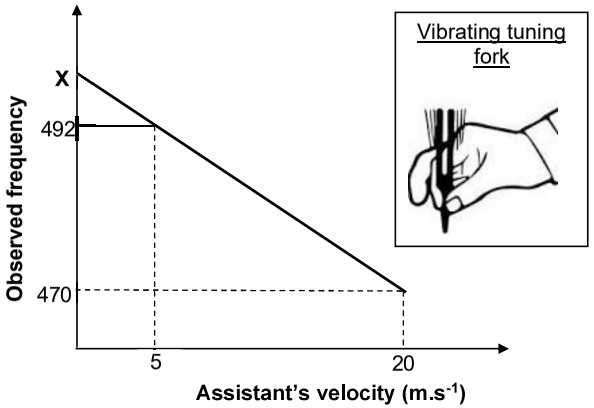
5.4 Use energy principles to calculate the:

5.4.1 Kinetic energy of the skateboarder at point **C** (4)

5.4.2 Magnitude of the frictional force along **BC** that will enable the skateboarder to come to rest at point **D** (5)
[16]

QUESTION 6

A laboratory assistant conducted an experiment to determine the frequency of a tuning fork. The tuning fork is set on vibration and mounted on a stand as shown in the inserted sketch. He then moves towards and away from the tuning fork with a detector which records the frequency of sound emitted by the tuning fork. The graph below represents the results he recorded. Take velocity of sound in air as 340 m.s^{-1}.



6.1 Name the phenomenon represented on the graph. (1)

6.2 Does the graph represent the instance when the laboratory assistant was moving TOWARDS or AWAY from the tuning fork? Explain your answer. (2)

6.3 Write down the relationship between the laboratory assistant's velocity and the observed frequency. (2)

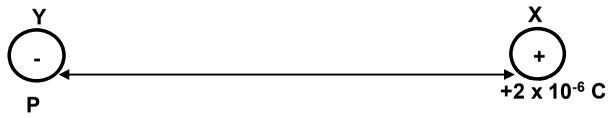
6.4 What does **X**, the intercept on the vertical axis, represent? (2)

6.5 Calculate the frequency of the tuning fork. (5)

6.6 The laboratory assistant intends to use the tuning fork to produce oscillations with wavelength of 0,71 m for a Grade 10 demonstration lesson. Use a calculation to determine whether or not the tuning fork will be suitable for the demonstration. (3)
[15]

QUESTION 7

A small, charged sphere **X** carrying a charge of +2 x 10^{-6} C is placed in a vacuum. When another small sphere **Y** of mass 5 mg carrying a negative charge is placed at point **P**, it accelerates from rest to a velocity of 6,25 x 10^{3} m.s^{-1} just before sphere **Y** touches sphere **X.** The time taken for sphere **Y** to reach sphere **X** is 2 x 10^{-3} seconds.



7.1 Calculate the number of electrons that were removed from the sphere **X** to obtain the charge on the sphere. (3)

7.2 Draw the electric field pattern around the charges while sphere **Y** is still at point **P**. (3)

7.3 Calculate the:

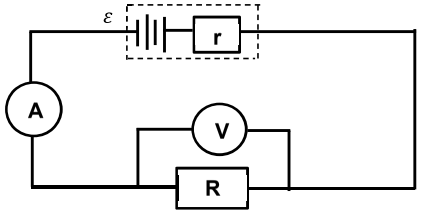
7.3.1 Net electric field strength at point **P** due to the charged sphere **X** (6)

7.3.2 Distance between the charges before sphere **Y** moved (3)

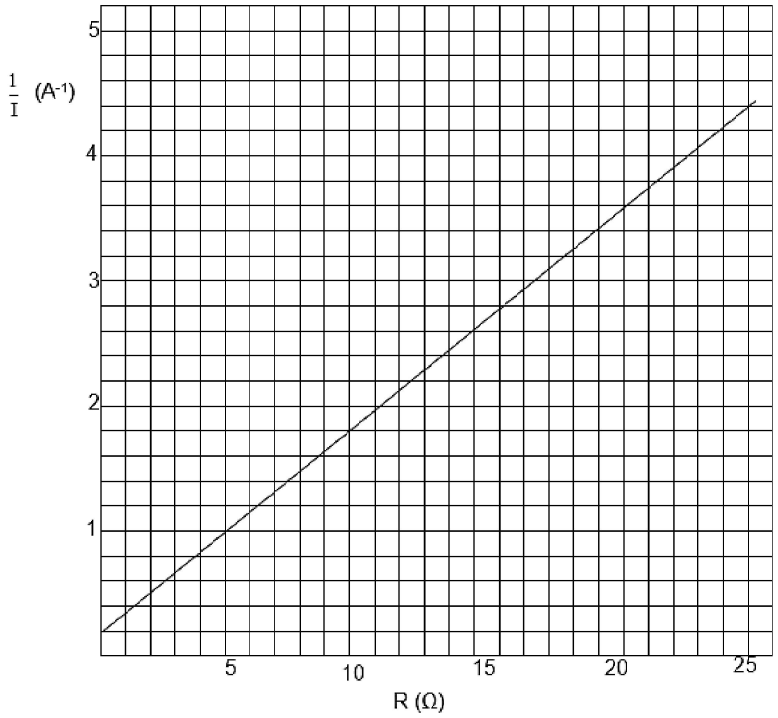
7.3.3 Charge on sphere **Y** (4)
[19]

QUESTION 8

In an experiment to determine the emf (ε) and internal resistance r, of a battery, a group of learners connected the circuit diagram below. They recorded the ammeter and voltmeter readings. They repeated the experiment each time with a different resistance.



Their results are plotted in the graph below.



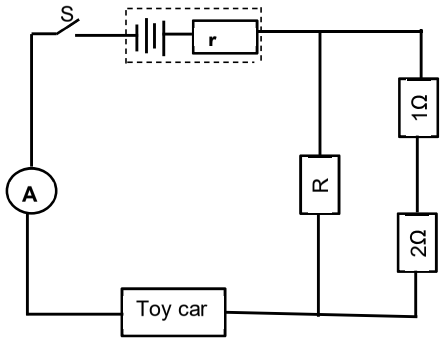
8.1 What is the independent variable for this experiment? (1)

8.2 Using the equation $\frac{1}{I} = \frac{R + r}{emf}$, calculate the:

8.2.1 Emf ε of the battery (4)

8.2.2 Internal resistance of the battery (3)

8.3 In the circuit diagram below the battery used in the above experiment is connected to three resistors and a toy car that is rated at 3 W, 1,5 V.



When the switch S is closed, calculate the:

8.3.1 Reading on the ammeter (3)

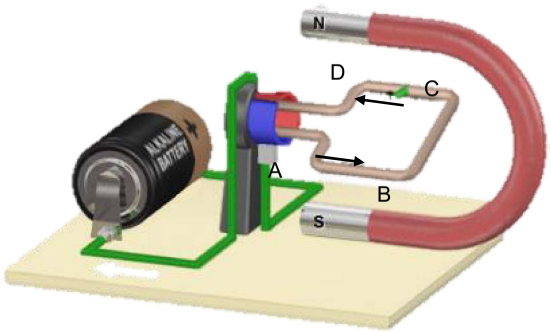
8.3.2 Resistance of resistor R (6)

8.4 If the resistor R is removed from the circuit, will the toy car be able to operate as rated? Answer only YES or NO. Explain your answer. (3)

[20]

QUESTION 9

A learner built an electrical device for her Eskom Expo science project as shown below.



9.1 What is name of the electrical device represented above? (1)

9.2 State the energy conversion taking place in this device. (2)

9.3 If current flows in the device as indicated by the arrows in the diagram above, in which direction will section AB rotate? Answer CLOCKWISE or ANTI-CLOCKWISE. (1)

9.4 Her teacher advised her to modify the above device into one that can supply households with electricity. How can she modify the device for the desired purpose? (2)

9.5 A kettle rated at 1 500 W is plugged into a wall socket that supplies 230 V. Calculate the:

9.5.1 Resistance of the conducting coil in the kettle (3)

9.5.2 Maximum (peak) current that passes through the kettle (4)

[13]

TOTAL: 150

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CHEMISTRY DATA SHEETS

4.3 INFORMATION SHEETS – PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6,02 \times 10^{23}$ mol^{-1}
Standard pressure	p^θ	$1,01 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 dm^3·mol^{-1}
Standard temperature	T^θ	273 K

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH = -log[H_3O^+]
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$	

PERIODIC TABLE

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**Ac**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number
Atoomgetal

29
1,9 **Cu**
63,5

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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STANDARD REDUCTION POTENTIALS

TABLE 4A: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↑

Increasing reducing ability ↓

Half-reactions			$E^{\ominus}$ (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Na^+ + e^-$	⇌	Na	– 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Cs^+ + e^-$	⇌	Cs	- 2,92
$K^+ + e^-$	⇌	K	– 2,93
$Li^+ + e^-$	⇌	Li	– 3,05

TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↓

Increasing reducing ability ↑

Half-reactions			$E^{\ominus}$ (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	– 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

CHEMISTRY PAPER 2 PRACTICE

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: CHEMISTRY (P2)

2023

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only NE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER B K, e.g. 1.11 E.

1.1 For which ONE of the following molecular formulae are CHAIN isomers possible?

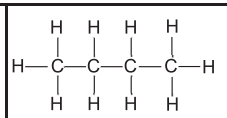
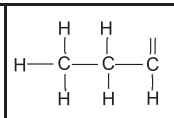
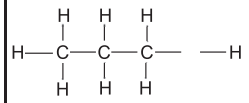
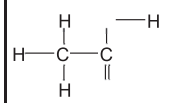
A C_4H_{10}

B C_3H_8

C C_2H_6O

D C_3H_8O (2)

1.2 Which NE of the following compounds has the L WEST vapour pressure under the same conditions?

A		B	
C		D	

(2)

1.3 The type of organic compound formed when a haloalkane is heated in the presence of a concentrated strong base is an …

A alkane.

B alkene.

C alkyne.

D alcohol. (2)

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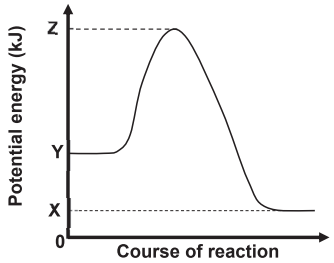
1.4 EXCESS HCℓ(aq) of concentration 0,1 mol·dm^{-3} reacts with 2 g of Mg under different conditions.

Which ONE of the following combinations of conditions will produce the largest volume of $H_2(g)$ in the FIRST MINUTE of the reaction?

	STATE OF DIVISION OF Mg	TEMPERATURE OF HCℓ(aq) (°C)
A	Powder	20
B	Granules	20
C	Powder	50
D	Granules	50

(2)

1.5 The potential energy diagram for a chemical reaction is shown below.



Which ONE of the following combinations is CORRECT for the FORWARD reaction?

	∆H	ACTIVATION ENERGY	POTENTIAL ENERGY OF THE ACTIVATED COMPLEX
A	Y–X	Z+Y	Z
B	Y–X	Z–Y	Z+Y
C	X–Y	Z–Y	Z
D	X–Y	Z	Z–Y

(2)

1.6 Consider the following reaction that reaches equilibrium in a beaker:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$

A few drops of concentrated NaOH(aq) are now added to the beaker.

Which ONE of the following combinations correctly identifies the DISTURBANCE ON THE SYSTEM and the SYSTEM'S RESPONSE to the disturbance?

	DISTURBANCE ON THE SYSTEM	SYSTEM'S RESPONSE
A	$[H^+]$ decreases	Forward reaction favoured
B	$[H^+]$ decreases	Reverse reaction favoured
C	$[CrO_4^{2-}]$ decreases	Reverse reaction favoured
D	$[CrO_4^{2-}]$ increases	Forward reaction favoured

(2)

1.7 According to the Lowry-Brønsted theory, a conjugate base is formed when a/an …

A proton is added to the acid.

B electron is added to the acid.

C proton is removed from the acid.

D electron is removed from the acid. (2)

1.8 Consider the statements below regarding an alkaline substance.

An alkaline substance:

(i) Reacts with an acid to form a neutral solution

(ii) Turns red litmus blue

(iii) Forms a salt when it reacts with an acid

Which of the statements above are ALWAYS TRUE?

A (i), (ii) and (iii)

B (i) and (ii) only

C (i) and (iii) only

D (ii) and (iii) only (2)

1.9 Consider the cell notation for a galvanic cell.

$$Pt \mid H_2(g) \mid OH^-(aq) \mid H_2O(\ell) \parallel Ag^+(aq) \mid Ag(s)$$

Which ONE of the following equations represents the half-reaction taking place at the positive electrode?

A $Ag^+(aq) + e^- \rightarrow Ag(s)$

B $Ag(s) \rightarrow Ag^+(aq) + e^-$

C $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

D $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(\ell) + 2e^-$ (2)

1.10 A concentrated solution of sodium chloride, NaCℓ(aq), undergoes electrolysis.

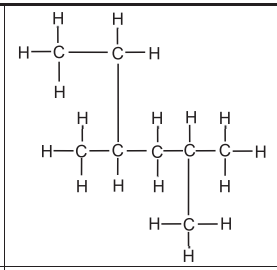
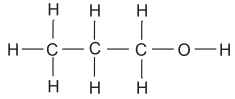
Which ONE of the combinations correctly shows the products formed at each electrode?

	CATHODE	ANODE
A	Na	$C\ell_2$
B	H_2	OH^-
C	$C\ell_2$	H_2 and OH^-
D	H_2 and OH^-	$C\ell_2$

(2)
[20]

QUESTION 2 (Start on a new page.)

Study the table below and answer the questions that follow.

A		**B**	
C	C_4H_8O	**D**	$CH_3(CH_2)_4CHCH_2$
E	$C_XH_YO_Z$		

2.1 Define the term *unsaturated* hydrocarbon. (2)

2.2 Write down the:

2.2.1 Letter that represents an UNSATURATED hydrocarbon (1)

2.2.2 IUPAC name of compound **A** (3)

2.2.3 IUPAC name of the POSITIONAL isomer of compound **B** (2)

2.2.4 IUPAC name of compound **D** (2)

2.2.5 Balanced equation, using MOLECULAR FORMULAE, for the complete combustion of compound **A** (3)

2.3 The formula C_4H_8O represents two compounds that are functional isomers of each other.

2.3.1 Define the term *functional isomer*. (2)

2.3.2 Write down the STRUCTURAL FORMULAE of each of these two FUNCTIONAL isomers. (4)

2.4 A 2 g sample of compound **E** contains 1,09 g carbon and 0,18 g hydrogen. The molecular mass of compound **E** is 88 $g \cdot mol^{-1}$.

Determine the molecular formula of compound **E** by means of a calculation. (6)
[25]

QUESTION 3 (Start on a new page.)

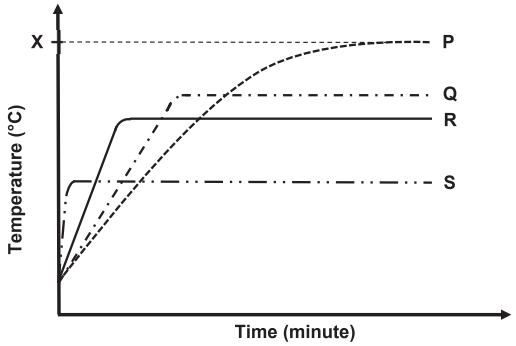
Learners investigate the boiling points of the four organic compounds given below.

ORGANIC COMPOUND	MOLECULAR MASS ($g \cdot mol^{-1}$)
Butanone	72
Butan-1-ol	74
Propanoic acid	74
2-methylpropan-1-ol	74

3.1 Define the term *boiling point.* (2)

3.2 Which compound, butan-1-ol or 2-methylpropan-1-ol, will have the higher boiling point? Fully explain the answer. (4)

The curves **P**, **Q**, **R** and **S** below were obtained from the results of the investigation. **X** represents a specific temperature.



3.3 Which physical property is represented by temperature **X**? (1)

3.4 Which curve (**P**, **Q**, **R** or **S**) represents:

3.4.1 Butanone (1)

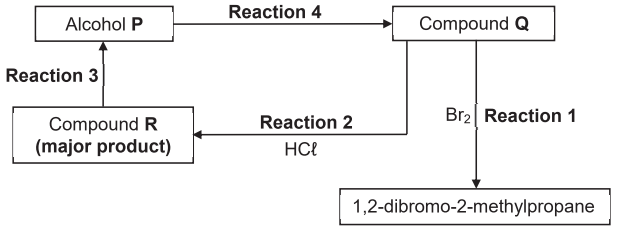
3.4.2 Propanoic acid (1)

3.4.3 2-methylpropan-1-ol (1)

3.5 Give a reason for the answer to QUESTION 3.4.2. (1)
[11]

QUESTION 4 (Start on a new page.)

4.1 The flow diagram below shows different organic reactions.
P, **Q** and **R** are organic compounds.



Reaction 1 is an addition reaction.

Write down:

4.1.1 The TYPE of addition reaction (1)

4.1.2 ONE observable change which occurs in the container during the reaction (1)

4.1.3 The STRUCTURAL FORMULA of compound **Q** (2)

Consider **reaction 2**.

4.1.4 Write down the IUPAC name of compound **R**. (2)

For **reaction 3**, write down:

4.1.5 A balanced equation using STRUCTURAL FORMULAE for the organic compounds (6)

4.1.6 The IUPAC name of alcohol **P** (2)

Reaction 4 is an elimination reaction.

4.1.7 Write down the TYPE of elimination reaction. (1)

4.2 Butan-1-ol reacts with propanoic acid in the presence of a catalyst.

Write down the:

4.2.1 TYPE of reaction that takes place (1)

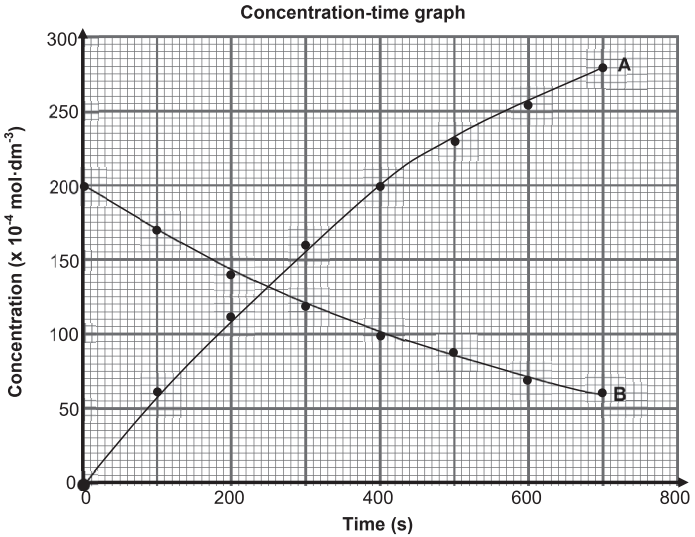
4.2.2 IUPAC name of the organic product formed (2)
[18]

QUESTION 5 (Start on a new page.)

Consider the following decomposition reaction that takes place in a sealed 2 dm^3 container:

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

The graph below shows how the concentrations of $N_2O_5(g)$ and $NO_2(g)$ change with time.



5.1 Refer to the graph above and give a reason why curve **A** represents the change in the concentration of $NO_2(g)$. (1)

5.2 Consider the statement below:

The rate of decomposition of $N_2O_5(g)$ is half the rate of formation of $NO_2(g)$.

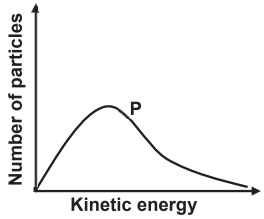
Is this statement TRUE or FALSE? Give a reason for the answer. (2)

5.3 Calculate the:

5.3.1 Mass of $NO_2(g)$ present in the container at 400 s (4)

5.3.2 Average rate of production of $O_2(g)$ in $mol \cdot dm^{-3} \cdot s^{-1}$ in 700 s (4)

5.4 The Maxwell-Boltzmann distribution curve for the $N_2O_5(g)$ initially present in the container is shown below.



The initial concentration of the $N_2O_5(g)$ is now INCREASED.

5.4.1 Redraw the distribution curve above in the ANSWER BOOK and label this curve as **P**.

On the same set of axes, sketch the curve that will be obtained for the higher concentration of $N_2O_5(g)$. Label this curve as **Q**. (2)

5.4.2 Will the rate of decomposition of $N_2O_5(g)$ at the higher concentration be HIGHER THAN, LOWER THAN or EQUAL TO the original rate of decomposition? Explain the answer using the collision theory. (3)
[16]

QUESTION 6 (Start on a new page.)

One mole of pure hydrogen iodide gas, HI(g), is sealed in a 1 dm^3 container at 721 K. Equilibrium is reached according to the following balanced equation:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

It is found that 0,11 moles of $I_2(g)$ are present at equilibrium.

6.1 State Le Chatelier's principle. (2)

6.2 Determine the number of moles of EACH of the following at equilibrium:

6.2.1 $H_2(g)$ (1)

6.2.2 HI(g) (1)

6.3 The equilibrium constant, K_c, at 721 K is 0,02.

The temperature of the container is now increased to 850 K.
The equilibrium constant, K_c, at 850 K is 0,09.

6.3.1 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

6.3.2 Fully explain the answer to QUESTION 6.3.1. (3)

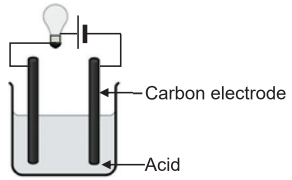
6.3.3 Calculate the mass of HI(g) present at the new equilibrium at 850 K. (8)
[16]

QUESTION 7 (Start on a new page.)

7.1 The conductivity of three acid solutions, **A**, **B** and **C**, as shown below is investigated at the same temperature.

A	0,1 mol·dm^{-3} $H_2SO_4(aq)$
B	0,1 mol·dm^{-3} $HNO_3(aq)$
C	0,1 mol·dm^{-3} $CH_3COOH(aq)$

The brightness of the bulb in the apparatus shown below is used as a measure of the conductivity of the solutions.



The acid solutions are electrolytes.

7.1.1 Define the term *electrolyte*. (2)

The brightness of the bulb for each of the solutions is compared.

7.1.2 In which solution, **A** or **B**, will the bulb be brighter? Give a reason for the answer by referring to the types of acids. (2)

7.1.3 In which solution, **B** or **C**, will the bulb be brighter? Give a reason for the answer by referring to the types of acids. (2)

7.2 A hydrochloric acid solution, HCℓ(aq), is standardised by titrating it against 25 cm^3 of a 0,04 $mol \cdot dm^{-3}$ sodium carbonate solution $Na_2CO_3(aq)$. At the endpoint, it is found that 19,5 cm^3 of HCℓ(aq) has reacted.

The balanced equation for the reaction is:

$$Na_2CO_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

.2.1 Calculate the concentration of the HCℓ(aq). (3)

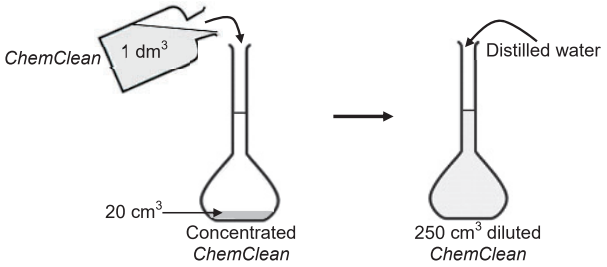
.2.2 Suppose a few drops of water were present in the burette before it was filled with the hydrochloric acid solution.

How will the volume of the HCℓ solution needed to reach the endpoint be affected?

Choose from GREATER THAN, SMALLER THAN or REMAINS THE SAME. Give a reason for the answer. (2)

A concentrated household product, *ChemClean*, contains ammonia as the main cleaning agent. To determine the amount of ammonia present in 1 dm^3 of *ChemClean*, the following procedure is followed:

20 cm^3 of *ChemClean* is added to a 250 cm^3 flask. The flask is then filled to the 250 cm^3 mark with distilled water.



The diluted solution is titrated against the hydrochloric acid solution of the concentration as calculated in QUESTION 7.2.1.

During the titration, 22 cm^3 of the diluted *ChemClean* solution is neutralised by 18,7 cm^3 of the HCℓ solution. The balanced equation for the reaction is:

$$NH_3(aq) + HC\ell(aq) \rightarrow NH_4^+(aq) + C\ell^-(aq)$$

.2.3 Calculate the mass of ammonia in 1 dm^3 of *ChemClean*. (7)

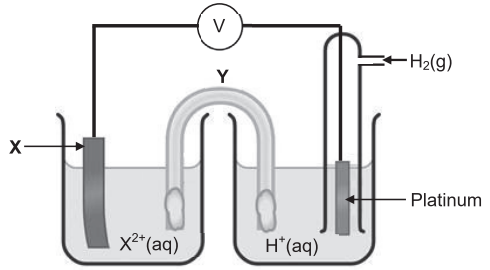
.2.4 Will the pH of the solution at the end of the titration be GREATER THAN 7, EQUAL TO 7 or LESS THAN 7?

Write down the relevant equation as motivation for the answer. (3)
[21]

QUESTION 8 (Start on a new page.)

Learners want to identify an unknown metal **X** using a standard half-cell, $X \mid X^{2+}$.

They set up an electrochemical cell under standard conditions using two half-cells, as shown in the diagram below.



The initial emf of this cell is 1,20 V.

8.1 State the standard conditions under which this cell functions. (3)

8.2 State ONE function of component **Y**. (1)

After the cell has operated for some time, it is found that the mass of electrode **X** has increased.

8.3 Identify **X** by means of a suitable calculation. (5)

8.4 Write down the oxidation half-reaction that takes place in this cell. (2)

Half-cell $X \mid X^{2+}$ is now replaced by an $Au \mid Au^{3+}$ half-cell.

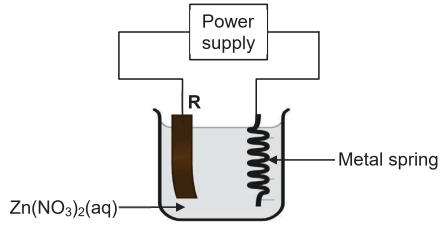
The initial emf of the cell is now 1,50 V. As the cell operates, the Au electrode increases in mass.

8.5 Arrange the oxidising agents, X^{2+}, Au^{3+} and H^+, in order of increasing strength.

Fully explain the answer. (3)
[14]

QUESTION 9 (Start on a new page.)

The simplified electrolytic cell below is used to electroplate a metal spring. Zinc nitrate, $Zn(NO_3)_2(aq)$, is used as an electrolyte and **R** is an electrode.



9.1 Define the term *electrolytic cell*. (2)

9.2 Which electrode (**R** or **METAL SPRING**) is the ANODE? Give a reason for the answer. (2)

9.3 Write down the:

9.3.1 Equation for the half-reaction occurring at the metal spring (2)

9.3.2 NAME or FORMULA of a suitable metal that can be used as electrode **R** (1)

9.4 Explain the answer to QUESTION 9.3.2. (2)
[9]

TOTAL: 150

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Basic Education
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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following terms describes hydrocarbons that contain only single bonds?

A Isomers

B Saturated

C Unsaturated

D Homologous series (2)

1.2 Which ONE of the following combinations correctly indicates the STRONGEST intermolecular forces found in ethanoic acid and methyl propanoate respectively?

	ETHANOIC ACID	METHYL PROPANOATE
A	Hydrogen bonds	Hydrogen bonds
B	Dipole-dipole forces	London forces
C	Hydrogen bonds	London forces
D	Hydrogen bonds	Dipole-dipole forces

(2)

1.3 A test tube contains a liquid hydrocarbon.

When bromine water (Br_2) is added to the test tube, the mixture decolourises IMMEDIATELY.

Which ONE of the following combinations correctly identifies the COMPOUND and the TYPE OF REACTION that takes place in the test tube?

	COMPOUND	TYPE OF REACTION
A	Hexane	Addition
B	Hexane	Substitution
C	Hex-2-ene	Addition
D	Hex-2-ene	Substitution

(2)

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1.4 Which ONE of the following statements is the CORRECT definition for the rate of a reaction?

A The time taken for the reaction to take place

B The speed at which the reaction takes place

C The rate of change in concentration of the products or reactants

D The rate of change in concentration of the products or reactants per unit time (2)

1.5 Consider the balanced equation for the reaction between magnesium powder and EXCESS dilute hydrochloric acid, HCℓ(aq):

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following will NOT increase the rate of this reaction?

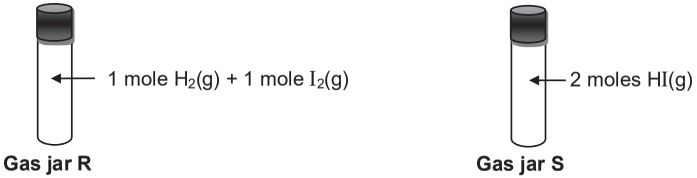
A Increasing the volume of HCℓ(aq)

B Increasing the temperature of HCℓ(aq)

C Increasing the concentration of HCℓ(aq)

D Adding more magnesium powder (2)

1.6 Two identical sealed gas jars, **R** and **S**, initially contain gases as shown below.



Equilibrium is reached in both gas jars at 500 °C according to the following balanced equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the following statements is TRUE at equilibrium?

A **S** will contain 1 mole of $I_2(g)$.

B **R** will contain a larger amount of $I_2(g)$ than **S**.

C **R** and **S** will contain the same amount of HI(g).

D **S** will contain a larger amount of HI(g) than **R**. (2)

1.7 Which ONE of the following salts, when dissolved in water, will NOT change the pH of the water?

A Na_2CO_3

B $(COO)_2Na_2$

C $NH_4C\ell$

D $NaC\ell$ (2)

1.8 A dilute acid is titrated against a potassium hydroxide solution, KOH(aq).

At the equivalence point the pH is 7.

Which ONE of the following combinations correctly identifies the acid and the MOST SUITABLE indicator for this titration?

	ACID	INDICATOR
A	$(COOH)_2(aq)$	Phenolphthalein
B	$(COOH)_2(aq)$	Bromothymol blue
C	HCℓ(aq)	Phenolphthalein
D	HCℓ(aq)	Bromothymol blue

(2)

1.9 Which ONE of the following statements is TRUE for an oxidising agent?

A It gains electrons.

B It causes another species in the reaction to be reduced.

C Its oxidation number does not change during a chemical reaction.

D Its oxidation number increases during a chemical reaction. (2)

1.10 Which ONE of the following metals will reduce $Cd^{2+}(aq)$ to Cd(s), but will NOT reduce $Mn^{2+}(aq)$ to Mn(s)?

A Zn

B Ag

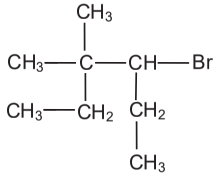
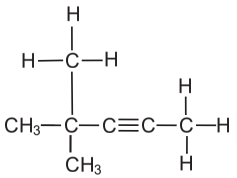
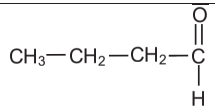
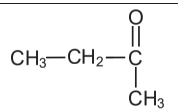
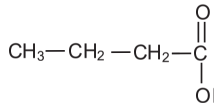
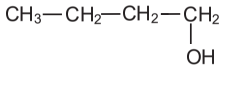
C Ni

D Mg (2)

[20]

QUESTION 2 (Start on a new page.)

A to **F** in the table below represent six organic compounds.

A		**B**	
C		**D**	
E		**F**	

2.1 Write down the:

2.1.1 Letters that represent TWO organic compounds that are isomers of each other (1)

2.1.2 Type of isomers (CHAIN, FUNCTIONAL or POSITIONAL) identified in QUESTION 2.1.1 (1)

2.1.3 GENERAL FORMULA of the homologous series to which compound **B** belongs (1)

2.1.4 NAME of the functional group of compound **F** (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **A** (3)

2.2.2 Compound **B** (2)

2.2.3 Compound **C** (2)

2.3 Compound **F** reacts with a carboxylic acid to form compound **S** in the presence of a strong acid.

2.3.1 Write down the type of reaction that takes place. (1)

Compound **S** has an EMPIRICAL FORMULA of C_3H_6O and a molecular mass of 116 g·mol^{-1}.

2.3.2 Write down the MOLECULAR FORMULA of the carboxylic acid. (3)
[15]

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QUESTION 3 (Start on a new page.)

3.1 The melting points of some organic compounds are given in the table below.

COMPOUND	IUPAC NAME	MELTING POINTS (°C)
A	Propanone	-95,4
B	Butanone	-86,9
C	Pentan-2-one	-77,8
D	3-methylbutanone	-92

3.1.1 To which homologous series do the above compounds belong? (1)

The melting points of compounds **A**, **B** and **C** are compared.

3.1.2 Write down the controlled variable for this comparison. (1)

The melting points of compounds **C** and **D** are compared.

3.1.3 Fully explain the difference in the melting points of these two compounds. (4)

3.2 The table below shows the results obtained from an experiment to determine the vapour pressure of different STRAIGHT CHAIN primary alcohols at 300 K.

ALCOHOL	VAPOUR PRESSURE (kPa)
CH_3OH	16,8
C_2H_5OH	7,88
C_3H_7OH	2,8
C_4H_9OH	0,91
$C_5H_{11}OH$	0,88
$C_6H_{13}OH$	0,124

3.2.1 Define the term *vapour pressure*. (2)

3.2.2 Write down a suitable conclusion for this investigation. (2)

3.2.3 Write down the IUPAC name of the alcohol with the HIGHEST boiling point. (3)

3.2.4 The experiment is now repeated at 320 K.

Will the vapour pressure of each compound INCREASE, DECREASE or REMAIN THE SAME? (1)
[14]

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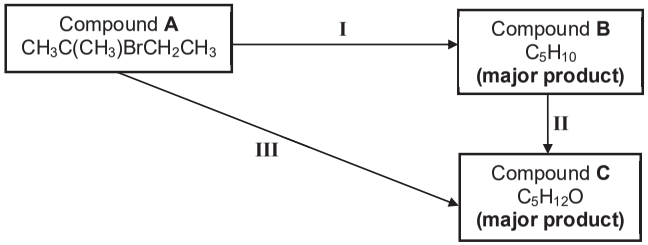
QUESTION 4 (Start on a new page.)

The flow diagram below shows how compound **A** can be used as a starting reactant to prepare two different compounds.

I, **II** and **III** represent three organic reactions.



4.1 Is compound **A** a PRIMARY, SECONDARY or TERTIARY haloalkane? Give a reason for the answer. (2)

4.2 Consider reaction **I**.

4.2.1 Besides heat, write down the other reaction condition needed. (1)

4.2.2 Write down the type of reaction that takes place. (1)

4.2.3 Using STRUCTURAL FORMULAE for the organic compounds, write down a balanced equation for the reaction. (5)

4.3 Consider reaction **II**.

Write down the:

4.3.1 STRUCTURAL FORMULA of compound **C** (2)

4.3.2 NAME or FORMULA of the inorganic reagent needed (1)

4.3.3 Type of addition reaction that takes place (1)

4.4 Consider reaction **III**.

4.4.1 Write down of the type of reaction that takes place. (1)

4.4.2 Besides heat, write down the other reaction condition needed. (1)
[15]

QUESTION 5 (Start on a new page.)

Three experiments, **A**, **B** and **C**, are carried out to investigate some of the factors that affect the rate of decomposition of hydrogen peroxide, $H_2O_2(\ell)$.

The balanced equation for the reaction is:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

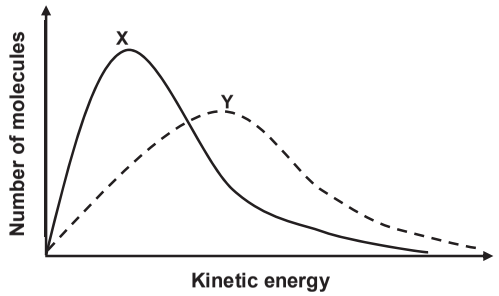
Identical samples of hydrogen peroxide are used in each experiment.

The conditions used in each experiment are summarised in the table below.

EXPERIMENT	TEMPERATURE (°C)	
A	25	Without catalyst
B	25	With catalyst
C	35	Without catalyst

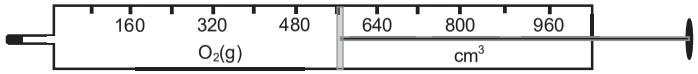
5.1 In which experiment, **A** or **B**, is the reaction rate higher? Use the collision theory to explain the answer. (4)

5.2 The Maxwell-Boltzmann distribution curves, **X** and **Y**, for two of the above experiments are shown below.



Identify the curve (**X** or **Y**) that represents experiment **C**. (2)

5.3 The volume of oxygen gas, $O_2(g)$, produced in experiment **B** during the first 3,6 s is collected in a syringe, as shown below.



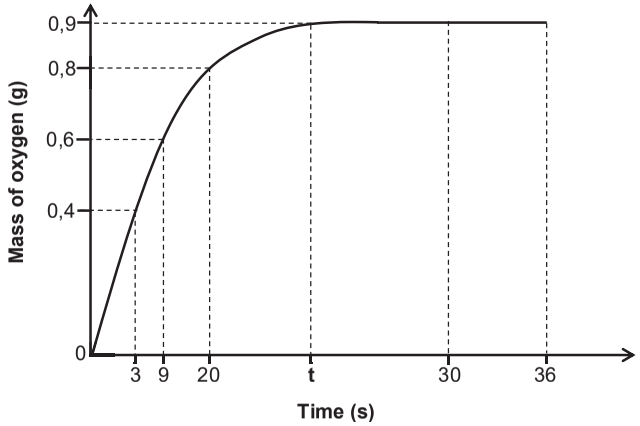
5.3.1 Write down the volume of $O_2(g)$ collected in the syringe. (2)

The balanced equation for the reaction is:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

5.3.2 Calculate the mass of water, $H_2O(\ell)$, that was produced during the first 3,6 s. Take the molar gas volume to be 24 000 $cm^3 \cdot mol^{-1}$ at 25 °C. (4)

5.4 The graph below, NOT drawn to scale, is obtained for the mass of oxygen gas produced over a period of time in experiment **A**.



Use the information in the graph to answer the following questions:

5.4.1 Write down the rate of production of oxygen gas for the interval 30 s to 36 s. (1)

5.4.2 Will the rate of the reaction in the interval 3 s to 9 s be GREATER THAN, SMALLER THAN or EQUAL TO the rate of the reaction in the interval 9 s to 20 s? (1)

5.4.3 The average rate of decomposition of hydrogen peroxide is 2,1 x 10^{-3} $mol \cdot s^{-1}$.

Calculate the value of time **t** on the graph. (5)
[19]

QUESTION 6 (Start on a new page.)

Carbon, C(s), reacts with sulphur, S(g), according to the following balanced equation:

$$C(s) + 2S(g) \rightleftharpoons CS_2(g) \qquad \Delta H > 0$$

The system reaches equilibrium at temperature T in a sealed 2 dm^3 container.

The K_c value is 9,4 at temperature T.

6.1 State Le Chatelier's principle. (2)

At equilibrium, 1 mole of carbon disulphide, $CS_2(g)$, is present in the container.

6.2 Calculate the concentration of S(g) present at equilibrium. (4)

The volume of the container is now DOUBLED at temperature T. After a while, a NEW equilibrium is established.

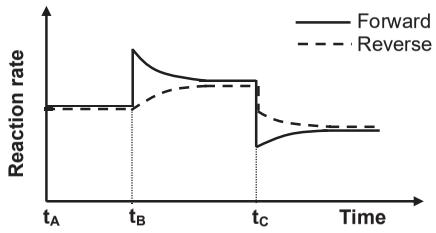
6.3 How will the amount of S(g) change as this new equilibrium is established? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 Explain the answer to QUESTION 6.3 in terms of Le Chatelier's principle. (3)

6.5 If the concentration of $CS_2(g)$ CHANGES by **x** $mol \cdot dm^{-3}$, write down an expression for the equilibrium constant, K_c, in terms of **x**.

Show ALL your workings. NO simplification or solving for **x** is required. (5)

6.6 The reaction rate-time graph below represents further changes made to the equilibrium mixture. The volume of the container is kept constant.



6.6.1 What do the parallel lines between t_A and t_B represent? (1)

6.6.2 What change was made to the equilibrium mixture at t_B? (1)

6.6.3 Give a reason for the sudden change in the reaction rate at t_C. (1)

6.6.4 Fully explain the answer to QUESTION 6.6.3. (3)
[21]

QUESTION 7 (Start on a new page.)

7.1 Ethanoic acid is a weak acid that reacts with water according to the following balanced equation:

$$CH_3COOH(aq) + H_2O(\ell) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Give a reason why ethanoic acid is classified as a WEAK acid. (1)

7.1.3 Write down the formulae of the TWO bases in the equation above. (2)

7.2 A flask contains 300 cm^3 of dilute sodium hydroxide, NaOH(aq), of concentration 0,167 $mol \cdot dm^{-3}$.

7.2.1 Calculate the number of moles of sodium hydroxide in the flask. (3)

Ethanoic acid of volume 500 cm^3 and of unknown concentration, **X**, is now added to this flask to give a solution of volume 800 cm^3.

It is found that the pH of the mixture is 11,4.

The balanced equation for the reaction is:

$$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$$

Calculate the:

7.2.2 Concentration of the $OH^-(aq)$ in the mixture (4)

7.2.3 Initial concentration, **X**, of the ethanoic acid solution (6)
[18]

QUESTION 8 (Start on a new page.)

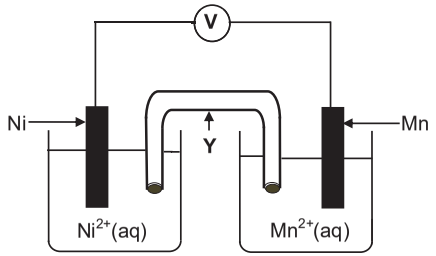
8.1 A piece of zinc (Zn) is placed in a test tube containing an acidified permanganate solution, $MnO_4^-(aq)$. After some time, it is found that a redox reaction has taken place.

Use the Table of Standard Reduction Potentials to answer the following questions:

8.1.1 Write down the NAME or FORMULA of the reducing agent. (1)

8.1.2 Refer to the relative strengths of the OXIDISING AGENTS to explain why a redox reaction has taken place. (3)

8.2 A standard electrochemical cell is set up as shown below.



8.2.1 Write down the function of component **Y**. (1)

8.2.2 In which direction will electrons flow in the external circuit? Choose from 'Ni to Mn' OR 'Mn to Ni'. (2)

8.2.3 Calculate the initial emf of this cell. (4)

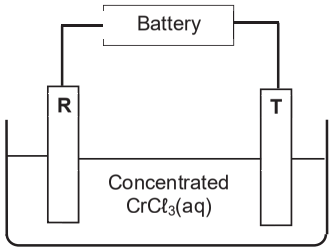
8.2.4 Write down the balanced equation for the net cell reaction taking place. (3)

8.2.5 The concentration of $Ni^{2+}(aq)$ is now increased.

Will the reading on the voltmeter INCREASE, DECREASE or REMAIN THE SAME? (1)
[15]

QUESTION 9 (Start on a new page.)

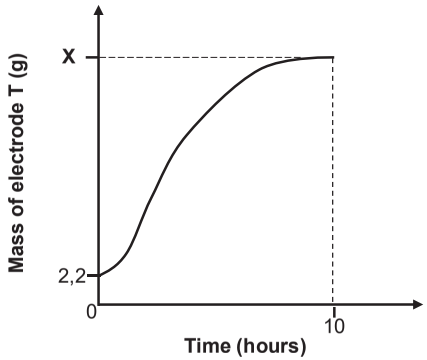
The diagram below represents a simplified cell used for the electrolysis of CONCENTRATED chromium(III) chloride, $CrC\ell_3(aq)$. Electrodes **R** and **T** are made of carbon.



The net cell reaction is: $2CrC\ell_3(aq) \rightarrow 2Cr(s) + 3C\ell_2(g)$

9.1 Define the term *electrolysis*. (2)

9.2 The graph below, NOT drawn to scale, represents the changes in the mass of electrode **T** during electrolysis.



9.2.1 Write down the half-reaction that takes place at electrode **T**. (2)

A current of 2,5 A passes through the cell for 10 hours.

Calculate the:

9.2.2 Total charge that flows through the cell during this time (3)

9.2.3 Value of **X** as shown on the graph (6)
[13]

TOTAL: 150

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Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2022

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 21 pages, including 4 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The name of the functional group of propanoic acid is ...

A formyl.

B carboxyl.

C carbonyl.

D hydroxyl. (2)

1.2 Which ONE of the following is the CORRECT name for the addition reaction of water to an alkene?

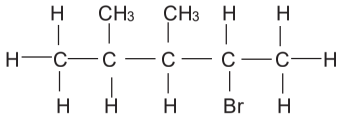
A hydration

B hydrolysis

C dehydration

D hydrohalogenation (2)

1.3 Consider the compound shown below:



The CORRECT IUPAC name of the above compound is:

A 4-bromo-2,3-dimethylpentane

B 2-bromo-3,4-dimethylpentane

C 2,3-dimethyl-4-bromopentane

D 3,4-dimethyl-2-bromopentane (2)

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1.4 Which ONE of the following organic molecules will react rapidly with bromine water?

A CH_3CH_2OH

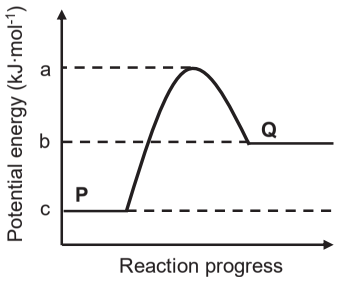
B CH_3CH_3

C CH_2CH_2

D $CH_3CH_2CH_3$ (2)

1.5 Consider the potential energy profile below for the following hypothetical reaction:

P ⇌ Q



Which ONE of the following combinations correctly indicates both the activation energy and the heat of reaction (ΔH) for the REVERSE REACTION?

	Activation energy (kJ·mol^{-1})	Heat of reaction (ΔH)
A	**a – b**	**b – c**
B	**b – a**	**a – c**
C	**a – b**	**c – b**
D	**b – c**	**a – b**

(2)

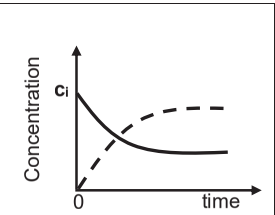
1.6 H_2S (g) decomposes according to the following balanced equation:

$$H_2S\ (g) \rightleftharpoons H_2\ (g) + S\ (s)$$

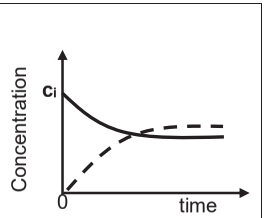
In each of four separate experiments, **A** to **D**, H_2S of initial concentration c_i is placed in identical empty flasks which are then sealed and heated. The graphs below display the results of the experiments **A** to **D**.

Which experiment has the largest K_c value?

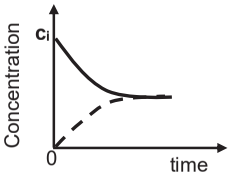
A



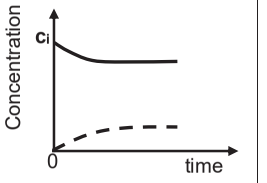
B



C



D



(2)

1.7 The reaction below represents the general equation for the reaction of an acid-base indicator.

$$\underset{\text{yellow}}{HIn\ (aq)} + H_2O\ (\ell) \rightleftharpoons H_3O^+\ (aq) + \underset{\text{blue}}{In^-\ (aq)}$$

In which ONE of the following salt solutions will this indicator turn yellow?

A $KC\ell(aq)$

B $NH_4C\ell(aq)$

C $NaHCO_3(aq)$

D $CH_3COONa(aq)$ (2)

1.8 The function of a salt bridge in a galvanic cell is to …

A allow for the movements of protons.

B allow for the movements of electrons.

C provide a site for reduction to occur.

D ensure electrical neutrality of solutions. (2)

1.9 Which ONE the substances can act as an ampholyte in some reactions?

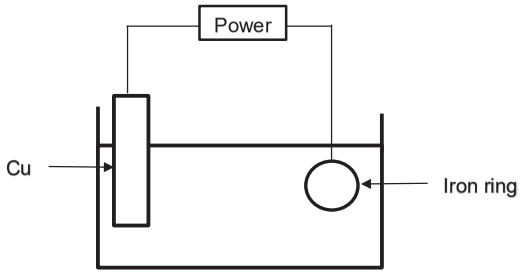
A CH_3COO^-

B HSO_4^-

C H_3O^+

D NH_4^+ (2)

1.10 The electrolytic cell below is used during the electroplating of an iron ring with copper.



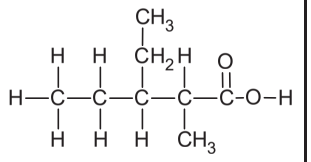
Which ONE of the following combinations is CORRECT about the ions in the electrolyte when the cell is operating?

	Concentration	Positive ions
A	Remain constant	Cu^{2+}
B	Remain constant	Fe^{2+}
C	Increases	Fe^{3+}
D	Increases	Cu^{2+}

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **D** in the table below represent four organic compounds that belong to different homologous series.

A 2-methylpropanal	**B** 
C $CH_3C \equiv CCH_2CH_3$	**D** Pentane

2.1 Define the term *homologous series*. (2)

2.2 Write down the:

2.2.1 Letter that represents a saturated hydrocarbon (1)

2.2.2 General formula of the homologous series to which compound **C** belongs (1)

2.2.3 Structural formula of compound **A** (2)

2.3 Write down the IUPAC name of compound **B**. (3)

2.4 Compound **D** has three structural isomers.

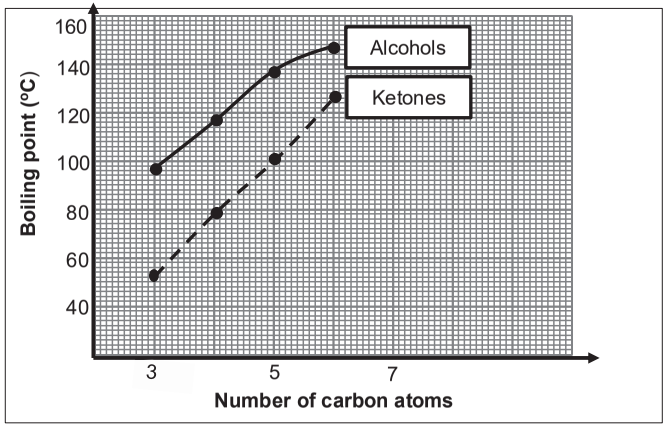
Write down the:

2.4.1 Structural formula of the isomer with the shortest chain (3)

2.4.2 Balanced equation for the combustion reaction of compound **D** in EXCESS oxygen using molecular formulae (3)
[15]

QUESTION 3 (Start on a new page.)

3.1 The graphs below show the boiling points of straight chain primary alcohols and straight chain ketones with different number of carbon atoms.



3.1.1 Define the term *boiling point.* (2)

3.1.2 Explain why the boiling points of alcohols increase as the number of carbon atoms increase by referring to TYPE and STRENGTH of intermolecular forces only. (2)

3.1.3 Explain why the curve of the alcohols is higher than that of the ketones.

Refer to the TYPE and STRENGTH of intermolecular forces involved. (3)

The vapour pressure of the alcohol is compared to that of a ketone at the same temperature.

3.1.4 Why must the alcohol and ketone which are used for the comparison have the same number of carbon atoms? (1)

3.1.5 Which ONE will have a higher vapour pressure: ALCOHOL or KETONE?

Give a reason for the answer by referring to the data in the graph. (2)

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3.2 The boiling points of propanoic acid and propan-1-ol are compared.

3.2.1 Which compound has the higher boiling point? (1)

3.2.2 Explain the answer to QUESTION 3.2.1 by referring to TYPE, STRENGTH of intermolecular forces and ENERGY. (3)

[14]

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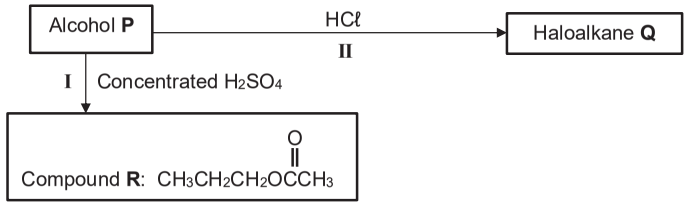
QUESTION 4 (Start on a new page.)

4.1 Compound **P** can be used to prepare organic compounds **R** and **Q** as shown in the flow diagram below.



In reaction **I**, alcohol **P** reacts with another organic compound in the presence of concentrated sulphuric acid.

4.1.1 Name the type of reaction represented by **I**. (1)

4.1.2 Besides the presence of a catalyst write down another reaction condition for reaction **I**. (1)

Write down the:

4.1.3 Structural formula of alcohol **P** (2)

4.1.4 IUPAC name of compound **R** (2)

4.1.5 IUPAC name of a straight chain FUNCTIONAL isomer of compound **R** (2)

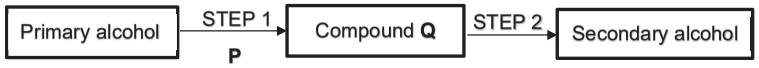
For reaction **II** write down the:

4.1.6 Type of reaction taking place (1)

4.1.7 Formula of the inorganic product (1)

4.1.8 Condensed structural formula of compound **Q** (2)

4.2 A primary alcohol that contains 3 carbon atoms is converted to a secondary alcohol in a TWO step process as shown in the flow diagram below:



P is an inorganic reagent while compound **Q** is an organic compound.

Write down the:

4.2.1 Formula of reagent **P** (2)

4.2.2 One reaction condition for the reaction in STEP 2 (1)

4.2.3 A balanced equation for the reaction in STEP 2 by using structural formulae for the organic compounds. (5)

[20]

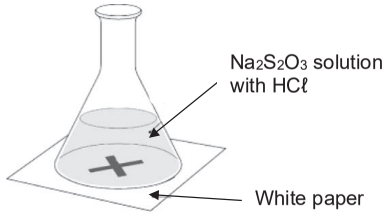
QUESTION 5 (Start on a new page.)

The reaction between sodium thiosulphate ($Na_2S_2O_3$) and EXCESS hydrochloric acid (HCℓ) is used to investigate the effect of concentration and temperature on the rate of reaction.

The balanced equation for this reaction is:

$$Na_2S_2O_3\,(aq) + 2\,HC\ell \rightarrow 2\,NaC\ell\,(aq) + S\,(s) + SO_2\,(g) + H_2O\,(\ell)$$

An Erlenmeyer flask is placed on a white paper marked with a light cross on it. The time taken for the visibility of the cross (X) to disappear is measured. See the diagram below.



NOTE: The same volume of $Na_2S_2O_3$ solution was used for all three reactions.

The table below shows the reaction conditions.

Exp	Concentration of $Na_2S_2O_3$	Concentration of HCℓ ($mol \cdot dm^{-3}$)	Temperature (°C)	Volume of HCℓ (cm^3)
1	0,05	2	25	25
2	0,05	1	25	25
3	0,05	2	40	25

5.1 Define the term *reaction rate.* (2)

5.2 Write down the name of the independent variable for the comparison of experiment **1** and **2**. (1)

5.3 How will the amount of sulphur (S) formed in experiment **1** compare to the amount of sulphur (S) produced in experiment **2** at the completion of the reaction?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO.

Give a reason for the answer. (2)

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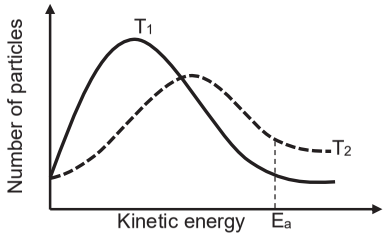
5.4 Experiments **1** and **3** are now compared.

The Maxwell-Boltzmann energy distribution curves for Experiments **1** and **3** are shown below.



5.4.1 Which experiment **1** or **3** is represented by curve T_2? (1)

5.4.2 Explain the answer to QUESTION 5.4.1 by referring to the collision theory. (3)

5.4.3 Sketch the curve of T_2 ONLY in the answer book and indicate the effect that a catalyst would have on E_a.

Indicate the new activation energy as **X** on the graph. (2)

5.5 0,7118 g of $Na_2S_2O_3$ reacted completely with HCℓ in **experiment 1** in 34 s.

Calculate the rate at which HCℓ reacted in **experiment 1** in $mol \cdot s^{-1}$. (5)

The volume of HCℓ used in **experiment 1** is now **doubled**. All other reaction conditions remain the same.

5.6 How would the reaction rate be affected by the change in volume?

Choose from INCREASES, DECREASES or REMAIN THE SAME. (1)
[17]

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QUESTION 6 (Start on a new page.)

6.1 The following reversible reaction can be used to demonstrate how certain factors influence chemical equilibrium:

$$\underset{\text{Blue}}{CoCl_4^{2-}\ (aq)} + 6\ H_2O\ (\ell) \rightleftharpoons \underset{\text{Pink}}{Co(H_2O)_6^{2+}\ (aq)} + 4\ Cl^-\ (aq)$$

6.1.1 Define the term *reversible reaction.* (2)

Initially, the solution is **BLUE**.

Write down either TURNS MORE BLUE or TURNS MORE PINK to describe what happens to the reaction mixture if some:

6.1.2 $CoCl_4^{2-}$ is added (1)

6.1.3 Concentrated HCl is added (1)

The test tube containing the reaction mixture is placed in a hot water bath. It is observed that the solution becomes more blue.

6.1.4 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

6.1.5 Explain the answer to QUESTION 6.1.4 by referring to Le Chatelier's principle. (2)

6.2 3,01 x 10^{23} molecules of N_2O_4 are sealed into a 4 dm^3 container and then heated to 400 K.

The following balanced equation represents the reaction that reaches equilibrium in the container at 400 K.

$$N_2O_4\ (g) \rightleftharpoons 2\ NO_2\ (g)$$

At equilibrium, it is found that 0,4 mol of N_2O_4 have decomposed to NO_2

Calculate the equilibrium constant (K_c) at 400 K. (8)
[15]

QUESTION 7 (Start on a new page.)

7.1 The equations below show the reactions occurring in hydrochloric acid (HCl) and ethanoic acid (CH_3COOH) solutions. Both acids have a concentration of 1 $mol \cdot dm^{-3}$, and are kept at a temperature of 25° C.

I: $HCl\ (aq) + H_2O\ (\ell) \rightleftharpoons Cl^-\ (aq) + H_3O^+\ (aq)$ $K_a = 1,3 \times 10^6$

II: $CH_3COOH\ (aq) + H_2O\ (\ell) \rightleftharpoons CH_3COO^-\ (aq) + H_3O^+\ (aq)$ $K_a = 1,8 \times 10^{-5}$

7.1.1 Define an *acid* according to the Lowry-Brønsted theory. (2)

7.1.2 Write down ONE conjugate acid pair-base pair in reaction **I**. (2)

7.1.3 Which solution, **I** or **II**, will have the lower pH value?

Explain the answer. (3)

7.2 10 cm^3 of a 1 $mol \cdot dm^{-3}$ sodium hydroxide (NaOH) solution is diluted with water until its pH is 13.

7.2.1 Calculate the number of moles of NaOH in the 10 cm^3 of the initial solution. (3)

7.2.2 Calculate the volume of the diluted solution in dm^3. (5)

All of the diluted sodium hydroxide solution is poured into a burette. During a titration, 15 cm^3 of oxalic acid of concentration 0,09 $mol \cdot dm^{-3}$ is exactly neutralised by a certain volume of the diluted sodium hydroxide solution.

The balanced equation for the reaction is:

$$2\ NaOH\ (aq) + H_2C_2O_4\ (aq) \rightarrow Na_2C_2O_4\ (aq) + 2\ H_2O\ (\ell)$$

7.2.3 Calculate the volume of the diluted sodium hydroxide that is left in the burette after the titration. (5)
[20]

QUESTION 8 (Start on a new page.)

A galvanic cell is set up under standard conditions using half-cells **A** and **B** shown below.

Half-cell **A**: $Cu(s)/Cu^{2+}(aq)$ Half-cell **B**: $H_2O(\ell)/O_2(g)/H^+(aq)$

8.1 Define *oxidation* in terms of electron transfer. (2)

8.2 Write down the:

8.2.1 Initial concentration of the $H^+(aq)$ solution in half-cell **B** (1)

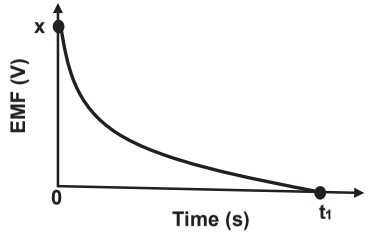
8.2.2 Name of the metal used as the electrode in half-cell **B** (1)

8.2.3 Formula of the reducing agent (1)

8.2.4 Reduction half reaction (2)

8.2.5 Balanced ionic equation for the overall cell reaction (3)

8.3 The graph below shows the EMF of this cell against time.



8.3.1 Calculate the value of **x** on the graph. (4)

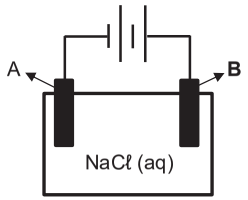
8.3.2 Explain the decrease in the EMF of the cell as time proceeds. (2)

8.3.3 What has happened to the reaction in the cell at time t_1? (1)

[17]

QUESTION 9 (Start on a new page.)

9.1 The diagram represents the apparatus used in the electrolysis of a concentrated NaCℓ solution. **A** and **B** are two carbon electrodes.



9.1.1 Define an *electrolytic cell.* (2)

9.1.2 Write down the half reaction that occurs at electrode **B**. (2)

Gas bubbles are observed at the cathode of the cell.

9.1.3 Write down the NAME or FORMULA of the gas formed at the cathode. (1)

9.1.4 Refer to the relative strengths of the oxidising agents to explain why the gas in QUESTION 9.1.3 and not Na, is formed at the cathode. (2)

9.2 An electrolytic cell is using an impure copper electrode consisting of 95% Cu and a pure copper electrode. Copper (II) chloride ($CuC\ell_2$) solution is used as the electrolyte.

9.2.1 Is the pure copper the ANODE or CATHODE? (1)

9.2.2 When all the copper in the impure copper electrode has been deposited on the copper electrode, it is found that 6 mol of electrons were transferred.

Calculate the initial mass of the IMPURE copper electrode. (4)

[12]

TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: CHEMISTRY (P2)

2022

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following compounds has the LOWEST melting point?

A Hexane

B Ethane

C Butane

D Octane (2)

1.2 When $CH_2 = CH_2$ is converted to CH_3CH_3, the type of reaction is …

A hydration.

B hydrolysis.

C halogenation.

D hydrogenation. (2)

1.3 Which ONE of the following compounds in solution will change the colour of bromothymol blue?

A CH_3CH_2CHO

B CH_3CH_2COOH

C $CH_3CH_2COCH_3$

D $CH_3CH_2COOCH_3$ (2)

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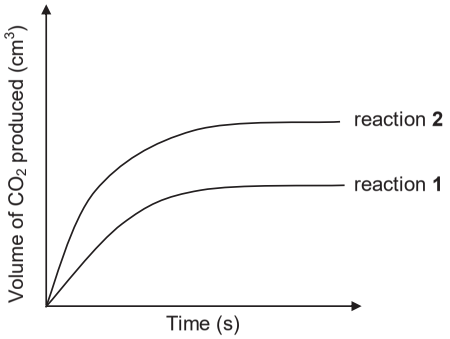
1.4 Two DIFFERENT samples of IMPURE $CaCO_3$ of EQUAL masses react with 0,1 mol·dm^{-3} H_2SO_4. Assume that the impurities do not react.

The graph below shows the volume of $CO_2(g)$ produced for each reaction.



When compared to reaction **2**, which ONE of the following statements BEST explains the curve obtained for reaction **1**?

A The temperature is higher in reaction **1**.

B The surface area is greater in reaction **2**.

C The amount of impurities is greater in reaction **2**.

D The amount of impurities is greater in reaction **1**. (2)

1.5 The equation below represents a hypothetical reaction.

$$A(g) + B(g) \rightleftharpoons C(g) \qquad \Delta H = -50 \text{ kJ·mol}^{-1}$$

The activation energy for the REVERSE reaction is 110 kJ·mol^{-1}.

Which ONE of the following is the activation energy (in kJ·mol^{-1}) for the FORWARD reaction?

A 50

B 60

C 110

D 160 (2)

1.6 A reaction reaches equilibrium at 25 °C in a flask according to the following balanced equation:

$$Co(H_2O)_6^{2+}(aq) + 4C\ell^-(aq) \rightleftharpoons CoC\ell_4^{2-}(aq) + 6H_2O(\ell) \qquad \Delta H > 0$$
pink blue

Which ONE of the following will change the colour of the mixture from pink to blue?

A Adding water

B Cooling the flask

C Adding NaOH(aq)

D Adding $NH_4C\ell$(aq) (2)

1.7 Dilute nitric acid is added to distilled water at 25 °C.

How will this affect the hydronium ion concentration [H_3O^+] and the ionisation constant (K_w) of water at 25 °C?

	[H_3O^+]	K_w
A	Increases	Increases
B	Increases	Decreases
C	Increases	Remains the same
D	Remains the same	Remains the same

(2)

1.8 Consider the ionisation reactions **I** and **II**.

I $H_2PO_4^- + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \mathbf{X}$

II $\mathbf{X} + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \mathbf{Y}$

Which ONE of the following combinations represents the formulae of **X** and **Y** respectively?

	X	Y
A	HPO_4^{2-}	PO_4^{3-}
B	HPO_4^{2-}	H_3PO_4
C	H_3PO_4	PO_4^{3-}
D	HPO_4^{2-}	$H_2PO_4^-$

(2)

1.9 An electrochemical cell was set up using a $Hg(\ell)|Hg^{2+}(aq)$ half-cell and another half-cell under standard conditions.

Which ONE of the following half-cells, when connected to the $Hg(\ell)|Hg^{2+}(aq)$ half-cell, will result in the HIGHEST cell potential?

A $A\ell(s)|A\ell^{3+}(aq)$

B $Zn(s)|Zn^{2+}(aq)$

C $Co(s)|Co^{2+}(aq)$

D $Pt(s)|H_2(g)|H^+(aq)$ (2)

1.10 The following reaction takes place in an electrochemical cell:

$$CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2(g)$$

Which ONE of the following is CORRECT for this cell?

A It is a galvanic cell.

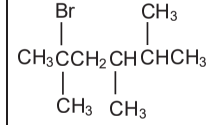
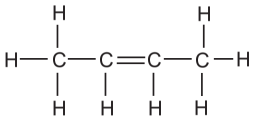
B A power source is needed.

C The reaction is spontaneous.

D Copper acts as the oxidising agent. (2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **H** in the table below represent eight organic compounds.

A		**B**	
C	Pent-2-ene	**D**	$CH_3CH_2CH_2CHO$
E	Butan-2-one	**F**	4,4-dimethylpent-2-yne
G	Butane	**H**	$CH_3CH_2CH_2COOH$

2.1 Write down the LETTER that represents a compound that:

2.1.1 Is a ketone (1)

2.1.2 Has the general formula C_nH_{2n-2} (1)

2.1.3 Is an isomer of 2-methylbut-2-ene (1)

2.1.4 Has the same molecular formula as ethyl ethanoate (1)

2.2 Write down the:

2.2.1 IUPAC name of compound **A** (3)

2.2.2 STRUCTURAL FORMULA of compound **F** (3)

2.3 For compound **D**, write down the:

2.3.1 Homologous series to which it belongs (1)

2.3.2 NAME of its functional group (1)

2.3.3 STRUCTURAL FORMULA of its functional isomer (2)

2.4 For compound **G**, write down:

2.4.1 The IUPAC name of a chain isomer (2)

2.4.2 A balanced equation, using molecular formulae, for its complete combustion (3)
[19]

QUESTION 3 (Start on a new page.)

Learners investigate factors that influence the boiling points of organic compounds. The boiling points of some organic compounds obtained are shown in the table below.

COMPOUND		MOLECULAR MASS ($g \cdot mol^{-1}$)	BOILING POINT (°C)
A	Propane	44	- 42
B	Butane	58	- 0,5
C	Pentane	72	36
D	Methylbutane	72	28
E	Ethanol	46	78
F	Ethanal	44	20

3.1 Define the term *boiling point.* (2)

3.2 The boiling points of compounds **A**, **B** and **C** are compared.

3.2.1 How do the boiling points vary from compound **A** to compound **C**?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

3.2.2 Explain the answer to QUESTION 3.2.1. (3)

3.3 The boiling points of compounds **B**, **C** and **D** are compared.

Is this a fair comparison?

Choose from YES or NO. Give a reason for the answer. (2)

3.4 The boiling points of compounds **E** and **F** are compared.

3.4.1 State the independent variable for this comparison. (1)

3.4.2 Write down the name of the strongest Van der Waals force present in compound **F**. (1)

3.5 Which compound, **D** or **E**, has a higher vapour pressure? Give a reason for the answer. (2)

[12]

QUESTION 4 (Start on a new page.)

4.1 Study the following incomplete equations for organic reactions **I** and **II**.

Compounds **P** and **Q** are ORGANIC compounds and **T** is an INORGANIC compound.

I	$CH_3CH(CH_3)CH_2Br + NaOH\ (conc.) \longrightarrow \underset{\text{(major product)}}{\mathbf{P}} + NaBr + \mathbf{T}$
II	CH_3COOH + compound **Q** → butyl ethanoate + H_2O

For reaction **I**, write down the:

4.1.1 Type of reaction that takes place (1)

4.1.2 IUPAC name of compound **P** (2)

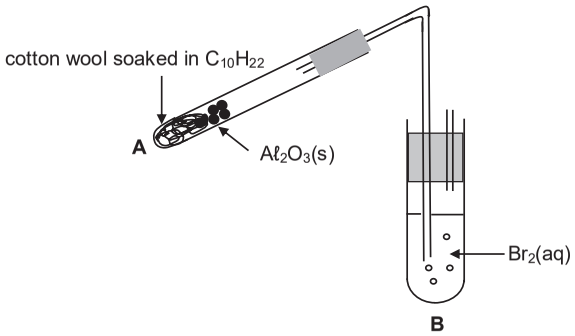
4.1.3 NAME or FORMULA of compound **T** (1)

For reaction **II**, write down:

4.1.4 TWO reaction conditions needed (2)

4.1.5 The STRUCTURAL FORMULA of compound **Q** (2)

4.2 The cracking of a long chain hydrocarbon, $C_{10}H_{22}$, takes place in test tube **A**, as shown below.



Two STRAIGHT CHAIN organic compounds, **X** and **Z**, are produced in test tube **A** according to the following balanced equation:

$$C_{10}H_{22}(\ell) \rightarrow 2\mathbf{X}(g) + \mathbf{Z}(g)$$

4.2.1 State the function of the $A\ell_2O_3(s)$ in test tube **A**. (1)

The organic compounds, **X** and **Z**, are now passed through bromine water, $Br_2(aq)$, at room temperature in test tube **B**. Only compound **X** reacts with the bromine water.

4.2.2 Apart from gas bubbles being formed, state another observable change in test tube **B**. (1)

4.2.3 Write down the TYPE of reaction that takes place in test tube **B**. (1)

4.2.4 Write down the molecular formula of compound **Z**. (3)

4.2.5 Write down the STRUCTURAL FORMULA of compound **X**. (3)
[17]

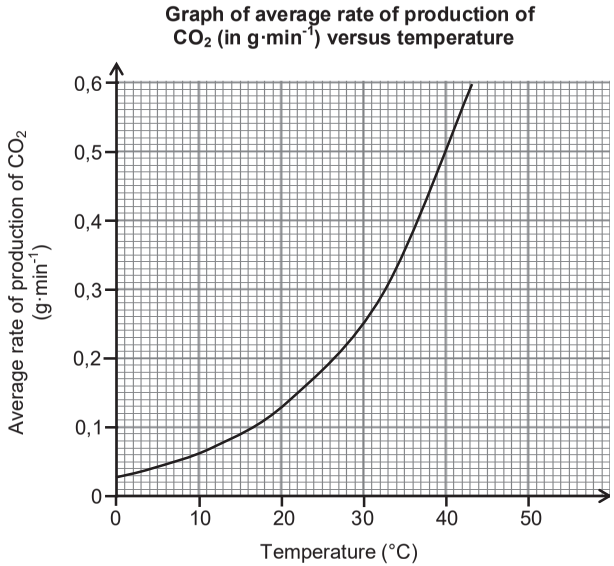
QUESTION 5 (Start on a new page.)

Learners use the reaction of $MgCO_3(s)$ with EXCESS dilute $HC\ell(aq)$ to investigate the relationship between temperature and the rate of a chemical reaction.

The balanced equation for the reaction is:

$$MgCO_3(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

The results obtained are represented in the graph below.



5.1 Define the term *rate of reaction*. (2)

5.2 State TWO conditions that must be kept constant during this investigation. (2)

5.3 Use the collision theory to explain the relationship shown in the graph. (4)

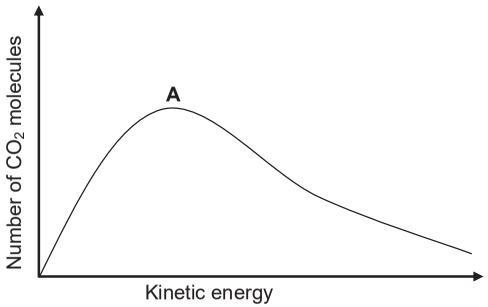
5.4 The learners obtained the graph above using 5 g $MgCO_3(s)$ with EXCESS $HC\ell$ at 40 °C.

Calculate the:

5.4.1 Time taken for the reaction to run to completion (6)

5.4.2 Molar gas volume at 40 °C if 1,5 dm^3 CO_2 is collected in a syringe (2)

5.5 The graph below represents the Maxwell-Boltzmann distribution curve for $CO_2(g)$ at 40 °C.



Redraw the graph above in the ANSWER BOOK. Clearly label the curve as **A**.

On the same set of axes, sketch the curve that will be obtained for the $CO_2(g)$ at 20 °C. Label this curve as **B**. (2)

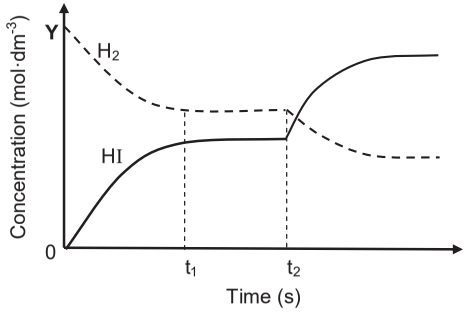
[18]

QUESTION 6 (Start on a new page.)

6.1 Initially, 4 moles $H_2(g)$ and 4 moles $I_2(g)$ are allowed to react in a sealed 2 dm^3 flask according to the following balanced equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H < 0$$

The graph below shows the concentrations of $H_2(g)$ and HI(g) versus time during the reaction.



6.1.1 Write down the value of **Y**. (1)

6.1.2 State Le Chatelier's principle. (2)

6.1.3 Changes were made to the temperature of the flask at time t_2.

Was the flask HEATED or COOLED? (1)

6.1.4 Fully explain the answer to QUESTION 6.1.3. (3)

6.2 The equation below represents the reversible reaction that takes place when $NO_2(g)$ is converted to $N_2O_4(g)$.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

Initially, **x** mol of $NO_2(g)$ is sealed in a 1 dm^3 container at 350 K. When equilibrium is established at this temperature, 0,81 mol $N_2O_4(g)$ is present in the container.

6.2.1 Write down the meaning of the term *reversible reaction*. (1)

6.2.2 Show that the equilibrium constant for this reaction is given by $\frac{0,81}{(x-1,62)^2}$. (5)

0,79 moles of $N_2O_4(g)$ is now added to the equilibrium mixture above. When the NEW equilibrium is established at 350 K, it is found that the amount of $NO_2(g)$ increased by 1,2 moles.

6.2.3 Calculate the value of **x**. (6)

[19]

QUESTION 7 (Start on a new page.)

7.1 Two acids, HX and HY, of EQUAL CONCENTRATIONS are compared. The pH of HX is 2,7 and the pH of HY is 0,7.

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Which acid, HX or HY, is STRONGER? Give a reason for the answer. (2)

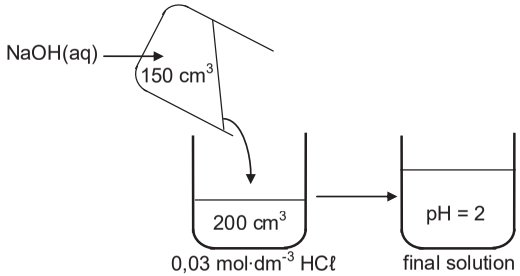
7.1.3 Acid HX ionises in water according to the following equation:

$$HX(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + X^-(aq)$$

The K_a value for the reaction is $1,8 \times 10^{-5}$ at 25 °C.

Is the concentration of the hydronium ions HIGHER THAN, LOWER THAN or EQUAL TO the concentration of HX? Give a reason for the answer. (2)

7.2 Learners add 150 cm^3 of a sodium hydroxide solution, NaOH, of unknown concentration to 200 cm^3 of a 0,03 $mol \cdot dm^{-3}$ hydrochloric acid solution, HCℓ, as illustrated below. They find that the pH of the final solution is 2. Assume that the volumes are additive.



The balanced equation for the reaction is:

$$HC\ell(aq) + NaOH(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

Calculate the:

7.2.1 Concentration of the H_3O^+ ions in the final solution (3)

7.2.2 Initial concentration of the NaOH(aq) (7)
[16]

QUESTION 8 (Start on a new page.)

8.1 An electrochemical cell is set up using an aluminium rod, Aℓ, and a gas **X**.

The initial emf measured under standard conditions is 2,89 V.

8.1.1 State the standard conditions under which this cell operates. (3)

8.1.2 Use a calculation to identify gas **X**. (5)

8.1.3 Write down the FORMULA of the reducing agent in this cell. (1)

8.1.4 Write down the half-reaction that takes place at the cathode. (2)

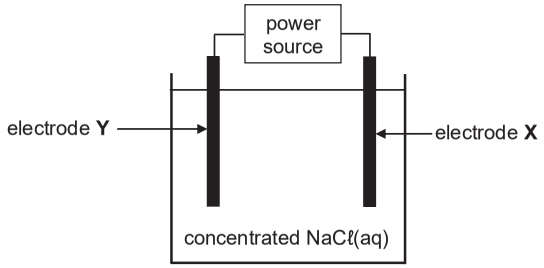
8.1.5 Write down the cell notation for this cell. (3)

8.2 Which container, ZINC or COPPER, will be more suitable to store an aqueous solution of nickel ions, Ni^{2+}?

Refer to the Table of Standard Reduction Potentials to fully explain the answer in terms of the relative strengths of reducing agents. (4)
[18]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrochemical cell used for the electrolysis of a concentrated sodium chloride solution, NaCℓ(aq). **X** and **Y** are carbon electrodes.



9.1 Define the term *electrolysis*. (2)

9.2 Chlorine gas, $C\ell_2(g)$, is released at electrode **X**.

Write down the:

9.2.1 Letter (**X** or **Y**) of the electrode where oxidation takes place (1)

9.2.2 Half-reaction that takes place at electrode **Y** (2)

9.2.3 Direction in which electrons flow in the external circuit

Choose from **X** to **Y** OR **Y** to **X**. (1)

9.2.4 Balanced equation for the net (overall) cell reaction that takes place in the cell (3)

9.3 How will the pH of the electrolyte change during the reaction?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

9.4 Give a reason for the answer to QUESTION 9.3. (1)
[11]

TOTAL: 150

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basic education

Department:
Basic Education
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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which formula shows the way in which atoms are bonded in a molecule but does not show all the bond lines?

A Empirical

B Molecular

C Structural

D Condensed structural (2)

1.2 Which ONE of the following compounds has hydrogen bonds between its molecules?

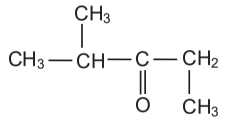
A $CH_3(CH_2)_2CH_3$

B $CH_3COCH_2CH_3$

C $CH_3COOCH_2CH_3$

D $CH_3CH(OH)CH_2CH_3$ (2)

1.3 Consider the compound below.



Which ONE of the following is the IUPAC name of this compound?

A 2-methylpentan-3-one

B 4-methylpentan-3-one

C 2,3-dimethylbutan-2-one

D 2,2,4-trimethylpropan-2-one (2)

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1.4 A 2 g piece of magnesium reacts with EXCESS hydrochloric acid according to the following balanced equation:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following changes will INCREASE the YIELD of $H_2(g)$?

A Crush the piece of magnesium.

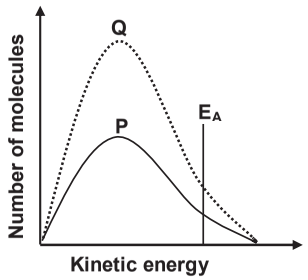
B Use a 3 g piece of magnesium.

C Use a greater volume of the acid.

D Use a higher concentration of the acid. (2)

1.5 The Maxwell-Boltzmann distribution curve **P** represents the number of molecules against kinetic energy for a certain reaction.

Curve **Q** is obtained after a change was made to one reaction condition.



Which ONE of the following changes resulted in curve **Q**?

A Addition of a catalyst

B Increase in temperature

C Increase in activation energy

D Increase in the concentration of the reactants (2)

1.6 The expression for the equilibrium constant (K_c) of a hypothetical reaction is given as follows:

$$K_c = \frac{[X]^3}{[Y]^2[Z]}$$

Which ONE of the following equations for a reaction at equilibrium matches the above expression?

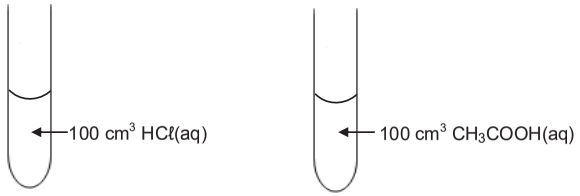
A $Z(g) + 2Y(g) \rightleftharpoons 3X(s)$

B $Z(aq) + 2Y(aq) \rightleftharpoons 3X(\ell)$

C $Z(g) + Y_2(g) \rightleftharpoons 3X(aq) + Q(s)$

D $Z(aq) + 2Y(aq) \rightleftharpoons 3X(aq) + Q(s)$ (2)

1.7 Two dilute acids of equal concentrations are added to separate test tubes as shown below.



Consider the following statements regarding these acids:

I: The pH of each is less than 7.
II: Both will react at the same rate with 5 g of magnesium powder.
III: Both will neutralise the same number of moles of NaOH(aq).

Which of the statements above is/are TRUE?

A **I** only

B **I**, **II** and **III**

C **I** and **III** only

D **II** and **III** only (2)

1.8 Which ONE of the following is the conjugate base of $H_2PO_4^-$?

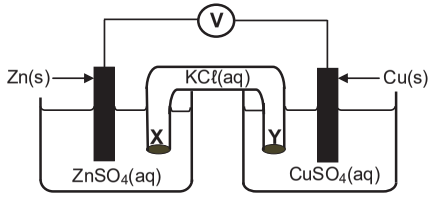
A PO_4^{3-}

B HPO_4^{2-}

C H_3PO_4

D $H_4PO_4^+$ (2)

1.9 The diagram below represents a voltaic cell.

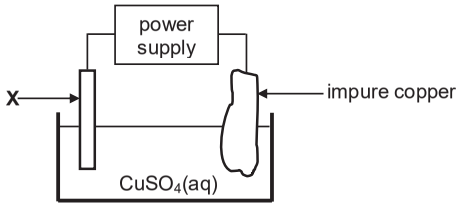


Which ONE of the following correctly describes the movement of ions in the cell?

	TYPE OF IONS	DIRECTION OF MOVEMENT
A	$C\ell^-(aq)$	**Y** to **X**
B	$SO_4^{2-}(aq)$	**X** to **Y**
C	$Cu^{2+}(aq)$	**Y** to **X**
D	$K^+(aq)$	**Y** to **X**

(2)

1.10 The diagram below represents a cell that is used for the refining of copper.



Which ONE of the following statements is TRUE?

A **X** is made of platinum.

B The mass of **X** increases.

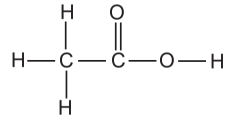
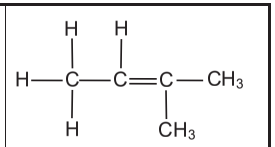
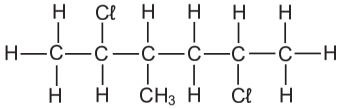
C **X** is the electrode where oxidation takes place.

D **X** is connected to the positive terminal of the power supply. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **H** in the table below represent eight organic compounds.

A		**B**	
C	$CH_3CH_2CH_2COCH_3$	**D**	C_2H_6O
E	C_2H_4	**F**	3-methylbutan-2-one
G		**H**	3-methylbutanal

2.1 Define the term *unsaturated compound*. (2)

2.2 Write down the:

2.2.1 Letter that represents an UNSATURATED compound (1)

2.2.2 NAME of the functional group of compound **C** (1)

2.2.3 Letter that represents a CHAIN ISOMER of compound **C** (2)

2.2.4 IUPAC name of compound **G** (3)

2.2.5 General formula of the homologous series to which compound **E** belongs (1)

2.3 Define the term *functional isomers*. (2)

2.4 For compound **A**, write down the:

2.4.1 Homologous series to which it belongs (1)

2.4.2 STRUCTURAL FORMULA of its FUNCTIONAL isomer (2)

2.5 Compound **D** undergoes a dehydration reaction. Write down the:

2.5.1 IUPAC name of compound **D** (1)

2.5.2 Letter that represents a product of this reaction (1)

2.5.3 NAME or FORMULA of the inorganic reactant that is used in this reaction (1)

[18]

QUESTION 3 (Start on a new page.)

The melting points and boiling points of four straight-chain ALKANES are shown in the table below.

COMPOUND	MELTING POINT (°C)	BOILING POINT (°C)
Pentane	-130	36,1
Hexane	-94	69
Heptane	-90,6	98,4
Octane	-57	125

3.1 Define the term *melting point*. (2)

3.2 Write down the general conclusion that can be made about the melting points of straight-chain alkanes. (2)

3.3 Name the type of Van der Waals forces between molecules of octane. (1)

3.4 Write down the predominant phase of the following alkanes at -100 °C.

Choose from GAS, LIQUID or SOLID.

3.4.1 Pentane (1)

3.4.2 Octane (1)

3.5 Hexane is now compared to 2,2-dimethylbutane.

3.5.1 Is the molecular mass of hexane GREATER THAN, LESS THAN or EQUAL to that of 2,2-dimethylbutane?

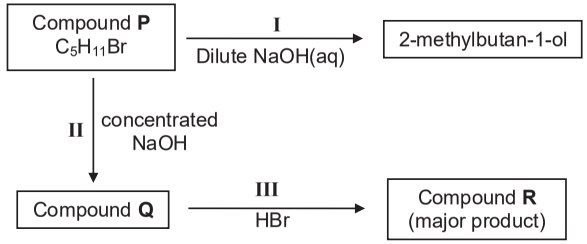
Give a reason for the answer. (2)

3.5.2 Is the boiling point of 2,2-dimethylbutane HIGHER THAN, LOWER THAN or EQUAL TO that of hexane? (1)

3.5.3 Fully explain the answer to QUESTION 3.5.2. (3)
[13]

QUESTION 4 (Start on a new page.)

4.1 Compound **P** is used as a starting reactant in each of two reactions as shown in the flow diagram below.



I, **II** and **III** represent organic reactions.

4.1.1 Name the type of reaction represented by **I**. (1)

4.1.2 Is 2-methylbutan-1-ol a PRIMARY, SECONDARY or TERTIARY alcohol?

Give a reason for the answer. (2)

4.1.3 Write down the STRUCTURAL FORMULA of compound **P**. (3)

4.1.4 Name the type of reaction represented by **II**. (1)

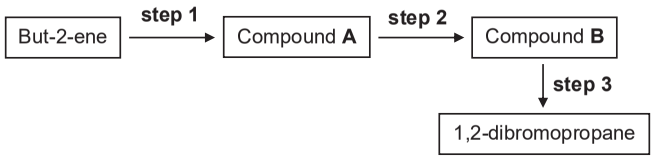
4.1.5 To which homologous series does compound **Q** belong? (1)

4.1.6 Name the type of reaction represented by **III**.

Choose from ADDITION, ELIMINATION or SUBSTITUTION. (1)

4.1.7 Write down the IUPAC name of compound **R**. (2)

4.2 1,2-dibromopropane can be prepared from but-2-ene by a three-step process as shown in the flow diagram below.



4.2.1 Using CONDENSED STRUCTURAL FORMULAE, write down a balanced equation for **step 1**. Indicate the reaction conditions on the arrow. (4)

4.2.2 Write down the type of reaction in **step 2**. (1)

4.2.3 Write down the IUPAC name of compound **B**. (2)

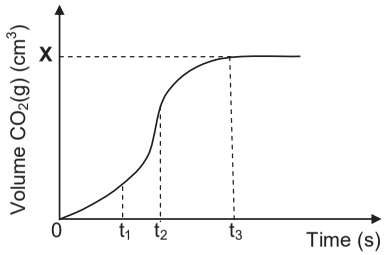
4.2.4 Using CONDENSED STRUCTURAL FORMULAE, write down a balanced equation for **step 3**. (3)
[21]

QUESTION 5 (Start on a new page.)

The reaction of 15 g of an IMPURE sample of calcium carbonate, $CaCO_3$, with EXCESS hydrochloric acid, HCℓ, of concentration 1,0 mol·dm^{-3}, is used to investigate the rate of a reaction. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

The volume of $CO_2(g)$ produced is measured at regular intervals. A sketch graph representing the total volume of carbon dioxide gas produced as a function of time is shown below.



5.1 Define the term *reaction rate*. (2)

5.2 Give a reason why the gradient of the graph decreases between t_2 and t_3. (1)

5.3 Changes in the graph between t_1 and t_2 are due to temperature changes within the reaction mixture.

5.3.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? (1)

5.3.2 Explain the answer by referring to the graph. (3)

5.4 The percentage purity of the sample is 82,5%.

Calculate the value of **X** on the graph assuming that the gas is collected at 25 °C. Take the molar gas volume at 25 °C as 24 000 cm^3. (5)

5.5 How will the reaction rate change if 15 g of a PURE sample of $CaCO_3$ reacts with the same HCℓ solution?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

5.6 Use the collision theory to explain the answer to QUESTION 5.5. (2)
[15]

QUESTION 6 (Start on a new page.)

Consider the balanced equation below for a hypothetical reaction that takes place in a sealed 2 dm^3 container at 300 K.

$$2P(g) + Q_2(g) \rightleftharpoons 2PQ(g)$$

6.1 Define the term *chemical equilibrium*. (2)

6.2 The amount of each substance present in the equilibrium mixture at 300 K is shown in the table below.

	AMOUNT (mol) AT EQUILIBRIUM
P	0,8
Q_2	0,8
PQ	3,2

The temperature of the container is now increased to 350 K.

When a NEW equilibrium is established, it is found that 1,2 mol P(g) is present in the container.

6.2.1 Is the heat of the reaction (ΔH) POSITIVE or NEGATIVE? (1)

6.2.2 Use Le Chatelier's principle to explain the answer to QUESTION 6.2.1. (3)

6.2.3 Calculate the equilibrium constant at 350 K. (8)

6.2.4 How will the equilibrium constant calculated in QUESTION 6.2.3 be affected when the volume of the container is decreased at constant temperature?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for the answer. (2)

6.3 More $Q_2(g)$ is now added to the reaction mixture at constant temperature.

How will EACH of the following be affected?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The yield of PQ(g) (1)

6.3.2 Number of moles of P(g) (1)
[18]

QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid, H_2SO_4, ionises into two steps as follows:

I $H_2SO_4(aq) + H_2O(\ell) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$ $K_a = 1 \times 10^3$

II $HSO_4^-(aq) + H_2O(\ell) \rightarrow SO_4^{2-}(aq) + H_3O^+(aq)$ $K_a = 1 \times 10^{-2}$

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Write down the NAME or FORMULA of the substance that acts as an ampholyte in the above equations.

Give a reason for the answer. (2)

7.1.3 The conductivity of solutions of $HSO_4^-(aq)$ and $H_2SO_4(aq)$ are compared. Which solution will have a LOWER conductivity?

Explain the answer. (3)

7.2 The pH of a hydrochloric acid solution, $HC\ell(aq)$, is 1,02 at 25 °C.

7.2.1 Calculate the concentration of the $HC\ell(aq)$. (3)

This $HC\ell$ solution reacts with sodium carbonate, Na_2CO_3, according to the following balanced equation:

$$2HC\ell(aq) + Na_2CO_3(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

50 cm^3 of the $HC\ell$ solution is added to 25 cm^3 of a 0,075 $mol \cdot dm^{-3}$ Na_2CO_3 solution.

7.2.2 Calculate the concentration of the EXCESS $HC\ell$ in the new solution. (8)
[18]

QUESTION 8 (Start on a new page.)

The table below shows two half-cells, **A** and **B**, used to assemble an electrochemical cell under STANDARD CONDITIONS.

Half-cell **A**	Cu^{2+} (aq) | Cu(s)
Half-cell **B**	Ag^{+} (aq) | Ag(s)

8.1 State the energy conversion that takes place in this cell. (1)

8.2 Calculate the mass of silver nitrate, $AgNO_3$, used to prepare 150 cm^3 of the electrolyte solution in half-cell **B**. (4)

8.3 Define the term *reducing agent*. (2)

8.4 Write down the:

8.4.1 NAME or FORMULA of the reducing agent (1)

8.4.2 Balanced equation for the reaction that takes place (3)

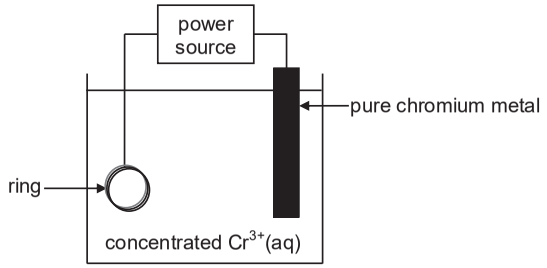
8.5 Calculate the initial emf of this cell. (4)

8.6 How will the emf of the cell be affected if the concentration of the copper ions in half-cell **A** increases?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
[16]

QUESTION 9 (Start on a new page.)

The diagram below shows a simplified electrolytic cell used to electroplate a ring.



9.1 Define the term *electrolyte*. (2)

9.2 Is the pure chromium metal the ANODE or the CATHODE of the cell? Give a reason for the answer. (2)

9.3 Write down the half-reaction that takes place at the ring. (2)

9.4 Calculate the total charge transferred when the mass of the pure chromium changes by 2 g. (5)
[11]

TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/
NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER EXAMINATION 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following is an ALKANE?

A C_6H_8

B C_6H_{10}

C C_6H_{12}

D C_6H_{14} (2)

1.2 Esters are formed by a reaction between two organic compounds, **X** and **Y**, each with a different functional group.

The functional groups of these compounds are:

	Compound X	Compound Y
A	Hydroxyl group	Carboxyl group
B	Hydroxyl group	Carbonyl group
C	Hydroxide ion	Carboxyl group
D	Hydroxide ion	Carbonyl group

(2)

1.3 When butane is subjected to high temperatures and pressures, the following reaction takes place:

Butane $\longrightarrow$ methane + **Y**

Which ONE of the following represents **Y**?

A $CHCCH_3$

B CH_2CHCH_3

C $CH_3CH_2CH_3$

D $CH_3CHCHCH_3$ (2)

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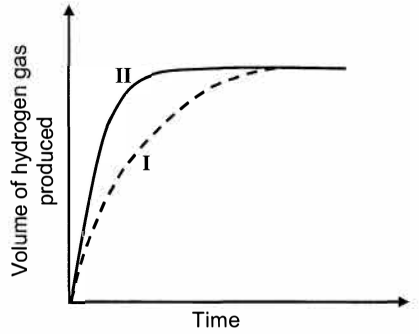
1.4 A hydrochloric acid solution, HCℓ(aq), of concentration 1 mol·dm^{-3} is added to EXCESS POWDERED magnesium at 25 °C.

Curve **I** below represents the volume of hydrogen gas produced during the reaction.

Curve **II** was obtained at different conditions using the SAME VOLUME of hydrochloric acid solution.



Which ONE of the following represents the conditions used to obtain curve **II**?

	STATE OF DIVISION OF Mg	CONCENTRATION OF ACID (mol·dm^{-3})	TEMPERATURE (°C)
A	Ribbon	0,5	25
B	Ribbon	2	25
C	Powder	1	20
D	Powder	1	30

(2)

1.5 In which ONE of the following reactions at equilibrium will the YIELD of the product increase when the VOLUME of the container is increased at constant temperature?

A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

B $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

D $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ (2)

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1.6 Which ONE of the following statements is TRUE for an EXOTHERMIC reaction?

A More energy is absorbed than released.

B More energy is released than absorbed.

C Heat of reaction (ΔH) is positive.

D Energy of the products is greater than the energy of the reactants. (2)

1.7 Consider the equation below.

$$H_3PO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + H_2PO_4^-(aq)$$

Which ONE of the following is a conjugate acid-base pair?

A $H_3O^+(aq)$ and $H_2O(\ell)$

B $H_3PO_4(aq)$ and $H_2O(\ell)$

C $H_3PO_4(aq)$ and $H_3O^+(aq)$

D $H_3O^+(aq)$ and $H_2PO_4^-(aq)$ (2)

1.8 Consider the balanced equation for the reaction below:

$$2Cr^{2+}(aq) + Sn^{4+}(aq) \rightarrow 2Cr^{3+}(aq) + Sn^{2+}(aq)$$

The OXIDISING AGENT is:

A $Cr^{2+}(aq)$

B $Cr^{3+}(aq)$

C $Sn^{2+}(aq)$

D $Sn^{4+}(aq)$ (2)

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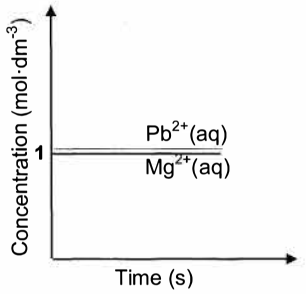
1.9 An electrochemical cell is set up at standard conditions. The cell notation for the cell is given below.

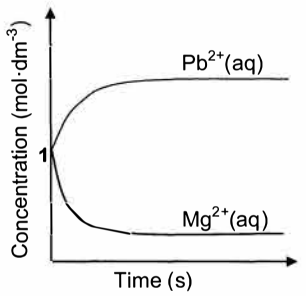
$$Mg(s) \mid Mg^{2+}(aq) \parallel Pb^{2+}(aq) \mid Pb(s)$$

The cell is now connected in a circuit. Which ONE of the graphs below BEST represents the concentrations of the electrolytes after a long time?

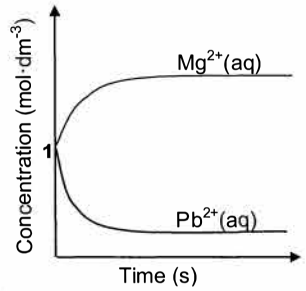
A



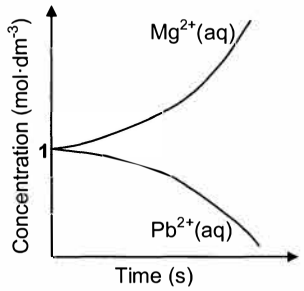
B



C



D



(2)

1.10 Two 50 kg bags, containing fertilisers **R** and **S** respectively, are labelled as follows:

Fertiliser **R**: 3 : 1 : 5 (20)
Fertiliser **S**: 1 : 2 : 6 (20)

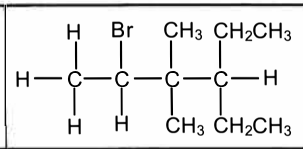
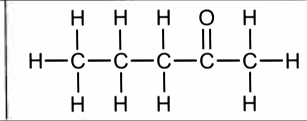
Identify the fertiliser(s) most suitable for healthy leaf growth and healthy root growth.

	LEAF GROWTH	ROOT GROWTH
A	R	R
B	S	R
C	R	S
D	S	S

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **E** in the table below represent five organic compounds.

A		**B**	C_xH_y
C		**D**	$CH_3(CH_2)_2CH(OH)CH_2CH_3$
E	$CH_3CH_2CH_2CH_2CH_2CH_2CHCH_2$		

2.1 Write down the LETTER that represents EACH of the following:

2.1.1 A ketone (1)

2.1.2 A hydrocarbon (1)

2.1.3 An alkene (1)

2.2 Write down the:

2.2.1 IUPAC name of compound **A** (3)

2.2.2 STRUCTURAL FORMULA of compound **D** (2)

2.2.3 IUPAC name of the STRAIGHT CHAIN FUNCTIONAL ISOMER of compound **C** (2)

2.3 Compound **B** is a straight chain compound that undergoes the following exothermic reaction:

$$2C_xH_y + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$$

2.3.1 Besides being exothermic, what type of reaction is represented above? (1)

2.3.2 Determine the MOLECULAR FORMULA of compound **B**. (2)

The reaction above takes place in a closed container at a constant temperature higher than 100 °C and at constant pressure.

2.3.3 Calculate the TOTAL VOLUME of gas formed in the container when 50 cm^3 of C_xH_y reacts completely with oxygen. (3)
[16]

QUESTION 3 (Start on a new page.)

Compounds **A**, **B** and **C** are used to investigate a factor which influences the boiling points of organic compounds. The results of the investigation are given in the table below.

	COMPOUND	BOILING POINT (°C)
A	Butan-1-ol	117
B	Butan-2-ol	100
C	2-methylpropan-2-ol	82

3.1 Is this a fair investigation? Choose from YES or NO. (1)

3.2 Give a reason for the answer to QUESTION 3.1. (1)

3.3 Fully explain the difference in the boiling points of compounds **B** and **C**. (3)

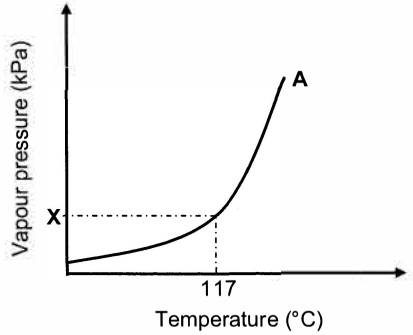
3.4 Define the term *positional isomer*. (2)

3.5 From compounds **A**, **B** and **C**, choose the letter(s) that represent(s) EACH of the following:

3.5.1 Positional isomers (1)

3.5.2 A tertiary alcohol
Give a reason for the answer. (2)

3.6 The graph below represents the relationship between vapour pressure and temperature for compound **A** (butan-1-ol).



3.6.1 Write down the value of **X**. (1)

3.6.2 Redraw the graph above in the ANSWER BOOK. On the same set of axes, sketch the curve that will be obtained for compound **C**. Clearly label the curves **A** and **C**. Indicate the relevant boiling point for compound **C** on the graph. (2)
[13]

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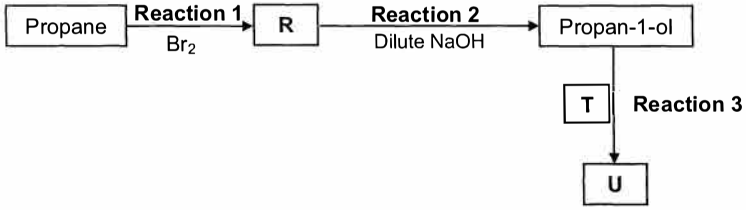
QUESTION 4 (Start on a new page.)

4.1 The flow diagram below shows various organic reactions using propane as starting reactant. **R**, **T** and **U** represent different organic compounds.

Compound **T** is a CARBOXYLIC ACID and compound **U** is a FUNCTIONAL ISOMER of pentanoic acid.



Write down the NAME of the type of reaction represented by:

4.1.1 Reaction **1** (1)

4.1.2 Reaction **2** (1)

Consider **reaction 1** and **reaction 2**.

4.1.3 Write down the IUPAC name of compound **R**. (2)

Reaction 3 takes place in the presence of a catalyst and heat.

Write down the:

4.1.4 NAME or FORMULA of the catalyst (1)

4.1.5 IUPAC name of compound **T** (2)

4.1.6 STRUCTURAL FORMULA of compound **U** (2)

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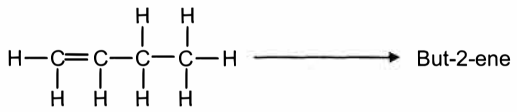
4.2 A laboratory technician wants to prepare but-2-ene using but-1-ene as starting reagent, as shown below.



The following chemicals are available in the laboratory:

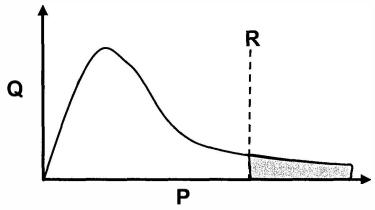
concentrated H_2SO_4	H_2O	concentrated NaOH

Select the chemicals required to design this preparation from the list above.

For EACH step of the preparation, write down the balanced equation, using STRUCTURAL FORMULAE for all organic compounds. Indicate the chemicals needed in each step. (6)
[15]

QUESTION 5 (Start on a new page.)

5.1 Study the Maxwell-Boltzmann distribution curve for a certain reaction below.



P and **Q** are the labels of the axes. What quantity is represented by:

5.1.1 **P** (1)

5.1.2 **Q** (1)

5.2 Line **R** represents the minimum energy required for the reaction to take place.

5.2.1 Write down the term for the underlined phrase. (1)

5.2.2 How will the shaded area on the graph be affected when a catalyst is added? Choose from INCREASE, DECREASE or REMAINS THE SAME. (1)

5.3 Use the collision theory to explain how a catalyst influences the rate of reaction. (4)

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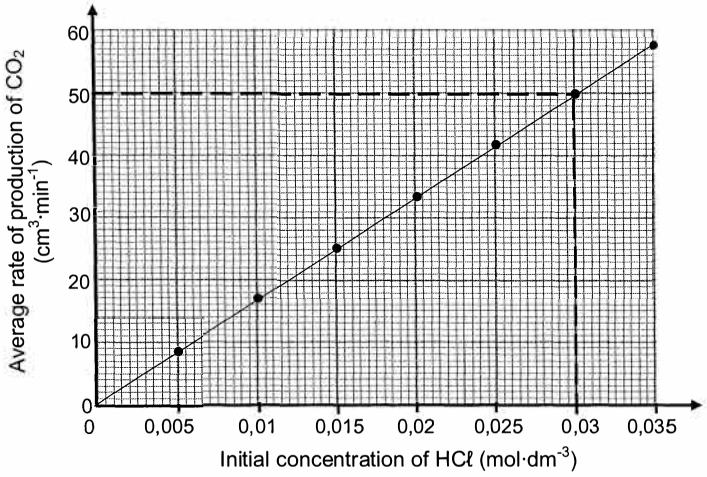
5.4 The reaction between POWDERED calcium carbonate, $CaCO_3(s)$, and EXCESS hydrochloric acid, $HC\ell(aq)$, is used to investigate reaction rate at 25 °C. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

Several experiments are conducted using the same mass of IMPURE calcium carbonate and different initial concentrations of dilute hydrochloric acid. The graph below represents the results obtained. Assume that the impurities do not react.



For this investigation, write down a:

5.4.1 Controlled variable (1)

5.4.2 Conclusion (2)

The $CaCO_3(s)$ in 6 g of the impure sample reacts completely with 0,03 $mol{\cdot}dm^{-3}$ $HC\ell(aq)$ in 26 minutes.

5.4.3 Use the information in the graph to calculate the percentage purity of the calcium carbonate. Assume that the molar gas volume at 25 °C is 24 000 cm^3. (6)
[17]

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QUESTION 6 (Start on a new page.)

Steam, $H_2O(g)$, reacts with hot carbon, C(s), at 1 000 °C according to the following balanced equation:

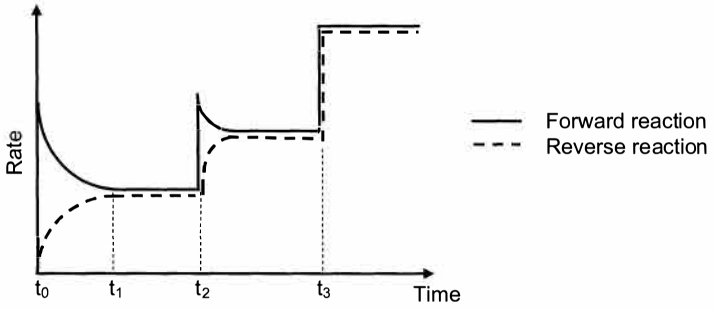
$$2H_2O(g) + C(s) \rightleftharpoons 2H_2(g) + CO_2(g)$$

Initially, 36 g of steam and a certain amount of carbon were placed in a 2 dm^3 sealed container and allowed to react. At equilibrium it was found that the amount of carbon changed by 0,225 mol.

6.1 Define the term *dynamic equilibrium*. (2)

6.2 Calculate the equilibrium constant, K_c, for the reaction at 1 000 °C. (8)

6.3 The graph shows how the rates of the forward and reverse reactions change with time.



6.3.1 Give a reason why the rate of the forward reaction decreases between t_0 and t_1. (1)

6.3.2 What change was made to the equilibrium mixture at t_3? (1)

At time t_2, the temperature of the system is increased.

6.3.3 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

6.3.4 Refer to Le Chatelier's principle to explain the answer to QUESTION 6.3.3. (2)
[15]

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QUESTION 7 (Start on a new page.)

Two beakers, **A** and **B**, contain strong bases.

Beaker **A**: 500 cm^3 of barium hydroxide, $Ba(OH)_2(aq)$ of unknown concentration **X**

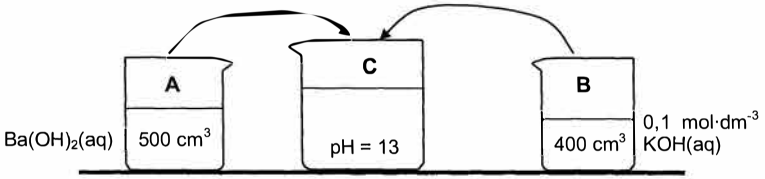
Beaker **B**: 400 cm^3 of potassium hydroxide, KOH(aq) of concentration 0,1 $mol \cdot dm^{-3}$

7.1 Define a *base* according to the Arrhenius theory. (2)

7.2 Calculate the number of moles of hydroxide ions (OH^-) in beaker **B**. (2)

7.3 The contents of beakers **A** and **B** are added together in beaker **C**. The solution in beaker **C** has a pH of 13.

Assume that the volumes are additive and that the temperature of the solutions is 25 °C.



7.3.1 Calculate the concentration, **X**, of the $Ba(OH)_2$ in beaker **A**. (8)

The solution in beaker **C** is titrated with ethanoic acid. It was found that 15 cm^3 of the solution neutralises 30 cm^3 of the acid.

The balanced equation for the reaction is:

$$CH_3COOH(aq) + OH^-(aq) \rightarrow CH_3COO^-(aq) + H_2O(\ell)$$

7.3.2 Is ethanoic acid, $CH_3COOH(aq)$, a WEAK acid or a STRONG acid?

Give a reason for the answer. (2)

7.3.3 Calculate the concentration of the ethanoic acid. (4)
[18]

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QUESTION 8 (Start on a new page.)

A galvanic cell at standard conditions is represented by the cell notation below. **X** and **Y** are unknown electrodes.

$$\mathbf{X} \mid Zn^{2+}(aq) \parallel Fe^{3+}(aq) , Fe^{2+}(aq) \mid \mathbf{Y}$$

8.1 Write down the NAME or FORMULA of:

8.1.1 Electrode **X** (1)

8.1.2 Electrode **Y** (1)

8.1.3 The oxidising agent (1)

8.2 Write down:

8.2.1 ONE function of electrode **Y** (1)

8.2.2 The half-reaction that takes place at electrode **Y** (2)

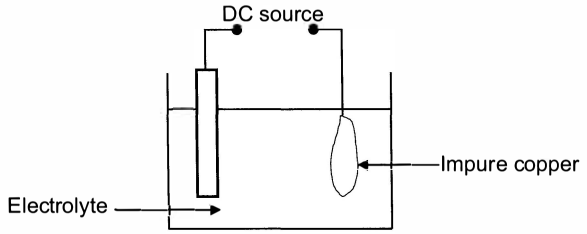
8.2.3 The net (overall) equation for the cell reaction that takes place in this cell (3)

8.3 Calculate the initial emf of this cell. (4)

8.4 How will the initial emf of the cell be affected when the concentration of the iron(III) ions is changed to 0,6 $mol \cdot dm^{-3}$? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
[14]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrochemical cell used for the purification of copper. The impure copper contains small amounts of silver (Ag) and zinc (Zn) as the only impurities.



9.1 Define the term *electrolysis*. (2)

9.2 Write down the NAME or FORMULA of TWO positive ions present in the electrolyte. (2)

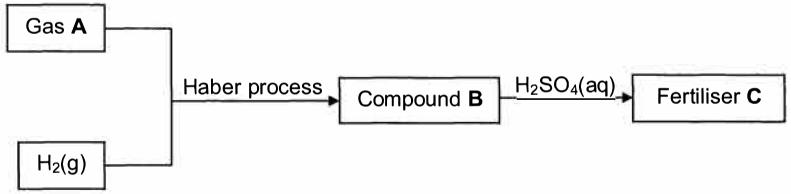
9.3 Write down the half-reaction that takes place at the cathode. (2)

9.4 Refer to the Table of Standard Reduction Potentials and explain why the purified copper will NOT contain any zinc. (3)

9.5 Calculate the maximum mass of Cu formed if 0,6 moles of electrons are transferred. (3)
[12]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows processes involved in the production of fertiliser **C**.



Write down the NAME or FORMULA of:

10.1.1 Gas **A** (1)

10.1.2 The catalyst used in the Haber process (1)

10.1.3 Compound **B** (1)

Write down the:

10.1.4 Name of the process used to produce gas **A** (1)

10.1.5 Balanced equation for the formation of fertiliser **C** (3)

10.2 A 40 kg bag of fertiliser contains 65% filler. The mass of the nutrients in the bag is shown in the table below.

NUTRIENTS	MASS (kg)
Nitrogen	**x**
Phosphorous	**2x**
Potassium	5

Calculate the NPK ratio of the fertiliser. (3)
[10]

TOTAL: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: CHEMISRTY P2

2021

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

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KWAZULU-NATAL

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following compounds has hydrogen bonds between molecules?

A Pentanal

B Pentan-2-one

C Pentanoic acid

D Methyl butanoate (2)

1.2 To which homologous series does a compound with molecular formula $C_6H_{12}O_2$ belong?

A Ketones

B Alcohols

C Aldehydes

D Carboxylic acids (2)

1.3 Which functional groups are involved in the formation of esters?

A Formyl and carbonyl

B Hydroxyl and carbonyl

C Hydroxyl and carboxyl

D Carbonyl and carboxyl (2)

1.4 The equation below represents a reaction at equilibrium.

$$\underset{\text{yellow}}{2CrO_4^{2-}(aq)} + 2H^+(aq) \rightleftharpoons \underset{\text{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(\ell)$$

Which ONE of the following will change the colour of the mixture from yellow to orange?

A Addition of sodium hydroxide pellets

B Addition of concentrated hydrochloric acid

C Increase in pressure at constant temperature

D Decrease in pressure at constant temperature (2)

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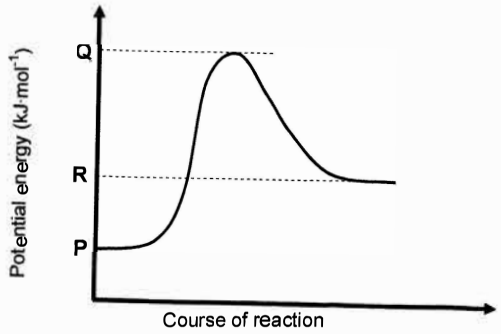
1.5 Consider the potential energy graph for the reaction shown below.



The activation energy for the FORWARD reaction in terms of **P**, **Q** and **R** is:

A **Q**

B **R – P**

C **Q – R**

D **Q – P**

(2)

1.6 A reaction reaches equilibrium in a closed container according to the following balanced equation:

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H < 0$$

Which ONE of the following changes will INCREASE the value of the equilibrium constant?

A Removing $NH_3(g)$

B Heating the container

C Cooling the container

D Increasing the volume of the container

(2)

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1.7 Sulphuric acid ionises in water according to the following equations:

$$H_2SO_4(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$$
$$HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$$

Consider the following statements regarding the ionisation above:

I: $H_2O(\ell)$ acts as a base in both reactions.
II: $HSO_4^-(aq)$ acts as an ampholyte.
III: $SO_4^{2-}(aq)$ is the conjugate base of H_2SO_4.

Which of the statements above is/are TRUE?

A **I** only

B **I** and **II**

C **I** and **III**

D **I**, **II** and **III**

(2)

1.8 Which ONE of the following reactions, when used in a voltaic cell, will give a positive reading on the voltmeter?

A $Mg^{2+}(aq) + Zn(s) \rightarrow Mg(s) + Zn^{2+}(aq)$

B $Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

C $Co^{2+}(aq) + Sn^{2+}(aq) \rightarrow Co(s) + Sn^{4+}(aq)$

D $3Ni^{2+}(aq) + 2Fe(s) \rightarrow 3Ni(s) + 2Fe^{3+}(aq)$

(2)

1.9 Which ONE of the following statements is CORRECT for an ELECTROLYTIC CELL?

A The anode is the positive electrode.

B The cathode is the positive electrode.

C Oxidation takes place at the cathode.

D Reduction takes place at the anode.

(2)

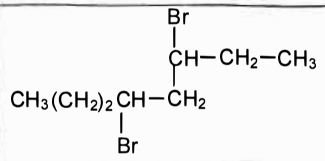
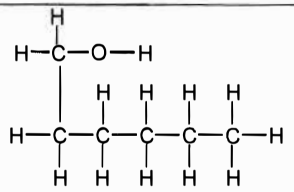
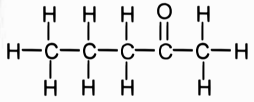
1.10 Which ONE of the following shows the industrial processes in which AMMONIA is a reactant and a product respectively?

	REACTANT	PRODUCT
A	Ostwald	Contact
B	Ostwald	Haber
C	Contact	Haber
D	Contact	Ostwald

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	Methanoic acid	**B**	Pentanal
C	$C_{10}H_{22}$	**D**	
E		**F**	

2.1 Write down the LETTER(S) that represent(s) the following:

2.1.1 A ketone (1)

2.1.2 TWO compounds that are FUNCTIONAL ISOMERS (1)

2.1.3 A hydrocarbon (1)

2.2 For compound **D**, write down the:

2.2.1 Homologous series to which it belongs (1)

2.2.2 IUPAC name (3)

2.3 Consider compound **F**.

Write down the IUPAC name of its:

2.3.1 POSITIONAL isomer (2)

2.3.2 CHAIN isomer (2)

2.4 During the reaction of compound **A** with compound **E** in the presence of an acid catalyst, two products are formed.

For the ORGANIC product formed, write down the:

2.4.1 IUPAC name (2)

2.4.2 STRUCTURAL FORMULA of its FUNCTIONAL GROUP (1)

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2.5 Compound **C** ($C_{10}H_{22}$) reacts at high temperatures and pressures to form a three-carbon alkene **P** and an alkane **Q**, as shown below.

$$C_{10}H_{22} \longrightarrow \mathbf{P} + \mathbf{Q}$$

Write down the:

2.5.1 Type of reaction that takes place (1)

2.5.2 Molecular formula of compound **Q** (2)

2.5.3 STRUCTURAL FORMULA of compound **P** (2)

[19]

QUESTION 3 (Start on a new page.)

Learners use compounds **A**, **B** and **C** to investigate one of the factors that influences the VAPOUR PRESSURE of organic compounds.

A	Butan-1-ol
B	Butan-2-one
C	Propanoic acid

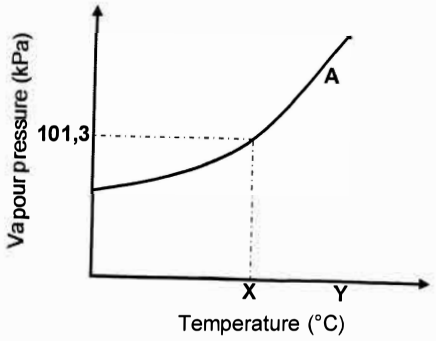
3.1 Define the term *vapour pressure*. (2)

3.2 Write down the independent variable for this investigation. (1)

3.3 Which compound, **A** or **B**, has the higher vapour pressure? (1)

3.4 Fully explain the answer to QUESTION 3.3.
Include the TYPES OF INTERMOLECULAR FORCES in your explanation. (4)

3.5 The graph below represents the relationship between vapour pressure and temperature for compound **A** at sea level. **X** and **Y** represent different temperatures.



3.5.1 Write down the term for the temperature represented by **X**. (1)

3.5.2 State the phase of compound **A** at temperature **Y**. Choose from GAS, LIQUID or SOLID. (1)

3.5.3 Redraw the graph above in your ANSWER BOOK. On the same set of axes, sketch the curve that will be obtained for compound **C**. Clearly label curve **A** and curve **C**. (2)
[12]

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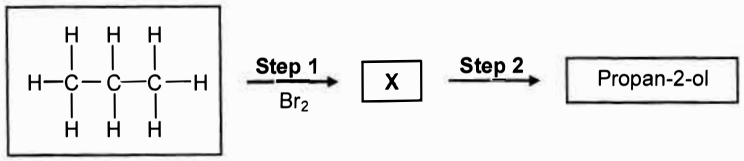
QUESTION 4 (Start on a new page.)

4.1 The flow diagram below shows the conversion of propane to propan-2-ol.



4.1.1 State ONE reaction condition for **Step 1**. (1)

4.1.2 Write down the NAME or FORMULA of the INORGANIC product formed in **Step 1**. (1)

4.1.3 Name the TYPE of substitution reaction represented by **Step 2**. (1)

4.1.4 Write down the NAME or FORMULA of the INORGANIC reagent needed in **Step 2**. (1)

4.1.5 Write down the IUPAC name of compound **X**. (2)

4.2 Ethane can be prepared from chloroethane ($CH_3CH_2C\ell$) by a TWO-STEP process. You are supplied with the following chemicals:

H_2	$HC\ell$	$C\ell_2$	H_2O	Pt	Ethanol	concentrated H_2SO_4	concentrated NaOH

Select chemicals in the table above that can be used for this preparation.

Using CONDENSED structural formulae, write down a balanced equation for EACH reaction. Indicate the reaction conditions for EACH reaction. (8)
[14]

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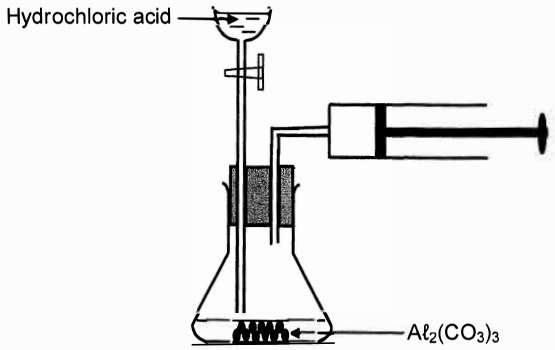
QUESTION 5 (Start on a new page.)

Two experiments, **I** and **II**, are conducted to investigate one of the factors that affects the rate of the reaction of aluminium carbonate, $A\ell_2(CO_3)_3$, with EXCESS hydrochloric acid, $HC\ell$. The balanced equation for the reaction is:

$$A\ell_2(CO_3)_3(s) + 6HC\ell(aq) \rightarrow 2A\ell C\ell_3(aq) + 3H_2O(\ell) + 3CO_2(g)$$

The apparatus used is shown below.



The reaction conditions used for each experiment are as follows:

Experiment I:
100 cm^3 of 1,5 $mol \cdot dm^{-3}$ $HC\ell(aq)$ reacts with 0,016 mol $A\ell_2(CO_3)_3$ granules at 25 °C

Experiment II:
50 cm^3 of 2 $mol \cdot dm^{-3}$ $HC\ell(aq)$ reacts with 0,016 mol $A\ell_2(CO_3)_3$ granules at 25 °C

5.1 Define the term *rate of a reaction*. (2)

5.2 Using the experimental setup above, state the measurements that must be made to determine the rate of this reaction. (2)

5.3 Use the collision theory to explain how the average reaction rate in **Experiment I** differs from the average reaction rate in **Experiment II**. (3)

5.4 The average rate of the reaction in **Experiment II** during the first 2,5 minutes is $4,4 \times 10^{-3}$ $mol \cdot min^{-1}$.

Calculate the number of moles of $A\ell_2(CO_3)_3$ that remains in the flask after 2,5 minutes. (3)

5.5 Calculate the maximum volume of $CO_2(g)$ that can be prepared at 25 °C in **Experiment I**. Take molar gas volume at 25 °C as 24 000 $cm^3 \cdot mol^{-1}$. (3)
[13]

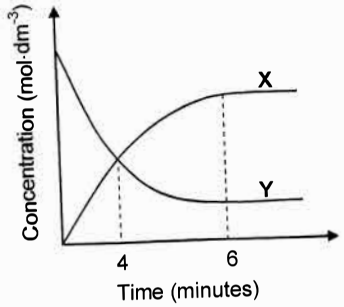
QUESTION 6 (Start on a new page.)

Pure hydrogen iodide gas, HI(g), of concentration 1 $mol \cdot dm^{-3}$, is sealed in a 500 cm^3 container at temperature **T**. The reaction reaches equilibrium according to the following balanced equation:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

6.1 Define the term *chemical equilibrium*. (2)

6.2 The graph below shows how the concentrations of the reactant and products vary with time during the reaction.

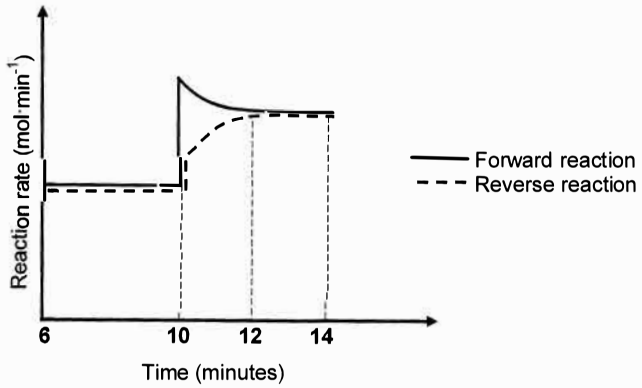


6.2.1 Which ONE of the curves, **X** or **Y**, represents the changes in the concentration of the products? Give a reason for the answer. (2)

6.2.2 How does the rate of the forward reaction compare to that of the reverse reaction at t = 4 minutes? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

6.3 The equilibrium constant, K_c, for the reaction is 0,04 at temperature **T**. Calculate the number of moles of iodine, $I_2(g)$, present at time t = 6 minutes. (9)

6.4 The graph below shows how the rates of the forward and reverse reactions change with time.



The temperature of the container is increased at t = 10 minutes.

6.4.1 Which reaction(s) show(s) an increase in rate at t = 10 minutes? Choose from FORWARD, REVERSE or BOTH FORWARD AND REVERSE. (1)

6.4.2 Is the heat of reaction (ΔH) for this reaction POSITIVE or NEGATIVE? Fully explain the answer. (4)
[19]

QUESTION 7 (Start on a new page.)

Learners prepare a solution of known concentration by dissolving 2 g pure sodium hydroxide crystals, NaOH, in water in a 250 cm^3 volumetric flask.

7.1 Write down the term for the underlined phrase. (1)

7.2 Calculate the:

7.2.1 Concentration of the sodium hydroxide solution (4)

7.2.2 pH of the solution (4)

The learners now react 1,5 g of pure $CaCO_3$ with 50 cm^3 dilute $HC\ell$ of unknown concentration. The EXCESS $HC\ell$ is neutralised with 25 cm^3 of the NaOH solution that they prepared. The balanced equations for the reactions are:

$$2HC\ell(aq) + CaCO_3(s) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

$$HC\ell(aq) + NaOH(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

7.3 Calculate the initial concentration of the dilute $HC\ell(aq)$. (8)
[17]

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QUESTION 8 (Start on a new page.)

8.1 When a piece of sodium metal (Na) is added to water in a test tube, hydrogen gas is released. When phenolphthalein indicator is added to the test tube, the solution turns pink.

8.1.1 Define the term *reduction* in terms of electron transfer. (2)

8.1.2 Write down the reduction half-reaction. (2)

8.1.3 Write down the balanced equation for the reaction that takes place (3)

8.1.4 Give a reason why the solution turns pink. (1)

When a piece of copper is added to water in a test tube, no reaction is observed.

8.1.5 Refer to the relative strengths of the REDUCING AGENTS to explain why no reaction is observed. (3)

8.2 Consider the cell notation below.

$$Pb(s) \mid Pb^{2+}(aq) \parallel Fe^{3+}(aq), Fe^{2+}(aq) \mid Pt(s)$$

8.2.1 What does the single line (|) in the cell notation above represent? (1)

8.2.2 State the energy conversion that takes place in this cell. (1)

8.2.3 Calculate the initial emf of the cell under standard conditions. (4)
[17]

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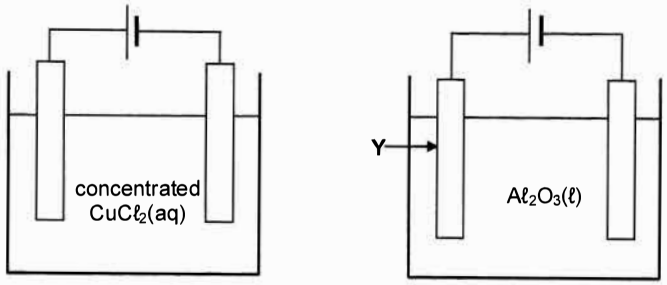
QUESTION 9 (Start on a new page.)

The diagrams below show two electrochemical cells in which carbon electrodes are used. In cell **A**, concentrated copper (II) chloride solution is used and in cell **B**, liquid aluminium oxide is used.



Cell A **Cell B**

9.1 What type of electrochemical cell, ELECTROLYTIC or GALVANIC, is shown above? Give a reason for the answer. (2)

9.2 Write down the:

9.2.1 Half-reaction that takes place at the anode of cell **A** (2)

9.2.2 Half-reaction that takes place at the cathode of cell **B** (2)

9.2.3 NAME or FORMULA of the product formed at the cathode of cell **A** (1)

9.3 Give a reason why the mass of electrode **Y** decreases after a while. (1)
[8]

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QUESTION 10 (Start on a new page.)

10.1 The incomplete equations below show the four steps involved in the industrial preparation of sulphuric acid (H_2SO_4). **A** and **B** represent two compounds.

Step I: $S(s) + O_2(g) \rightarrow$ **A**

Step II: **A** $+ O_2(g) \rightleftharpoons$ **B**

Step III: **B** $+ H_2SO_4 \rightarrow H_2S_2O_7$

Step IV: $H_2S_2O_7 + H_2O \rightarrow H_2SO_4$

Write down the NAME or FORMULA of:

10.1.1 Compound **A** (1)

10.1.2 Compound **B** (1)

10.1.3 The catalyst used in **Step II** (1)

The sulphuric acid formed in **Step IV** is used to prepare ammonium sulphate.

10.1.4 Write down a balanced equation for this reaction. (3)

10.2 The diagram below shows a bag of fertiliser.



10.2.1 Write down the meaning of NPK. (1)

10.2.2 The bag contains 4 kg of ammonium nitrate, NH_4NO_3, which is the only source of nitrogen. Calculate the mass of the fertiliser in the bag. (4)
[11]

TOTAL: 150

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SENIOR CERTIFICATE/
NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2020

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following is the general formula for the alkanes?

A C_nH_{2n}

B C_nH_{2n-2}

C C_nH_{2n+2}

D $C_nH_{2n+2}O$ (2)

1.2 The EMPIRICAL FORMULA of hexanoic acid is …

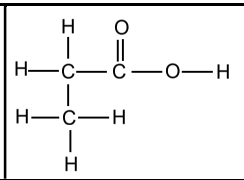
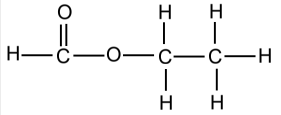
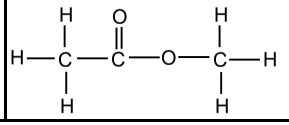
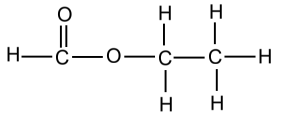
A $C_3H_6O_2$

B $C_6H_6O_2$

C $C_6H_{12}O_2$

D C_3H_6O (2)

1.3 Which ONE of the following is the CORRECT structural formula for METHYL ETHANOATE?

A		**B**	
C		**D**	

(2)

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1.4 Zinc (Zn) granules react as follows with EXCESS hydrochloric acid solution, HCℓ(aq):

$$Zn(s) + HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

Which ONE of the following combinations of volume and concentration of HCℓ(aq) will result in the highest INITIAL reaction rate for the same mass of zinc granules used? (Assume that the zinc granules are completely covered by the acid in all cases.)

	VOLUME HCℓ(aq) (cm^3)	CONCENTRATION HCℓ(aq) ($mol \cdot dm^{-3}$)
A	50	0,5
B	100	1,0
C	200	0,1
D	200	0,5

(2)

1.5 The role of a catalyst in a chemical reaction is to increase the …

A yield.

B activation energy.

C heat of reaction.

D rate of the reaction. (2)

1.6 Consider the equilibrium represented by the balanced equation below:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell) \quad \Delta H < 0$$

Which ONE of the following changes to the equilibrium will favour the forward reaction?

	TEMPERATURE	pH
A	Decrease	Increase
B	Decrease	Decrease
C	Increase	Increase
D	Increase	Decrease

(2)

1.7 The conjugate base of HPO_4^{2-} is …

A OH^-

B PO_4^{3-}

C $H_2PO_4^-$

D H_3PO_4 (2)

1.8 Which ONE of the following reactions will proceed spontaneously under standard conditions?

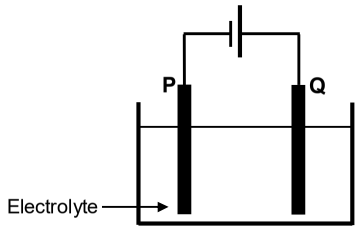
A $Ni^{2+}(aq) + H_2(g) \rightarrow Ni(s) + 2H^+(aq)$

B $Br_2(\ell) + 2C\ell^-(aq) \rightarrow 2Br^-(aq) + C\ell_2(g)$

C $2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$

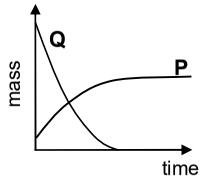
D $2Cu^+(aq) + Pb^{2+}(aq) \rightarrow 2Cu^{2+}(aq) + Pb(s)$ (2)

1.9 The simplified diagram below represents an electrochemical cell used for the PURIFICATION of copper.

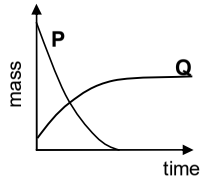


Which ONE of the graphs below represents the CHANGE IN MASS of electrodes **P** and **Q** during the purification process?

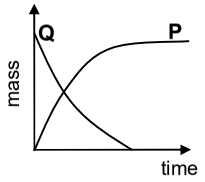
A



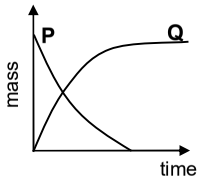
B



C



D



(2)

1.10 Eutrophication in water is caused by …

A algal bloom.

B bacterial nitrogen fixation.

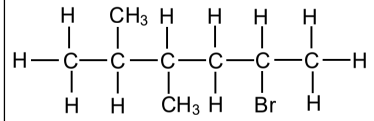
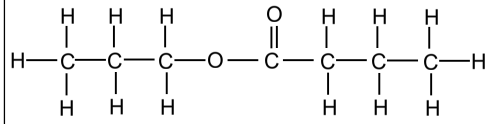
C an increase in plant nutrients.

D a depletion of oxygen concentration. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **E** in the table below represent five organic compounds.

A		**B**	C_3H_8O
C		**D**	Pentan-2-one
E	4-methylpent-2-yne		

Use the information in the table to answer the questions that follow.

2.1 For compound **D**, write down the:

2.1.1 Homologous series to which it belongs (1)

2.1.2 IUPAC name of a FUNCTIONAL ISOMER (2)

2.2 Write down the:

2.2.1 IUPAC name of compound **A** (3)

2.2.2 STRUCTURAL FORMULA of compound **E** (2)

2.3 Compound **B** is a primary alcohol.

2.3.1 Write down the meaning of the term *primary alcohol*. (2)

Compound **B** reacts with another organic compound **X** to form compound **C**.

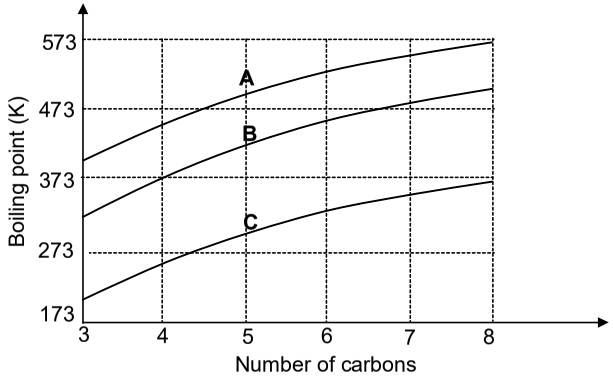
Write down the:

2.3.2 Type of reaction that takes place (1)

2.3.3 IUPAC name of compound **X** (1)
[12]

QUESTION 3 (Start on a new page.)

The relationship between boiling point and the number of carbon atoms in straight chain molecules of aldehydes, alkanes and primary alcohols is investigated. Curves **A**, **B** and **C** are obtained.



3.1 Define the term *boiling point*. (2)

3.2 Write down the STRUCTURAL FORMULA of the functional group of the aldehydes. (1)

3.3 The graph shows that the boiling points increase as the number of carbon atoms increases. Fully explain this trend. (3)

3.4 Identify the curve (**A**, **B** or **C**) that represents the following:

3.4.1 Compounds with London forces only (1)

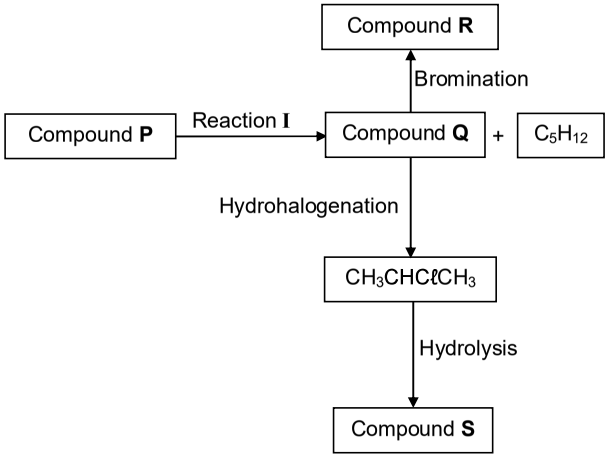
3.4.2 The aldehydes
Explain the answer. (4)

3.5 Use the information in the graph and write down the IUPAC name of the compound with a boiling point of 373 K. (2)

3.6 Write down the IUPAC name of the compound containing five carbon atoms, which has the lowest vapour pressure at a given temperature. (2)
[15]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how various organic compounds can be prepared using compound **P** as starting reagent.



4.1 Write down the meaning of the term *hydrohalogenation*. (2)

4.2 Write down the STRUCTURAL FORMULA of compound **Q**. (2)

4.3 **Reaction I** is an elimination reaction.

Write down the:

4.3.1 TYPE of elimination reaction (1)

4.3.2 MOLECULAR FORMULA of compound **P** (1)

4.4 Write down the IUPAC name of compound **R**. (2)

4.5 For the HYDROLYSIS REACTION, write down the:

4.5.1 Balanced equation using structural formulae (5)

4.5.2 TWO reaction conditions (2)
[15]

QUESTION 5 (Start on a new page.)

The reaction of calcium carbonate ($CaCO_3$) and EXCESS dilute hydrochloric acid ($HC\ell$) is used to investigate one of the factors that affects reaction rate. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

The same mass of $CaCO_3$ is used in all the experiments and the temperature of the hydrochloric acid in all experiments is 40 °C.

The reaction conditions for each experiment are summarised in the table below.

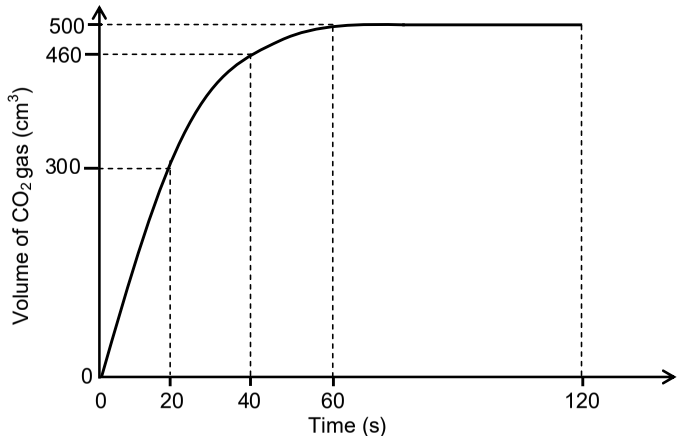
EXPERIMENT	VOLUME OF $HC\ell(aq)$ (cm^3)	CONCENTRATION OF $HC\ell(aq)$ ($mol \cdot dm^{-3}$)	STATE OF DIVISION OF $CaCO_3$
A	500	0,1	granules
B	500	0,1	lumps
C	500	0,1	powder

5.1 For this investigation write down the:

5.1.1 Dependent variable (1)

5.1.2 Independent variable (1)

The carbon dioxide gas, $CO_2(g)$, produced during EXPERIMENT **A**, is collected in a gas syringe. The volume of gas collected is measured every 20 s and the results obtained are shown in the graph below.



5.2 What can be deduced from the graph regarding the RATE OF THE REACTION during the time interval:

5.2.1 20 s to 40 s (1)

5.2.2 60 s to 120 s (1)

5.3 Calculate the average rate (in $cm^3 \cdot s^{-1}$) at which $CO_2(g)$ is produced in the experiment. (3)

5.4 How will the volume of $CO_2(g)$ produced in experiment **B** compare to that produced in experiment **A**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

5.5 A graph is now drawn for experiment **C** on the same set of axes. How will the gradient of this graph compare to the gradient of the graph for experiment **A**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO.

Use the collision theory to fully explain the answer. (4)

5.6 Assume that the molar gas volume at 40 °C is 25,7 $dm^3 \cdot mol^{-1}$. Calculate the mass of $CaCO_3(s)$ used in experiment **A**. (4)
[16]

QUESTION 6 (Start on a new page.)

The dissociation of iodine molecules to iodine atoms (I) is a reversible reaction taking place in a sealed container at 727 °C. The balanced equation for the reaction is:

$$I_2(g) \rightleftharpoons 2I(g)$$

K_c for the reaction at 727 °C is $3,76 \times 10^{-3}$.

6.1 Write down the meaning of the term *reversible reaction*. (1)

6.2 At equilibrium the pressure of the system is increased by decreasing the volume of the container at constant temperature.

How will EACH of the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.2.1 The value of the equilibrium constant (1)

6.2.2 The number of I_2 molecules (1)

6.3 Explain the answer to QUESTION 6.2.2 by referring to Le Chatelier's principle. (2)

6.4 At 227 °C, the K_C value for the reaction above is $5,6 \times 10^{-12}$.

Is the forward reaction ENDOTHERMIC or EXOTHERMIC?
Fully explain the answer. (4)

6.5 A certain mass of iodine molecules (I_2) is sealed in a 12,3 dm^3 flask at a temperature of 727 °C ($K_c = 3,76 \times 10^{-3}$).

When equilibrium is reached, the concentration of the iodine atoms is found to be $4,79 \times 10^{-3}$ $mol \cdot dm^{-3}$. Calculate the INITIAL MASS of the iodine molecules in the flask. (9)
[18]

QUESTION 7 (Start on a new page.)

7.1 Ethanoic acid (CH_3COOH) is an ingredient of household vinegar.

7.1.1 Is ethanoic acid a WEAK acid or a STRONG acid? Give a reason for the answer. (2)

7.1.2 An ethanoic acid solution has a pH of 3,85 at 25 °C. Calculate the concentration of the hydronium ions, $H_3O^+(aq)$, in the solution. (3)

Sodium ethanoate, $CH_3COONa(aq)$, forms when ethanoic acid reacts with sodium hydroxide.

7.1.3 Will the pH of a sodium ethanoate solution be GREATER THAN 7, LESS THAN 7 or EQUAL TO 7? (1)

7.1.4 Explain the answer to QUESTION 7.1.3 with the aid of a balanced chemical equation. (3)

7.2 Household vinegar contains 4,52% ethanoic acid, CH_3COOH by volume.

A 1,2 g impure sample of calcium carbonate ($CaCO_3$) is added to 25 cm^3 household vinegar.

On completion of the reaction, the EXCESS ethanoic acid in the household vinegar is neutralised by 14,5 cm^3 of a sodium hydroxide solution of concentration 1 $mol \cdot dm^{-3}$. The balanced equation for the reaction is:

$$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$$

7.2.1 Calculate the number of moles of the unreacted ethanoic acid. (3)

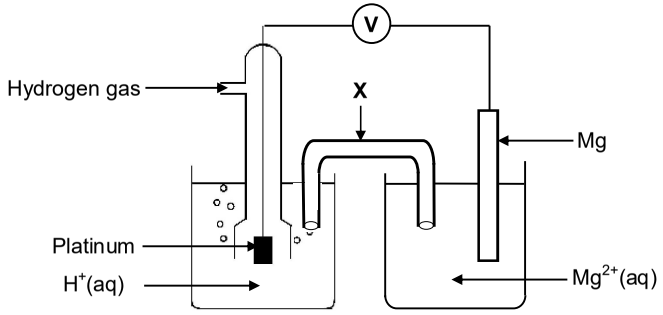
7.2.2 Calcium carbonate reacts with ethanoic acid according to the following balanced equation:

$$CaCO_3(s) + 2CH_3COOH(aq) \rightarrow (CH_3COO)_2Ca(aq) + H_2O + CO_2(g)$$

Calculate the percentage calcium carbonate in the impure sample if 1 cm^3 of household vinegar has a mass of 1 g. (8)
[20]

QUESTION 8 (Start on a new page.)

The electrochemical cell illustrated below is set up under standard conditions.



8.1 Component **X** completes the circuit in the cell. State ONE other function of component **X**. (1)

8.2 Define the term *anode*. (2)

8.3 Identify the anode in the cell above. (1)

8.4 Write down the:

8.4.1 Reduction half-reaction that takes place in this cell (2)

8.4.2 NAME or FORMULA of the reducing agent in this cell (1)

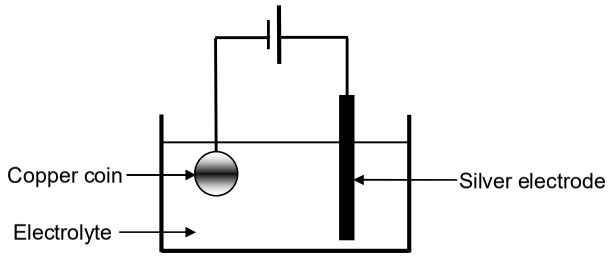
8.5 Calculate the initial voltmeter reading of this cell under standard conditions. (4)

8.6 The $Mg|Mg^{2+}$ half-cell is now replaced by a $Cu|Cu^{2+}$ half-cell. It is found that the direction of electron flow changes.

Fully explain why there is a change in direction of electron flow by referring to the relative strengths of the reducing agents involved. (3)
[14]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrolytic cell used to electroplate a copper (Cu) coin with silver (Ag).



9.1 Define the term *electrolysis*. (2)

9.2 Which component in the diagram indicates that this is an electrolytic cell? (1)

9.3 Write down the NAME or FORMULA of the electrolyte. (1)

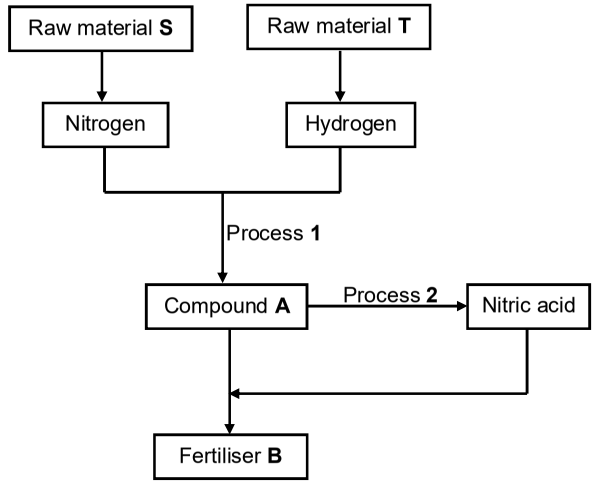
9.4 How will the concentration of the electrolyte change during electroplating? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for the answer. (2)

9.5 Write down the balanced equation of the half-reaction that takes place at the silver electrode. (2)
[8]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows how fertiliser **B** is produced in industry.



Write down the:

10.1.1 NAME of **S** (1)

10.1.2 NAME of **T** (1)

10.1.3 NAME or FORMULA of the catalyst used in process **1** (1)

10.1.4 NAME or FORMULA of compound **A** (1)

10.1.5 NAME of process **2** (1)

10.1.6 Balanced equation for the formation of fertiliser **B** (3)

10.2 A 20 kg bag of fertiliser is labelled as follows: **2 : 4 : 3 (X)**.

10.2.1 What does the ratio on the label represent? (1)

10.2.2 The bag contains 2,315 kg phosphorous.

Calculate the value of **X**. (3)
[12]

TOTAL: 150

Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2020

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 16 pages including 2 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following factors will increase the rate of a chemical reaction by offering an alternative path of lower activation energy?

A Pressure

B Temperature

C Surface area

D Positive catalyst (2)

1.2 Structural isomers always have the same …

A carbon chain.

B functional group.

C molecular formula.

D physical properties. (2)

1.3 Which ONE of the following has the HIGHEST vapour pressure?

A Pentane

B Hexane

C Heptane

D Octane (2)

1.4 Which ONE of the following is the structural formula for the functional group of ethanoic acid?

A		B	
C		D	

(2)

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1.5 Consider the chemical reaction given below:

$$\mathbf{X} + \text{concentrated } H_2SO_4 \longrightarrow CH_3CHCHCH_3 + H_2O$$

Which ONE of the following is CORRECT about reactant **X**?

Reactant **X** is a …

A tertiary alcohol.

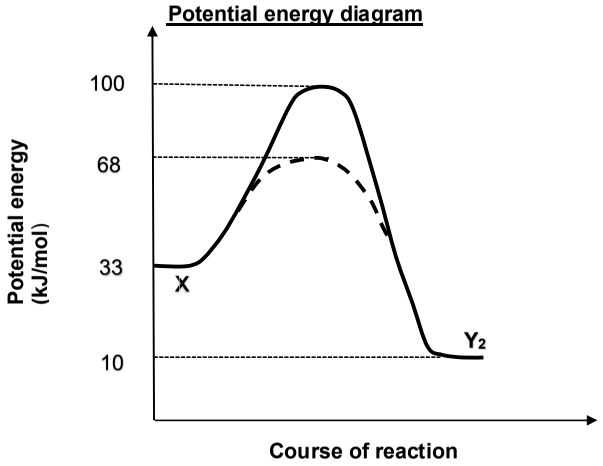
B primary alcohol.

C secondary alcohol.

D primary haloalkane. (2)

1.6 The potential energy diagram shown below is for the hypothetical reversible reaction shown below.

$$\mathbf{X}_2(g) \rightleftharpoons \mathbf{Y}_2(g)$$



The value of ΔH (in kJ/mol) for the catalysed forward reaction is equal to …

A 23

B -23

C 58

D -58 (2)

1.7 The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$$

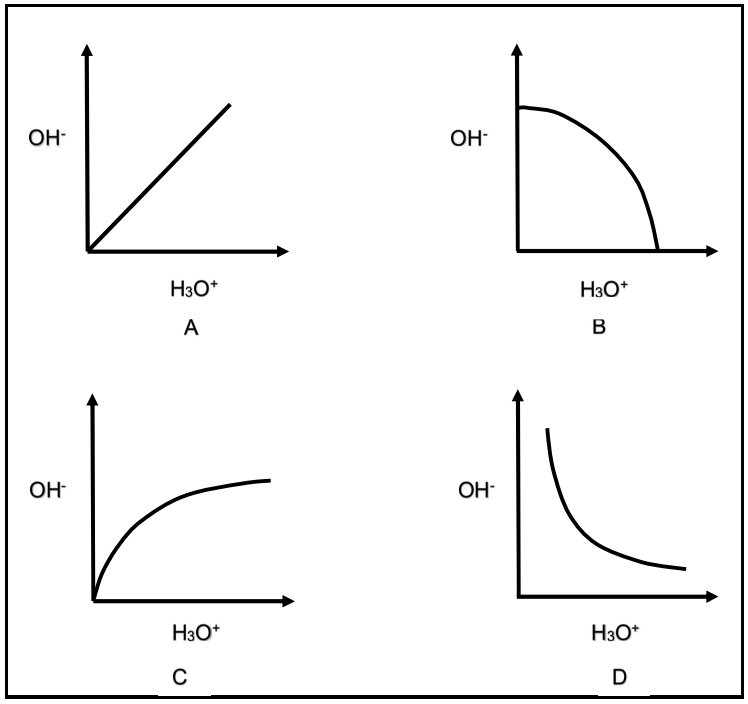
More C(s) and $CO_2(g)$ are added to the container at constant temperature.

How will the number of moles of CO(g) and the value of K_c be affected at equilibrium?

	NUMBER OF MOLES OF CO	K_c
A	Increases	Increases
B	Increases	Remains constant
C	Remains the same	Remains the same
D	Remains the same	Increases

(2)

1.8 The relationship between $[H_3O^+]$ and $[OH^-]$ in an aqueous solution at constant temperature is best represented by …



(2)

1.9 Gaseous chlorine ($C\ell_2$), used to disinfect water in public swimming pools reacts with water according to the following balanced equation.

$$C\ell_2 + H_2O \rightarrow HOC\ell + HC\ell$$

The addition of chlorine changes the pH of water in swimming pools.

Which ONE of the following substances must be added to public swimming pools periodically to increase the pH?

A $KC\ell$

B $NH_4C\ell$

C H_2SO_4

D Na_2CO_3 (2)

1.10 Consider the reaction in which magnesium powder reacts with EXCESS 50 cm^3 of a 0,1 $mol \cdot dm^{-3}$ of sulphuric acid solution.

$$Mg(s) + H_2SO_4(aq) \longrightarrow MgCl_2(aq) + H_2(g) \qquad \Delta H < 0$$

Which ONE of the following changes will increase the rate of production of hydrogen gas?

A Increase in pressure.

B Heating the reaction mixture.

C Using 100 cm^3 of the same acid solution.

D Adding water to the reaction mixture. (2)

[20]

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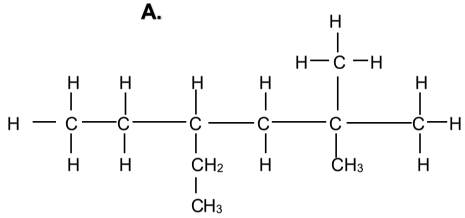
QUESTION 2 (Start on a new page.)

Consider compound **A** which is a member of homologous series of saturated hydrocarbons.

A.



2.1 Define the term *homologous series.* (2)

2.2 Give a reason why compound **A** is classified as a hydrocarbon. (2)

2.3 For compound **A** write down the:

2.3.1 General formula of the homologous series to which it belongs (1)

2.3.2 IUPAC name (3)

2.4 Consider compounds **P** and **Q** shown below:

P: 2-methyl-2-propanol **Q:** $(CH_3)_2CH-C(=O)-H$

Write down the:

2.4.1 Structural formula of compound **P** (2)

2.4.2 IUPAC name of a FUNCTIONAL isomer of compound **Q** (2)

2.4.3 Give a reason why compound **Q** CANNOT have a POSITIONAL isomer. (1)

2.5 Polyethene is produced when many ethene <u>monomer units join together to form a polymer</u> according to the equation:

$$n\ CH_2{=}CH_2 \longrightarrow \text{Polyethene}$$

2.5.1 Write down the type of reaction described by the underlined phrase. (1)

2.5.2 Give a reason why polyethene is regarded as saturated. (1)

2.5.3 Name ONE use of polyethene. (1)

[16]

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QUESTION 3 (Start on a new page.)

The boiling points shown in the table were obtained during an investigation into the boiling points of compounds **A**, **B** and **C**. The compounds have a comparable molecular mass.

Compound		Boiling point (°C)
A	Hexane	68
B	Pentanal	103
C	Pentan-2-ol	119

3.1 Define the term *boiling point*. (2)

3.2 Give a reason why the compounds used in the investigation must have a comparable molecular mass. (1)

3.3 Explain the difference in boiling points of compound **A** and **B** by referring to the TYPE and STRENGTH of intermolecular forces and energy involved. (4)

3.4 How will the vapour pressure of a CHAIN isomer of compound **C** compare to that of compound **C**?

Write down only HIGHER THAN, LOWER THAN or SAME AS. (1)

3.5 Explain the answer in QUESTION 3.4 by referring to MOLECULAR STRUCTURE and TYPE of INTERMOLECULAR FORCES. (3)

3.6 Using MOLECULAR FORMULAE write down a balanced equation for the complete combustion of hexane. (3)

[14]

QUESTION 4 (Start on a new page.)

Consider the THREE incomplete organic reactions below.

I: 2-bromobutane + dilute NaOH $\longrightarrow$

II: Compound **P** + H_2 $\longrightarrow$ $CH_3CH(CH_3)CH_3$

III: $CH_3CH_2CH_2COOH$ + $CH_3CH_2CH_2OH$ $\longrightarrow$ Ester + **Q**

4.1 For reaction **I** write down the:

4.1.1 Type of reaction taking place (1)

4.1.2 IUPAC name of the organic product formed (2)

The dilute sodium hydroxide in reaction **I** is replaced with concentrated sodium hydroxide and the reaction mixture is strongly heated.

4.2 Write down a balanced equation for the reaction taking place when concentrated sodium hydroxide is used in reaction **I** using STRUCTURAL FORMULAE.
(Ignore the MINOR product.) (6)

4.3 For reaction **II** write down the:

4.3.1 Name of the type of addition reaction taking place (1)

4.3.2 Name of the catalyst used (1)

4.3.3 Structural formula for compound **P** (2)

4.4 Consider reaction **III.**

Write down:

4.4.1 The name of the type of reaction taking place (1)

4.4.2 ONE reaction condition (1)

4.4.3 Name or formula of inorganic product **Q** (1)

4.4.4 The structural formula and IUPAC name of the ester produced (4)

[20]

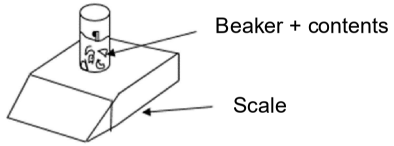
QUESTION 5 (Start on a new page.)

A factor influencing the rate of a chemical reaction is investigated by carrying out two experiments **1** and **2** in which the following reaction takes place.

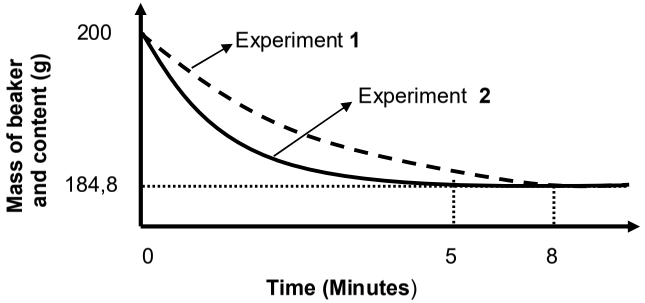
$$CaCO_3\,(s) + 2\,HC\ell\,(aq) \rightarrow CaC\ell_2\,(aq) + H_2O\,(\ell) + CO_2(g)$$

In both experiments chunks of pure calcium carbonate ($CaCO_3$) of the same mass are added to EXCESS hydrochloric acid solution ($HC\ell$) in OPEN flasks. One reaction condition is changed in experiment **2**.

Each flask is placed on a mass scale as shown in the diagram below.



The graph below shows the changes in mass of the beaker and its contents during the reaction in experiments **1** and **2**.



5.1 Define *reaction rate* in words. (2)

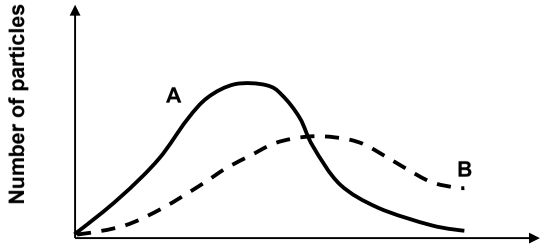
5.2 Write down the FORMULA or NAME of the substance responsible for the decrease in mass of the beaker and its contents as the reaction proceeds. (1)

5.3 Write down ONE other apparatus needed to measure the rate of reaction besides the scale balance for the above experiments. (1)

5.4 Calculate the average rate of reaction in $g \cdot min^{-1}$ for experiment **2**. (3)

5.5 Calculate the mass of calcium carbonate that was used in experiment **1**. (6)

5.6 The Maxwel-Boltzman distribution curves for the reaction in experiments **1** and **2** are given below.



5.6.1 Which factor affecting reaction rate is investigated? (1)

5.6.2 Which curve (**A** or **B**) represents the reaction in experiment **2**? (1)

5.6.3 Explain the answer to QUESTION 5.6.2 by referring to the collision theory. (3)

5.7 In a **second investigation** a third experiment (**experiment 3**), is carried out in which $HC\ell$ of HIGHER CONCENTRATION is used. All the other conditions remain the same in **experiment 3** as in **experiment 1**.

5.7.1 Write down an investigative question for the second investigation, in which experiment **3** is compared to experiment **1**. (2)

How do the following quantities in **experiment 3** compare to **experiment 1**?

Write down LOWER THAN or HIGHER THAN or EQUAL TO.

5.7.2 Time for the reaction taken to reach completion. (1)

5.7.3 Amount of CO_2 that is produced. (1)

5.8 Give a reason for the answer in QUESTION 5.7.3 above. (2)

[24]

QUESTION 6 (Start on a new page.)

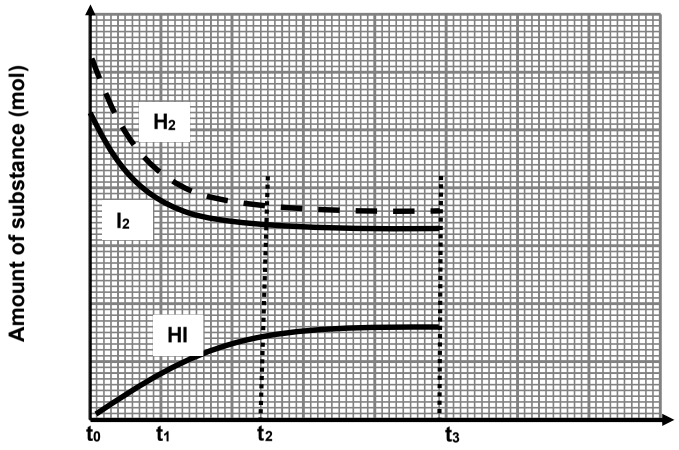
Consider the reversible reaction taking place in a closed container:

$$H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)$$

6.1 Define the term *reversible reaction*. (2)

The graph below shows the changes in the amount of the substances H_2, I_2 and HI from the moment the reactants are pumped into an empty container.

GRAPH OF AMOUNT OF SUBSTANCE VERSUS TIME



6.2 Which reaction (FORWARD or REVERSE) has a HIGHER rate of reaction during the interval t_0 to t_1? (1)

6.3 Did the chemical reaction stop during the interval t_2 to t_3?

Write only YES or NO.

Give a reason for the answer. (3)

At time t_3 the pressure on the equilibrium system is increased by decreasing the volume at constant temperature.

6.4 How will the increase in pressure affect the following?

Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.4.1 Rate of reaction. (1)

6.4.2 Number of moles of HI. (1)

6.4.3 Concentration of HI. (1)

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6.5 Explain the answer to QUESTION 6.4.3 above. (2)

6.6 The table below shows the equilibrium constants, K_c values for the reaction at different temperatures.

TEMPERATURE (°C)	K_c
448	50,3
227	129

6.6.1 Is there a HIGH or LOW YIELD at 227 °C?

Give a reason for the answer. (2)

6.6.2 Is the forward reaction EXOTHERMIC or ENDOTHERMIC?

Explain the answer by referring to Le Chatelier's principle. (4)

6.7 The reaction is started by placing hydrogen gas (H_2) and iodine gas (I_2) into an empty 0,5 dm^3 container which is then sealed and heated.

When the reaction reaches **equilibrium** at 448 °C it is found that the concentration of H_2 and I_2 are 0,46 $mol.dm^{-3}$ and 0,39 $mol.dm^{-3}$ respectively.

The value of the equilibrium constant, Kc is equal to 50,3 at 448 °C.

Calculate the:

6.7.1 Concentration of HI at equilibrium (4)

6.7.2 Percentage yield at 448 °C (7)

[28]

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QUESTION 7 (Start on a new page.)

7.1 Study the following reactions which show the step-by-step ionisation reaction of phosphoric acid (H_3PO_4).

I $H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+$ $Ka = 7,5 \times 10^{-3}$

II $H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$ $Ka = 1,3 \times 10^{-12}$

7.1.1 Define an *acid* according to Lowry-Bronsted model. (2)

7.1.2 Write down the formula of the substance that acts as an ampholyte in reaction **I** and **II**. (1)

7.1.3 Give a reason for the answer in QUESTION 7.1.2 above. (2)

7.1.4 Which substance, $H_2PO_4^-$ or HPO_4^{2-}, will have a HIGHER K_b value?

Give a reason for your answer. (3)

7.2 Consider the hydrolysis of the ion $C_2HO_4^-$ represented by the balanced equation below.

$$C_2HO_4^-(aq) + H_2O(\ell) \rightleftharpoons C_2H_2O_4 + OH^-$$

7.2.1 Define the term *hydrolysis.* (2)

7.2.2 Write down the conjugate base of $C_2H_2O_4$. (2)

7.2.3 Give a reason by referring to substance(s) in the equation why the hydrolysis of $C_2HO_4^-$ produces an ALKALINE solution? (2)

7.3 A group of learners perform a titration to determine **x** number of moles of water of crystallisation in hydrated oxalic acid ($C_2O_4H_2 \cdot$ **x** H_2O).

They first prepared a solution of hydrated oxalic acid, by adding 7,56 grams of hydrated oxalic acid to water and made a volume of 250 cm^3 solution.

During a titration 25 cm^3 of the solution of hydrated oxalic acid is neutralised by exactly 24 cm^3 of a 0,5 $mol \cdot dm^{-3}$ solution of sodium hydroxide according to the balanced equation:

$$C_2O_4H_2.\ \mathbf{x}\ H_2O(s) + 2\ NaOH(aq) \longrightarrow C_2O_4Na_2(aq) + (\mathbf{x}+2)\ H_2O(\ell)$$

(Water of crystallisation does not react with the base.)

7.3.1 Define a *strong* base. (2)

7.3.2 Calculate the pH of the 0,5 $mol \cdot dm^{-3}$ sodium hydroxide solution. (5)

7.3.3 Determine the value of **x** by calculation. (7)

[28]

TOTAL: 150

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PHYSICS PAPER 1 MEMORANDA

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
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PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 30 pages./
Hierdie nasienriglyne bestaan uit 30 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	B ✓✓ (accept Q/*aanvaar Q*)	(2)
1.3	D ✓✓	(2)
1.4	D ✓✓	(2)
1.5	D ✓✓	(2)
1.6	B **OR/*OF*** D ✓✓	(2)
1.7	B ✓✓	(2)
1.8	A ✓✓	(2)
1.9	A ✓✓	(2)
1.10	D ✓✓	(2)
		[20]

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QUESTION 2/*VRAAG 2*

2.1

Marking criteria/*Nasienkriteria*
- Formula to calculate a./*Formule om a te bereken.* ✓
- Correct substitution to calculate a./*Korrekte vervanging om a te bereken.* ✓✓

OPTION 1/*OPSIE 1*

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(3,41)^2$ ✓$= (0)^2 + (2)a(1,5)$ ✓
$a = 3,88\ m\cdot s^{-2}$

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(-3,41)^2$ ✓$= (0)^2 + (2)a(-1,5)$ ✓
$a = -3,88$
$a = 3,88\ m\cdot s^{-2}$

OPTION 2/*OPSIE 2*

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$1,5 = \left(\frac{0 + 3,41}{2}\right)\Delta t$
$\Delta t = 0,88\ s$

$v_f = v_i + a\Delta t$ ✓
$-3,41$ ✓$= (0) + a(0,88)$ ✓
$a = -3,88$
$a = 3,88\ m\cdot s^{-2}$

OR/*OF*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-1,5$ ✓$= (0)(0,88) + \frac{1}{2}a(0,88)^2$ ✓
$a = -3,88$
$a = 3,88\ m\cdot s^{-2}$

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$-1,5 = \left(\frac{0 - 3,41}{2}\right)\Delta t$
$\Delta t = 0,88\ s$

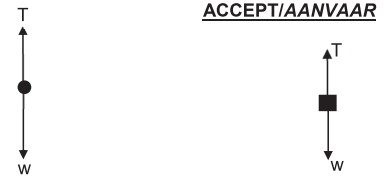
$v_f = v_i + a\Delta t$ ✓
$3,41$ ✓$= (0) + a(0,88)$ ✓
$a = 3,88\ m\cdot s^{-2}$

OR/*OF*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$1,5$ ✓$= (0)(0,88) + \frac{1}{2}a(0,88)^2$ ✓
$a = 3,88\ m\cdot s^{-2}$

(3)

2.2



ACCEPT/*AANVAAR*

	Accepted symbols/*Aanvaarde simbole*
w ✓	F_g/F_w/weight/*gewig*/mg/gravitational force/*gravitasiekrag*/$F_{Earth\ on\ block}$/ $F_{Aarde\ op\ blok}$/*73,5N*
T ✓	Tension/*Spanning*/$F_{Tension}$/$F_{Spanning}$/F_{rope}/F_{tou}/F_T/*F*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir byskrif en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te): Max*/*Maks* $\frac{1}{2}$

(2)

2.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp is.

OR/*OF*

The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force.
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwwerp in dieselfde rigting as die resulterende/netto krag.

(2)

2.4

Marking criteria/*Nasienkriteria*

- Any correct formula./*Enige korrekte formule.* ✓
- Correct substitution to calculate tension./*Korrekte vervanging om spanning te bereken.*✓✓
- Correct substitution to calculate mass of block A./*Korrekte vervanging om massa van blok A te bereken.* ✓
- Correct final answer/*Korrekte finale antwoord*: 3,25 kg ✓

Calculation of tension (Block B) 3 marks:
Berekening van spanning (Blok B)3 punte:

DOWNWARDS POSITIVE/*AFWAARTS POSITIEF*

$F_{net} = ma$
$F_g + T = ma$ ✓Any one/ *Enige een*
$mg - T = ma$

$\underline{7,5(9,8) - T}$ ✓$= \underline{7,5(3,88)}$ ✓
$T = 44,40$ N

UPWARDS POSITIVE/*OPWAARTS POSITIEF*

$F_{net} = ma$
$T - F_g = ma$ ✓Any one/ *Enige een*
$T - mg = ma$

$\underline{T - 7,5(9,8)}$ ✓$= \underline{7,5(-3,88)}$ ✓
$T = 44,40$ N

Calculation of mass (Block A) 2 marks:
Berekening van massa (Blok A) 2 punte:

UPWARDS POSITIVE
OPWAARTS POSITIEF

$F_{net} = ma$
$T - F_g = ma$
$T - mg = ma$
$\underline{44,40 - m(9,8) = m(3,88)}$✓
$m = 3,25$ kg✓

DOWN POSITIVE
AF POSITIEF

$F_{net} = ma$
$F_g - T = ma$
$mg - T = ma$
$\underline{m(9,8) - 44,40 = m(-3,88)}$✓
$m = 3,25$ kg ✓ (5)

2.5

Marking criteria/*Nasienkriteria*

- Any correct formula./*Enige korrekte formule.* ✓
- Correct substitution of v_i and v_f./*Korrekte vervanging van v_i en v_f.* ✓
- Correct substitution of 9,8 $m \cdot s^{-2}$./Korrekte vervanging van 9,8 $m \cdot s^{-2}$. ✓
- Adding 1,5 m to calculated Δy. /*Tel 1,5 m by berekende Δy.* ✓
- Correct final answer/*Korrekte finale antwoord*: 2,09 m ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{(0^2) = (3,41)^2}$ ✓$+ \underline{(2)(-9,8)\Delta y}$ ✓
$\Delta y = 0,59$ m

Maximum height $= 0,59 + 1,5$ ✓
$= 2,09$ m ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{(0^2) = (-3,41)^2}$ ✓ $+ \underline{(2)(9,8)\Delta y}$ ✓
$\Delta y = -0,59$
$\Delta y = 0,59$ m

Maximum height $= 0,59 + 1,5$ ✓
$= 2,09$ m ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$
$0 = 3,41 + (-9,8)\Delta t$
$\Delta t = 0,35$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{(3,41)(0,35)}$ ✓$+ \underline{\frac{1}{2}(-9,8)(0,35)^2}$ ✓
$= 0,59$ m

Maximum height $= 0,59 + 1,5$ ✓
$= 2,09$ m ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$
$0 = -3,41 + (9,8)\Delta t$
$\Delta t = 0,35$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{(-3,41)(0,35)}$ ✓$+ \underline{\frac{1}{2}(9,8)(0,35)^2}$ ✓
$= -0,59$
$\Delta y = 0,59$ m

Maximum height $= 0,59 + 1,5$ ✓
$= 2,09$ m ✓

OPTION 3/*OPSIE 3*	
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ $0 = 3{,}41 + (-9{,}8)\Delta t$ $\Delta t = 0{,}35$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\frac{3{,}41 + 0}{2}\right)$ ✓ (0,35) ✓ $= 0{,}59$ m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓	$v_f = v_i + a\Delta t$ $0 = -3{,}41 + (9{,}8)\Delta t$ $\Delta t = 0{,}35$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\frac{-3{,}41 + 0}{2}\right)$ ✓ (0,35) ✓ $= -0{,}59$ m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓
Note/*Aantekening*: **OPTION 4 TO 5/*OPSIE 4 TOT 5*** Substitution of incorrect mass/*Vervanging van verkeerde massa:* *max/maks*: $^3/_5$	
OPTION 4/*OPSIE 4*	
$(E_{mech})_{top} = (E_{mech})_{bottom}$ $(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$ $(mgh + \frac{1}{2}mv_i^2)_{top} = (mgh + \frac{1}{2}mv_f^2)_{bottom}$ ✓Any one/*Enige een* $(9{,}8)(h) + (0)$ ✓ = $(0) + \frac{1}{2}(3{,}41)^2$ ✓ h = 0,59 m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓	
OPTION 5/*OPSIE 5*	
$W_{nc} = \Delta K + \Delta U$ $W_{nc} = \Delta K + mg(h_f - h_i)$ $0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ ✓Any one/*Enige een* $(0) = (0) - \frac{1}{2}(3{,}41)^2$ ✓ + $(9{,}8)(h)$ ✓ h = 0,59 m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓	
OPTION 6/*OPSIE 6*	
$W_{net} = \Delta E_k$ $w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige een* $(9{,}8)(\Delta y)\cos 180°$ ✓ = $0 - \frac{1}{2}(3{,}41)^2$ ✓ $\Delta y = 0{,}59$ m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓	

(5)
[17]

QUESTION 3/*VRAAG 3*

3.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gravitasie/gewig/gravitasiekrag.
(2 or/of 0)

OR/*OF*
Motion in which the only force acting is the gravitational force.
Beweging waar die enigste krag wat inwerk gravitasiekrag is. (2)

3.2.1

Marking criteria/*Nasienkriteria*
- Formula to calculate Δt./*Formule om Δt te bereken.* ✓
- Correct substitution to calculate Δt./Korrekte v*ervanging om Δt te bereken.* ✓
- Final answer/*Finale antwoord*: 1,76 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-15{,}2 = (0) + \frac{1}{2}(-9{,}8)\Delta t^2$ ✓ $\Delta t = 1{,}76$ s ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $15{,}2 = (0) + \frac{1}{2}(9{,}8)\Delta t^2$ ✓ $\Delta t = 1{,}76$ s ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (0)^2 + (2)(-9{,}8)(-15{,}2)$ $v_f = -17{,}26$ m·s^{-1} →	$v_f = v_i + a\Delta t$ ✓ $-17{,}26 = (0) + (-9{,}8)\Delta t$ ✓ $\Delta t = 1{,}76$ s ✓
DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*	**OR/*OF***
$v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (0)^2 + (2)(9{,}8)(15{,}2)$ $v_f = 17{,}26$ m·s^{-1} →	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-15{,}2 = \left(\frac{0 - 17{,}26}{2}\right)\Delta t$ ✓ $\Delta t = 1{,}76$ s ✓

OPTION 3/*OPSIE 3*

$(E_{mech})_{top} = (E_{mech})_{bottom}$ $(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$ $(mgh + \frac{1}{2}mv_i^2)_{top} = (mgh + \frac{1}{2}mv_f^2)_{bottom}$ $(9{,}8)(15{,}2) + 0 = 0 + (\frac{1}{2})(v_f)^2$ $v_f = 17{,}26$ m·s^{-1} →	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
	$v_f = v_i + a\Delta t$ ✓ $17{,}26 = (0) + (9{,}8)\Delta t$ ✓ $\Delta t = 1{,}76$ s ✓
	OR/*OF*
	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $15{,}2 = \left(\frac{0 + 17{,}26}{2}\right)\Delta t$ ✓ $\Delta t = 1{,}76$ s ✓

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta K + \Delta U$ $W_{nc} = \Delta K + mg(h_f - h_i)$ $0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ $0 = \frac{1}{2}(v_f^2 - 0) + (9{,}8)(15{,}2)$ $v_f = 17{,}26$ m·s^{-1} →	

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$ $w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(9{,}8)(15{,}2)\cos 180° = 0 - \frac{1}{2}(v_f)^2$ $v_f = 17{,}26$ m·s^{-1} →	

OPTION 6/*OPSIE 6*	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	
$F_{net}\Delta t = \Delta p = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een*	$F_{net}\Delta t = \Delta p = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een*
$-9,8\Delta t = -17,26 - (0)$ ✓	$9,8\Delta t = 17,26 - (0)$ ✓
$\Delta t = 1,76$ s ✓	$\Delta t = 1,76$ s ✓

(3)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1.**
POSITIEWE NASIEN VANAF VRAAG 3.2.1.

Marking criteria/*Nasienkriteria*

- Correct substitution to calculate Δt for ball A./*Korrekte vervanging om Δt te bereken vir bal A.* ✓
- Subtraction 1,76 – 0,81./*Aftrekking 1,76 – 0,81.* ✓
- Correct formula to calculate v_i for ball B./*Korrekte formule om v_i te bereken vir bal B.* ✓
- Correct substitution to calculate v_i for ball B./*Korrekte vervanging om v_i te bereken vir bal B.* ✓
- Final answer/*Finale antwoord:* 4,66 m·s^{-1} ✓ (4,66 to/*tot* 4,7)

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓	$-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓
$\Delta t = 0,81$ s	$\Delta t = 0,81$ s
$\Delta t(B) = 1,76 - 0,81$ ✓	$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95$ s	$\Delta t(B) = 0,95$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$v_f = v_i + a\Delta t$
$(0) = v_i(0,95) + \frac{1}{2}(-9,8)(0,95)^2$ ✓	$-v_i = v_i + (-9,8)(0,95)$ ✓
$v_i = 4,66$ m·s^{-1}✓	$v_i = 4,66$ m·s^{-1}✓
DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓	$3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓
$\Delta t = 0,81$ s	$\Delta t = 0,81$ s
$\Delta t(B) = 1,76 - 0,81$ ✓	$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95$ s	$\Delta t(B) = 0,95$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$v_f = v_i + a\Delta t$
$0 = -v_i(0,95) + \frac{1}{2}(9,8)(0,95)^2$ ✓	$v_i = -v_i + (9,8)(0,95)$ ✓
$v_i = 4,66$ m·s^{-1} ✓	$v_i = 4,66$ m·s^{-1}✓

Calculate/*Bereken*: $v_f = 7,92$ m·s^{-1}

OPTION 3/*OPSIE 3*

UPWARDS +/ *OPWAARTS +*
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(-9,8)(-3,2)$
$v_f = -7,92$ m·s^{-1} →

DOWNWARDS +/ *AFWAARTS +*
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(9,8)(3,2)$
$v_f = 7,92$ m·s^{-1} →

OPTION 4/*OPSIE 4*
$(E_{mech})_{top} = (E_{mech})_{bot}$
$(E_p + E_k)_{top} = (E_p + E_k)_{bot}$
$(mgh+\frac{1}{2}mv_i^2)_{top} = (mgh+\frac{1}{2}mv_f^2)_{bot}$
$(9,8)(3,2) + 0 = 0 + (\frac{1}{2})(v_f)^2$
$v_f = 7,92$ m·s^{-1} →

OPTION 5/*OPSIE 5*
$W_{nc} = \Delta K + \Delta U$
$W_{nc} = \Delta K + mg(h_f - h_i)$
$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
$0 = \frac{1}{2}(v_f^2 - 0) + (9,8)(3,2)$
$v_f = 7,92$ m·s^{-1} →

OPTION 6/*OPSIE 6*
$W_{net} = \Delta E_k$
$w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(9,8)(3,2)\cos 0° = \frac{1}{2}v_f^2 - 0$
$v_f = 7,92$ m·s^{-1} →

Calculate/*Bereken*: $\Delta t(B) = 0,95$ s

UPWARDS +/ *OPWAARTS +*
$v_f = v_i + a\Delta t$
$-7,92 = (0) + (-9,8)\Delta t$ ✓
$\Delta t = 0,81$ s
$\Delta t(B) = 1,76 - 0,81$✓
$\Delta t(B) = 0,95$ s →

OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$-3,2 = \left(\frac{0 - 7,92}{2}\right)\Delta t$ ✓
$\Delta t = 0,81$ s
$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95$ s →

OR/*OF*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
-12✓$= -7,92\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 0,95$ s →

DOWNWARDS +/ *AFWAARTS +*
$v_f = v_i + a\Delta t$
$7,92 = (0) + (9,8)\Delta t$ ✓
$\Delta t = 0,81$ s
$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95$ s →

OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$3,2 = \left(\frac{0 + 7,92}{2}\right)\Delta t$ ✓
$\Delta t = 0,81$ s
$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95$ s →

OR/*OF*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
12✓$= 7,92\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 0,95$ s →

Calculate/*Bereken*: $v_i = 4,66$ m·s^{-1}

UPWARDS +/ *OPWAARTS +*
($\Delta t_{up\ and\ down} = 0,95$ s)
$v_f = v_i + a\Delta t$ ✓
$-v_i = v_i + (-9,8)(0,95)$ ✓
$v_i = 4,66$ m·s^{-1}✓

OR/*OF*
($\Delta t_{up} = 0,475$ s)
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(0,475)$ ✓
$v_i = 4,66$ m·s^{-1}✓

OR/*OF*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = v_i(0,95) + \frac{1}{2}(-9,8)(0,95)^2$✓
$v_i = 4,66$ m·s^{-1}✓

DOWNWARDS +/ *AFWAARTS +*
$v_f = v_i + a\Delta t$ ✓
$v_i = v_i + (9,8)(0,95)$ ✓
$= -4,66$
$v_i = 4,66$ m·s^{-1}✓

OR/*OF*
($\Delta t_{up} = 0,475$ s)
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (9,8)(0,475)$ ✓
$= -4,66$
$v_i = 4,66$ m·s^{-1}✓

OR/*OF*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = -v_i(0,95) + \frac{1}{2}(9,8)(0,95)^2$✓
$v_i = 4,66$ m·s^{-1}✓

OPTION 7/*OPSIE 7*	
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
$F_{net}\Delta t = \Delta p$ $= m(v_f - v_i)$ } ✓Any one /*Enige een*	$F_{net}\Delta t = \Delta p$ $= m(v_f - v_i)$ } ✓Any one /*Enige een*
$\underline{(-9,8)(0,95)}$ ✓ $= \underline{-2v_i}$ ✓✓	$\underline{(9,8)(0,95)}$ ✓ $= \underline{2v_i}$ ✓✓
$v_i = 4,66\ m{\cdot}s^{-1}$ ✓ $(4,655\ m{\cdot}s^{-1})$	$v_i = 4,66\ m{\cdot}s^{-1}$ $(4,655\ m{\cdot}s^{-1})$ ✓

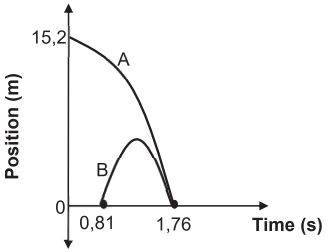
(5)

3.3 **POSITIVE MARKING FROM QUESTION 3.2.1/**
POSITIEWE NASIEN VANAF VRAAG 3.2.1

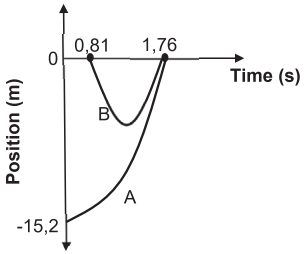
Marking criteria/*Nasienkriteria:*

- Initial position of ball A = 15,2 m and B = 0 m./*Oorspronklike posisie van A = 15,2 m en B = 0 m.* ✓
- Starting times for A = 0 s and B = 0,81 s./*Begintye van A = 0 s en B = 0,81 s.* ✓
- Both balls strike the ground at t = 1,76 s./*Albei balle tref die grond op t = 1,76 s.* ✓
- Shape of graph for ball A./*Vorm van grafiek vir bal A.* ✓
- Shape of graph for ball B./*Vorm van grafiek vir bal B.* ✓
- If graphs are drawn on seperate axis/*Indien grafieke op apparte asse geteken word:*
  max/*maks:* $^4/_5$

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF* (CHANGED GRAPH)



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



(5)
[15]

QUESTION 4 /*VRAAG 4*

4.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

In an isolated system the total (linear) momentum is conserved/remains constant. ✓✓ (accept closed system)
In 'n geïsoleerde sisteem bly die totale (lineêre) momentum behoue/konstant. ✓✓ (aanvaar geslote sisteem)

ACCEPT FOR 1 MARK/*AANVAAR VIR 1 PUNT*
The total (linear) momentum before collision is equal to the total (linear) momentum after collision provided the system is isolated/the net external force on the system is zero.
Die totale (lineêre) momentum voor 'n botsing is gelyk aan die totale (lineêre) momentum na botsing mits die stelsel geïsoleer is/die netto eksterne krag op die stelsel is nul.

(2)

4.2.1

OPTION 1/*OPSIE 1*

RIGHT AS POSITIVE/*REGS AS POSITIEF:*

$\sum p_i = \sum p_f$
$m_Av_{Ai} + m_Bv_{Bi} = m_Av_{Af} + m_Bv_{Bf}$ } ✓Any one/*Enige een*
$m_Av_{Ai} + m_Bv_{Bi} = (m_A + m_B)v_f$
$\underline{(7,2)(0,4) + (0) = (7,2 + 5,3)v_f}$ ✓
$v_f = 0,23\ m{\cdot}s^{-1}$ ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF:*

$\sum p_i = \sum p_f$
$m_Av_{Ai} + m_Bv_{Bi} = m_Av_{Af} + m_Bv_{Bf}$ } ✓Any one/*Enige een*
$m_Av_{Ai} + m_Bv_{Bi} = (m_A + m_B)v_f$
$\underline{(7,2)(-0,4) + (0) = (7,2 + 5,3)v_f}$ ✓
$v_f = -0,23$
$\therefore v_f = 0,23\ m{\cdot}s^{-1}$ ✓

OPTION 2/*OPSIE 2*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\Delta p_{trolley\ A} = -\Delta p_{trolley\ B}$
$m_A(v_{Af} - v_{Ai}) = -m_B(v_{Bf} - v_{Bi})$ } ✓Any one/*Enige een*
$\underline{(7,2)(v_f - 0,4) = -(5,3)(v_f - 0)}$ ✓
$v_f = 0,23\ m{\cdot}s^{-1}$ ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\Delta p_{trolley\ A} = -\Delta p_{trolley\ B}$
$m_A(v_{Af} - v_{Ai}) = -m_B(v_{Bf} - v_{Bi})$ } ✓Any one/*Enige een*
$\underline{(7,2)(v_f + 0,4) = -(5,3)(v_f - 0)}$ ✓
$v_f = -0,23$
$\therefore v_f = 0,23\ m{\cdot}s^{-1}$ ✓

(3)

4.2.2 **POSITIVE MARKING FROM QUESTIONS 4.2.1.**
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

OPTION 1/*OPSIE 1* **RIGHT AS POSITIVE/** **REGS *AS POSITIEF:*** **Force of B on A/*Krag van B op A:*** $F_{net}\Delta t = \Delta p$ ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ *Enige een* $F_{net}(0,02) = 7,2(0,23 - 0,4)$ ✓ $F_{net} = -61,2$ $\therefore F_{net} = 61,2$ N ✓ (60,95 N to/*tot* 61,2 N)	**LEFT AS POSITIVE/** **LINKS *AS NEGATIEF:*** **Force of B on A/*Krag van B op A:*** $F_{net}\Delta t = \Delta p$ ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ *Enige een* $F_{net}(0,02) = 7,2(-0,23 + 0,4)$ ✓ $F_{net} = 61,2$ N ✓ (60,95 N to/*tot* 61,2 N)
OPTION 2/*OPSIE 2* **RIGHT AS POSITIVE/** **REGS *AS POSITIEF:*** **Force of A on B/*Krag van A op B:*** $F_{net}\Delta t = \Delta p$ ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ *Enige een* $F_{net}(0,02) = 5,3(0,23 - 0)$ ✓ $F_{net} = 60,95$ N ✓ (60,95 N to/*tot* 61,2 N)	**LEFT AS POSITIVE/** **LINKS *AS POSITIEF:*** **Force of A on B/*Krag van A op B:*** $F_{net}\Delta t = \Delta p$ ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ *Enige een* $F_{net}(0,02) = 5,3(-0,23 - 0)$ ✓ $F_{net} = -60,95$ $\therefore F_{net} = 60,95$ N ✓ (60,95 N to/*tot* 61,2 N)
OPTION 3/*OPSIE 3* **RIGHT AS POSITIVE/*REGS AS POSITIEF*** **A:** $v_f = v_i + a\Delta t$ $0,23 = 0,4 + a(0,02)$ $a = -8,5\ m\cdot s^{-2}$ $F_{net} = ma$ ✓ $= (7,2)(-8,5)$ ✓ $= -61,20$ $F_{net} = 61,20$ N ✓	**LEFT AS POSITIVE/*LINKS AS POSITIEF*** **A:** $v_f = v_i + a\Delta t$ $-0,23 = -0,4 + a(0,02)$ $a = 8,5\ m\cdot s^{-2}$ $F_{net} = ma$ ✓ $= (7,2)(8,5)$ ✓ $= 61,20$ N $F_{net} = 61,20$ N✓
OPTION 4/*OPSIE 4* **RIGHT AS POSITIVE/*REGS AS POSITIEF*** **B:** $v_f = v_i + a\Delta t$ $0,23 = 0 + a(0,02)$ $a = 11,5\ m\cdot s^{-2}$ $F_{net} = ma$ ✓ $= (5,3)(11,5)$ ✓ $= 60,95$ N $F_{net} = 60,95$ N✓	**LEFT AS POSITIVE/*LINKS AS POSITIEF*** **B:** $v_f = v_i + a\Delta t$ $-0,23 = 0 + a(0,02)$ $a = -11,5\ m\cdot s^{-2}$ $F_{net} = ma$ ✓ $= (5,3)(-11,5)$ ✓ $= -60,95$ N $F_{net} = 60,95$ N✓

(3)
[8]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

A force is non-conservative if the work it does/done on an object which is moving between two points depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig/doen op 'n voorwerp wat tussen twee punte beweeg afhanklik is van die pad gevolg.

OR/*OF*
A force is non-conservative if the work it does/done in moving an object around a closed path is non-zero. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig/doen om 'n voorwerp op 'n geslote pad te beweeg, nie nul is nie. (2)

Note/*Aantekening*:
If the word 'work' is omitted, 0/2.
Indien die woord 'arbeid' weggelaat is, 0/2.

5.2

Marking criteria/*Nasienkriteria*
- Any one of the correct equations./*Enige een van die korrekte vergelykings.* ✓
- Correct substitution for work done by gravity or ΔU. ✓
  Korrekte vervanging vir arbeid verrig deur gravitasie of ΔU.
- Correct substitution for work done by motor and friction./*Korrekte vervanging aan van arbeid verrig deur motor en wrywing.* ✓
- Correct substitution for ΔK./*Korrekte vervanging vir* ΔK.✓
- Correct final answer/*Korrekte finale antwoord:* 5,96 $m\cdot s^{-1}$ ✓

OPTION 1/*OPSIE 1*
$W_{net} = \Delta K$
$W_w + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige een*
$mgsin\theta\Delta xcos\theta + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(20)(9,8)(sin18°)(15,6)cos180°$✓$+(13,5)(15,6)cos180°+(96,8)(15,6)cos0°$✓$= \frac{1}{2}(20)(v_f^2 - 0^2)$✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*
$W_{nc} = \Delta K + \Delta U$
$W_f + W_F = \Delta K + mg(h_f - h_i)$ ✓Any one/*Enige een*
$f\Delta xcos\theta + F\Delta xcos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
$13,5(15,6)cos180° + 96,8(15,6)cos0°$✓$= \frac{1}{2}(20)(v_f^2 - 0^2)$✓ $+(20)(9,8)(15,6\ sin18° - 0)$✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓

OPTION 3/*OPSIE 3*
$W_{net} = \Delta K$
$W_w + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige*
$-\Delta E_p + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$-(20)(9,8)(15,6sin18°)$✓ $+(13,5)(15,6)cos180° + (96,8)(15,6)cos0°$✓$= \frac{1}{2}(20)(v_f^2 - 0^2)$ ✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$W_w + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige*
$mg\Delta x\cos\theta + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\underline{(20)(9,8)(15,6)\cos108^\circ}$✓ + $\underline{(13.5)(15,6)\cos180^\circ}$ + $\underline{(96,8)(15,6)\cos0^\circ}$✓ = $\underline{\frac{1}{2}(20)(v_f^2 - 0^2)}$ ✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓

OPTION 5/*OPSIE 5*

$F_{net} = ma$
$F_{net} = F - F_{w//} - f$
$= 96,8 - \underline{(20)(9,8)\sin18^\circ}$ ✓ – 13,5
$= 22,73\ N$

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige*
$\underline{22,73(15,6)\cos0^\circ}$✓ = $\underline{\frac{1}{2}(20)(v_f^2 - 0^2)}$ ✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓

(5)

5.3 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VANAF VRAAG 5.2.

Marking criteria/*Nasienkriteria*
- Correct equation for power/*Korrekte vergelyking vir drywing*. ✓
- Correct substitution into power equation./ ✓
  Korrekte vervanging in drywingvergelyking.
- Correct final answer/*Korrekte finale antwoord*: 288,46 W ✓
  Range: 286,46 W to/*na* 288,73 W

OPTION1/*OPSIE 1*

$P_{ave} = Fv_{ave}$ ✓
$= 96,8\left(\frac{(0) + 5,96}{2}\right)$ ✓
$= 288,46\ W$ ✓

OPTION2/*OPSIE 2*

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$15,6 = \left(\frac{(0) + 5,96}{2}\right)\Delta t$
$\Delta t = 5,23\ s$ (5,24)

OPTION 3/*OPSIE 3*

$v_f^2 = v_i^2 + 2a\Delta x$
$(5,96)^2 = 0^2 + 2a(15,6)$
$a = 1,14\ m\cdot s^{-2}$ (1,13)
$v_f = v_i + a\Delta t$
$\underline{5,96 = 0 + (1,14)\Delta t}$
$\Delta t = 5,23\ s$ (5,27)

$P = \frac{W}{\Delta t}$
$P = \frac{F\Delta x\cos\Theta}{\Delta t}$ ✓Any one/*Enige een*
$P = \frac{96,8(15,6)\cos0^\circ}{5,23}$ ✓
$P = 288,73\ W$ ✓

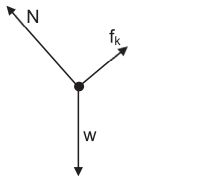
OR/*OF*

$v_{ave} = \frac{\Delta x}{\Delta t}$
$= \frac{15,6 - 0}{5,23 - 0}$
$= 2,98\ m\cdot s^{-1}$

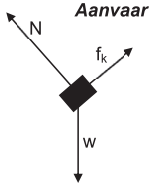
$P_{ave} = Fv_{ave}$ ✓
$= 96,8(2,98)$ ✓
$= 288,46\ W$ ✓

(3)

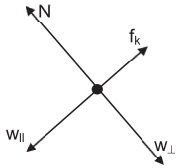
5.4



Accept force diagram/
Aanvaar kragte-diagram:



Accept/Aan*vaar:*



	Accepted symbols/*Aanvaarde simbole*
N ✓	F_N/196N/Normal/*Normaal*/F_{normal}/$F_{normaal}$
f ✓	(kinetic) friction/(kineties) wrywing/F_f/F_w/f_k/f_r
w ✓	F_g/F_w/weight/*gewig*/mg/gravitational force/*gravitasiekrag*/$F_{Earth\ on\ crate}$/ $F_{Aarde\ op\ krat}$

Notes/*Aantekeninge:*
- Accept correct numerical values for the forces./*Aanvaar korrekte numeriese waardes vir die kragte.*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te): Max*/*Maks* $^2/_3$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $^2/_3$

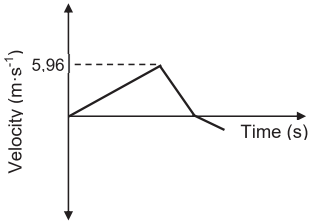
(3)

5.5 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VANAF VRAAG 5.2.

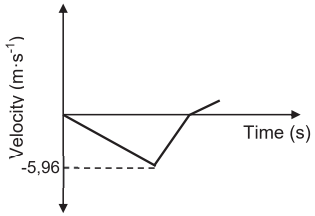
Marking criteria/*Nasienkriteria:*
- First straight line starting at zero with positive gradient, reaching a maximum velocity./*Eerste reguit lyn met 'n positiewe gradiënt begin by nul en bereik maksimum snelheid.* ✓
- Second straight line with negative gradient from maximum velocity to zero./ *Tweede reguit lyn met negatiewe gradiënt vanaf maksimum snelheid na zero.* ✓
- Third straight line continuing from second line at zero and extending below the x-axis./*Derde reguit lyn wat aangaan vanaf tweede lyn vanaf nul en verleng onder die x-as.* ✓
- Third line has a smaller negative gradient than the second line./*Derde reguit lyn het 'n kleiner negatiewe gradiënt as die tweede lyn* ✓

Note/Aantekening:
Direction of gradients opposite for graph 2./*Rigting van hellings teenoorgesteld vir grafiek 2.*
No marks given for values of velocities./*Geen punte toegeken vir waardes van snelhede nie.*

UPWARDS AS POSITIVE
OPWAARTS *AS POSITIEF:*



DOWNWARDS AS POSITIVE
AFWAARTS *AS POSITIEF:*



(4)
[17]

QUESTION 6/*VRAAG 6*

6.1.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓
Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/*OF*
An (apparent) change in observed/detected frequency/pitch as a result of the relative motion between a source and an observer/listener.
'n (Skynbare) verandering in waargenome frekwensie/toonhoogte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.1.2
$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_S$

$f_L = \left(\frac{340 + 22}{340}\right)$ ✓ $24\,000$ ✓

$f_L = 25\,552{,}94$ Hz

$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ **OR/*OF*** $f_L = \frac{v}{v - v_S} f_S$

$f_L = \left(\frac{340}{340 - 22}\right)$ ✓ $25\,552{,}94$ ✓

$f_L = 27\,320{,}75$ Hz ✓ (6)

6.2 The frequencies of the spectral lines would have decreased./*Die frekwensies van die spektrale lyne sou verminder het.*✓✓

OR/*OF*
The spectral lines from the distant star are shifted towards lower frequency end of the spectrum./*Die spektrale lyne van die ver af ster sou verskuif na 'n laer frekwensie op die spektrum.*
(2)
[10]

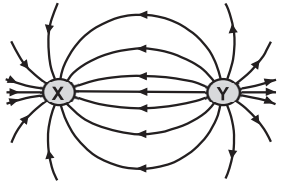
QUESTION 7/*VRAAG 7*

7.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*
If any refrence is made to mass/*Indien enige verwysing gemaak is na massa*: $^0/_2$

The magnitude of the electrostatic force exerted by one (stationary) point charge (**Q_1**) on another (stationary) point charge (**Q_2**) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (**r**) between them.✓✓

*Die grootte van die elektrostatiese krag uitgeoefen deur een (stilstaande) puntlading (**Q_1**) op'n ander puntlading (**Q_2**) is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.* (2)

7.2



Criteria for graph/*Kriteria vir grafiek:*	
Correct shape/ *Korrekte vorm*	✓
Correct direction from **Y** to **X**. /*Korrekte rigting van **Y** na **X**.*	✓
Lines must not cross and must touch charges./ *Lyne mag nie kruis nie en moet die ladings raak.*	✓

Note/*Aantekening*:
- If the net electric field pattern is drawn for two like charges: $^0/_3$
  Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is: $^0/_3$
- Ignore labels for point charges/ *Ignoreer byskrifte vir puntladings.*

(3)

7.3

$$F = \frac{kQ_YQ_X}{r^2} \checkmark$$

$$F = \frac{\left(9 \times 10^9\right)\left(7{,}2 \times 10^{-9}\right)\left(7{,}2 \times 10^{-9}\right)}{(0{,}03)^2} \checkmark$$

$= 5{,}18 \times 10^{-4}$ N ✓ (0,000518 N) (3)

7.4 E_Y✓ ← • → E_Z ✓ **accept/ *aanvaar*** E_Z ✓ → ← E_Y✓ **OR/*OF*** E_Z ✓ → / ← E_Y✓

Notes/*Aantekeninge:*
- 1 Mark for arrows in opposite directions./*1 Punt vir pyle in teenoorgestelde rigtings.*
- 1 Mark for correct labels./*1 Punt vir korrekte benoemings.*
- Do not penalise for length of arrow since drawing is not to scale./*Moenie penaliseer vir die lengte van die pyltjie nie aangesien tekening nie volgens skaal is nie.*
- Accept Y and Z as labels./*Aanvaar Y en Z as benoeming.*

(2)

7.5

OPTION 1/*OPSIE 1*
Marking criteria/*Nasienkriteria*
- Formula for electric field./*Formule vir elektriese veld.* ✓
- Substitution of E_{net}./*Vervanging van E_{net}.* ✓
- Correct substitution into $\frac{kQ}{r^2}$ equation for charge Z or charge Y✓
  Korrekte vervanging in $\frac{kQ}{r^2}$ .vergelyking vir lading Z of lading Y
- Subtraction of electric fields ($E_Z + E_Y$)/*Aftrek van elektriese velde ($E_Z + E_Y$)* ✓
- Correct final answer✓/*Korrekte finale antwoord*: 6,25 x 10^{-9}C
  Range/*Gebied*: 6,25 x 10^{-9} C to/*na* 6,26 x 10^{-9} C

OPTION 1/*OPSIE 1*

$E_{net} = E_Z + E_Y$
$= E_Z - E_Y$

$$E_{net} = \frac{kQ_z}{r^2} + \frac{kQ_y}{r^2}$$

$$4{,}91 \times 10^5 \checkmark = \left(\frac{\left(9 \times 10^9\right)(Q_z)}{0{,}01^2}\right) \checkmark - \left(\frac{\left(9 \times 10^9\right)\left(7{,}2 \times 10^{-9}\right)}{0{,}03^2}\right) \checkmark$$

$Q_Z = 6{,}25 \times 10^{-9}$ C ✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM QUESTION 7.3/
POSITIEWE NASIEN VANAF VRAAG 7.3
Marking criteria/*Nasienkriteria*
- Correct formula for electric field./*Korrekte formule vir elektriese veld.* ✓
- Substitution of F_{net}./*Vervanging van F_{net}.* ✓
- Correct substitution into $\left(\frac{kQ_zQ_x}{r^2}\right)$ for charge Z. ✓
  Korrekte vervanging in $\left(\frac{kQ_zQ_x}{r^2}\right)$ vir lading Z
- Subtraction of forces✓./*Aftrek van kragte.*
- Correct final answer/*Korrekte finale antwoord*: 6,26 x 10^{-9} C ✓
  Range/*Gebied*: 6,25 x 10^{-9} C to/*na* 6,26 x 10^{-9} C

$$E = \frac{F}{Q} \checkmark$$

$$4{,}91 \times 10^5 = \frac{F}{7{,}2 \times 10^{-9}}$$

$F_{net} = 3{,}54 \times 10^{-3}$ N

$$F_{net} = F_{Z \text{ on } X} + F_{Y \text{ on } X}$$

$$F_{net} = \left(\frac{kQ_ZQ_X}{r^2}\right) + \left(\frac{kQ_YQ_X}{r^2}\right)$$

$$(3{,}54 \times 10^{-3}) \checkmark = \left(\frac{(9 \times 10^9)(7{,}2 \times 10^{-9})Q_Z}{(0{,}01)^2}\right) \checkmark - (5{,}18 \times 10^{-4})$$

$Q_Z = 6{,}26 \times 10^{-9}$ C ✓

(5)
[15]

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided all other physical conditions remain constant). ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits alle ander fisiese toestande konstant bly).

OR/*OF*
The ratio of potential difference to current is constant at constant temperature.
Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided all other physical conditions remain constant).
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits alle fisiese toestande konstant bly). (2)

8.2.1

OPTION 1/*OPSIE 1*

$R = \frac{V}{I}$ ✓

$7 = \frac{V}{1,5}$ ✓

V = 10,5 V ✓

OPTION 2/*OPSIE 2*

$R = \frac{V}{I}$ ✓

$2 = \frac{V}{1,5}$ $\qquad$ $5 = \frac{V}{1,5}$

V = 3 V $\qquad$ V = 7,5 V

$V_T = V_1 + V_2$
= 3 ✓+ 7,5 (addition of calculated values/*optel van berekende waardes*)
= 10,5 V ✓

OPTION 3/*OPSIE 3*
Ratio of R:
3 : 7
Ratio of I:
7 : 3
$I = 1,5 \times \frac{7}{3} = 3,5$ A

V = IR ✓
= (3,5)(3) ✓
= 10,5 V✓ (3)

8.2.2 **POSITIVE MARKING FROM QUESTION 8.2.1.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1.

OPTION 1/*OPSIE 1*

$R = \frac{V}{I_3}$ ✓

$3 = \frac{10,5}{I_3}$ ✓

I_3 = 3,5 A

✓
I_T = 1,5 + 3,5 (addition of calculated values/*optel van berekende waardes*)
= 5 A ✓

OPTION 2/*OPSIE 2*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ **OR/*OF***

$\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3}$ ✓

R_p = 2,1 Ω

$R = \frac{V}{I_T}$ ✓

$2,1 = \frac{10,5}{I_T}$ ✓

I_T = 5 A ✓

$R_p = \frac{R_1 R_2}{R_{1+R_2}}$

$R_p = \frac{(7)(3)}{7+3}$ ✓

= 2,1 Ω

OPTION 3/*OPSIE 3*

$I_{3\Omega} = \frac{7}{3} \times 1,5$ ✓
= 3,5 A ✓

✓
I_{total} = 3,5 + 1,5
= 5 A✓

OPTION 4/*OPSIE 4*

$I_S = (\frac{R_{3\Omega}}{R_{3\Omega}+R_S}) \times I_{total}$ ✓

1,5 ✓= $\frac{3}{3+7}$ ✓x I_{total}

I_{total} = 5 A ✓

(4)

8.2.3 **POSITIVE MARKING FROM QUESTION 8.2.1 AND/OR QUESTION 8.2.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1 EN/OF VRAAG 8.2.2.

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$P = \frac{V^2}{R}$ ✓ $= \frac{10,5^2}{3}$ ✓ = 36,75 W ✓	$P = I^2R$ ✓ $= \frac{(3,5)^2(3)}{}$ ✓ = 36,75 W ✓
OPTION 3/*OPSIE 3*	
P = VI ✓ = (10,5)(3,5) ✓ = 36,75 W ✓	

(3)

8.3 **POSITIVE MARKING IF OPTION 2 IS USED IN QUESTION 8.2.2./**
POSITIEWE NASIEN INDIEN OPSIE 2 GEBRUIK IS IN VRAAG 8.2.2.

Marking criteria/*Nasienkriteria*
- Correct equation for emf./*Korrekte vergelyking vir emk.* ✓
- Correct substitution for S_2 closed. /*Korrekte vervanging vir S_2* gesluit. ✓
- Correct substitution for S_2 open./*Korrekte vervanging vir S_2 oop.* ✓
- Equating emf or internal resistance equations. ✓
  Gelykstelling van emk of interne weerstand vergelykings.
- Correct final answer/*Korrekte finale antwoord:* 12,05 V ✓
  Range/*Gebied*: 12,04 V to/*tot* 12,05 *V*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3}$

$R_p = 2,1\ \Omega$

For S_1 and S_2 closed:
$\varepsilon = I(R + r)$
$\varepsilon = IR + Ir$
$\varepsilon = V_{int} + V_{ext}$
✓ Any one/ *Enige een*
$= \underline{5(2,1 + r)}$ ✓…(1)

For S_2 open:
$\varepsilon = I(R+r)$
$= \underline{3,64(3 + r)}$ ✓…(2)

(1) = (2)
$5(2,1 + r) = 3,64(3 + r)$ ✓
$r = 0,31\ \Omega$

$\varepsilon = 5(2,1 + 0,31)$
$= 12,05$ V ✓ (12,04)

OR/*OF*

$\varepsilon = 3,64(3 + 0,31)$
$= 12,05$ V ✓ (12,04)

(1) = (2):
$\frac{\varepsilon - 10,5}{5} = \frac{\varepsilon - 10,92}{3,64}$ ✓
$\varepsilon = 12,05$ V ✓ (12,04)

(5)

8.4 Increases/*Toeneem* ✓
(Total) resistance increases./(*Totale) weerstand neem toe.* ✓
Current decreases./*Stroom neem af.* ✓
$V_{internal}$ /Internal volts decreases./V_{intern}/*Interne volts neem af.* ✓ (4)

Note/*Aantekening:*
Award marks if learner proved the statement using calulated numerical values./
Ken punte toe indien leerder die stelling bewys deur berekende waardes te gebruik.

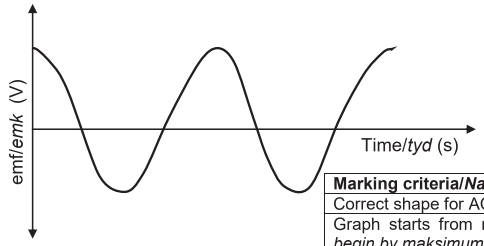
[21]

QUESTION 9/*VRAAG 9*

9.1.1 North pole/*Noord-pool* ✓ (1)

9.1.2 Y to X/*Y na X* ✓ (1)

9.1.3



Marking criteria/*Nasienkriteria*	
Correct shape for AC./*Korrekte vorm vir WS.*	✓
Graph starts from maximum value./*Grafiek begin by maksimum waarde.*	✓
Two complete waves/ *Twee volledige golwe*	✓
Note/*Aantekening:*	
Accept graph starting at negative max./*Aanvaar grafiek wat by negatiewe maks begin.*	

(3)

9.2.1 **Marking criteria/*Nasienkriteria*:**
- Formula to calculate V_{max} or I_{rms}./*Formule om V_{maks} of I_{wgk} te bereken.* ✓
- Correct substitution of V_{rms} or I_{max}./*Korrekte vervanging van V_{wgk} of I_{maks}.* ✓
- Correct substitution to calculate R./*Korrekte vervanging om R te bereken.* ✓
- Correct final answer/*Korrekte finale antwoord*: 47,14 Ω to/*tot* 47,2 Ω ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $200 = \frac{V_{max}}{\sqrt{2}}$ ✓ $V_{max} = 282,84$ V $R = \frac{V}{I}$ $= \frac{282,84}{6}$ ✓ R = 47,14 Ω ✓	$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $I_{rms} = \frac{6}{\sqrt{2}}$ ✓ $I_{rms} = 4,24$ A $R = \frac{V}{I}$ $= \frac{200}{4,24}$ ✓ R = 47,17 Ω ✓

OPTION 3/*OPSIE 3*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{6}{\sqrt{2}}$ ✓

$I_{rms} = 4,24$ A

$P_{ave} = V_{rms}I_{rms}$
$= (200)(4,24)$
$= 848$ W (848,53)

$P_{ave} = \frac{V^2_{rms}}{R}$

$848 = \frac{(200)^2}{R}$ ✓

$R = 47,17\ \Omega$ ✓

OR/*OF*

$P_{ave} = I^2_{rms}R$
$848 = (4,24)^2R$ ✓
$R = 47,17\ \Omega$ ✓

(4)

9.2.2 **POSITIVE MARKING FROM QUESTION 9.2.1.**
POSITIEWE NASIEN VANAF VRAAG 9.2.1.

OPTION 1/*OPSIE 1*

$W = I^2R\Delta t$ ✓
$= (4,24)^2(47,17)$ ✓(7200) ✓
$= 6,11 \times 10^6$ J ✓ $(6,10 \times 10^6)$

OPTION 2/*OPSIE 2*

$W = VI\Delta t$ ✓
$= (200)(4,24)$ ✓(7200) ✓
$= 6,11 \times 10^6$ J ✓

OPTION 3/*OPSIE 3*

$W = \frac{V^2\Delta t}{R}$ ✓

$= \frac{(200^2)(7200)}{47,27}$ ✓ ✓

$= 6,11 \times 10^6$ J ✓ $(6,10 \times 10^6)$

OPTION 4/*OPSIE 4*

$P = \frac{W}{\Delta t}$ ✓ ✓

$848 = \frac{W}{7200}$ ✓

$= 6,11 \times 10^6$ J ✓

(4)
[13]

QUESTION 10/*VRAAG 10*

10.1 $6,63 \times 10^{-34}$ ✓ (1)

10.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted or extra incorrect words added, deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat of inkorrekte woorde bygevoeg is, trek 1 punt af.*

The minimum energy needed to eject an electron from a (metal) surface. ✓✓
Die minimum energie benodig om 'n elektron uit 'n (metaal)oppervlak vry te stel. (2)

10.3.1 $W_o = hf_o$ ✓
$= (6,63 \times 10^{-34})(5 \times 10^{14})$ ✓
$= 3,32 \times 10^{-19}$ J ✓ (3)

10.3.2 **POSITIVE MARKING FROM QUESTION 10.3.1./ *POSITIEWE NASIEN VANAF VRAAG 10.3.1.***

OPTION 1/*OPSIE 1*

Gradient $= \frac{\Delta E_k}{\Delta f}$ ✓

$6,63 \times 10^{-34}$ ✓$= \frac{(X - 0)}{(12,54 \times 10^{14} - 5 \times 10^{14})}$ ✓

$X = 5 \times 10^{-19}$ (J) ✓

OPTION 2/*OPSIE 2*

$E = W_o + E_{k(max)}$
$hf = hf_o + \frac{1}{2}mv^2_{max}$
$h\frac{c}{\lambda} = h\frac{c}{\lambda_o} + E_{k(max)}$
✓ Any one/*Enige een*

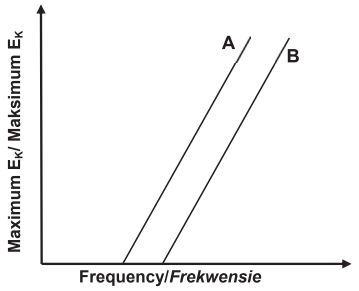
$(6,63 \times 10^{-34})(12,54 \times 10^{14})$ ✓ $= 3,32 \times 10^{-19} + E_{k(max)}$ ✓
$E_{k(max)} = 5 \times 10^{-19}$ J ✓
$X = 5 \times 10^{-19}$ (J)

Note/*Aantekkening*:
Do not penalise learner again in 10.3.2 if (x 10^{14}) is omitted in 10.3.1/*Moenie leerder weer penaliseer in 10.3.2 indien (x 10^{14}) uitgelaat is in 10.3.1 nie.* (4)

10.4.1 No effect/*Geen effek* ✓ (1)

10.4.2 Increases/*Toeneem* ✓ (1)

10.5



Marking criteria/*Nasienkriteria*	
Graph B to the right of graph A./ *Grafiek B aan regterkant van grafiek A.*	✓
Lines are parallel./*Lyne is parallel.*	✓
If both graphs are not labelled/*Indien beide grafieke nie benoem is nie*: $0/2$	
If two seperate graphs are drawn/*Indien twee aparte grafieke geteken is* : $0/2$	

(2)
[14]

TOTAL/*TOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2022

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 32 pages.
Hierdie nasienriglyne bestaan uit 32 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	A ✓✓	(2)
1.4	D ✓✓	(2)
1.5	B ✓✓	(2)
1.6	C ✓✓	(2)
1.7	C ✓✓	(2)
1.8	A ✓✓	(2)
1.9	C ✓✓	(2)
1.10	D ✓✓	(2)

[20]

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QUESTION 2/*VRAAG 2*

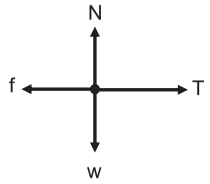
2.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

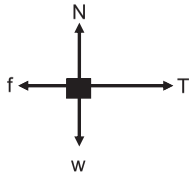
When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Die versnelling is direk eweredig aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The resultant/net force acting on an object is equal to the rate of change of momentum of the object. **(2 or 0)**
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum. ***(2 of 0)*** (2)

2.2



Accept force diagram/
Aanvaar kragte-diagram:



Accepted labels/*Aanvaarde benoemings*	
w	F_g /F_w /$F_{earth\ on\ P}$ /weight /mg /12,25 N /gravitational force F_g /F_w /$F_{aarde\ op\ P}$ /*gewig /mg /12,25 N /gravitasiekrag*
T	F_T /F_{string} /F_{tou} /F_t /tension /*spanning* /F_s
f	F_f /f_k /(kinetic) friction /*(kinetiese) wrywing* /1,8 N /F_w
N	F_N /Normal /F_{normal} /$F_{normaal}$ /*Normaal*

Notes/*Aantekeninge*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* Max/*Maks* $\frac{3}{4}$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $\frac{3}{4}$
- If force(s) do not make contact with the dot /*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/*Maks* $\frac{3}{4}$

(4)

2.3.1

For P/*Vir P* **RIGHT AS POSITIVE/ *REGS AS POSITIEF***	**For P/*Vir P*** **LEFT AS POSITIVE/ *LINKS AS POSITIEF***
F_{net} = ma T + f = ma T – f = ma } ✓ Any one/ *Enige een* T - 1,8 ✓= (1,25)(0,1) ✓ T = 1,93 N ✓ (1,925 N)	F_{net} = ma T + f = ma -T +f = ma } ✓ Any one/ *Enige een* -T + 1,8 ✓= (1,25)(-0,1) ✓ T = 1,93 N ✓ (1,925 N)

(4)

2.3.2

POSITIVE MARKING FROM QUESTION 2.3.1/ *POSITIEWE NASIEN VANAF VRAAG 2.3.1.*
RIGHT AS POSITIVE/*REGS AS POSITIEF:* **For Q/*Vir Q*** **Accept/*Aanvaar*** Sin(90°- θ) F_{net} = ma Fcosθ - T - f = ma Fcosθ + T + f = ma 7,5cosθ - 1,93 - 2,2 ✓= (2)(0,1) ✓ θ = 54,74°✓ (Range:54,55° - 54,78°)
LEFT AS POSITIVE/*LINKS AS POSITIEF:* **For Q/*Vir Q*** **Accept/*Aanvaar*** Sin(90°- θ) F_{net} = ma -Fcosθ + T + f = ma Fcosθ + T + f = ma -7,5cosθ + 1,93 + 2,2 ✓= (2)(- 0,1) ✓ θ = 54,74° ✓ (Range:54,55° - 54,78°)

(3)
[13]

QUESTION 3/*VRAAG 3*

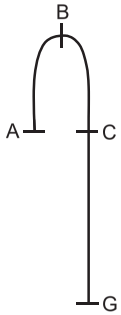
3.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gravitasie/gewig/swaartekrag.
(2 or/of 0)

OR/*OF*
Motion in which the only force acting is gravity/weight/gravitational force.
Beweging waar die enigste krag wat inwerk, gravitasie/gewig/swaartekrag is.
(2 or/of 0) (2)

3.2.1

Marking criteria/*Nasienkriteria*

- Formula with Δt/*Formule met Δt* ✓
- Correct substitution into formula/*Korrekte vervanging in formule* ✓
- Final answer/*Finale antwoord*: 1,22 s ✓ (1,22 s to/*tot* 1,23 s)



OPTION 1/*OPSIE 1*
A-B:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$0 = 12 + (-9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$0 = -12 + (9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

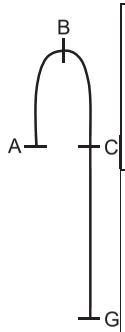
OPTION 2/*OPSIE 2*
B-C:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$-12 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$12 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

OPTION 3/*OPSIE 3*
A-C:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$-12 = 12 + (-9,8)\Delta t$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$12 = -12 + (9,8)\Delta t$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓

OPTION 4/*OPSIE 4*
A-C:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = (12)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = (-12)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓



OPTION 5/*OPSIE 5*
A-B OR/*OF* B-C:
$(E_{mech})_{Top/Bo} = (E_{mech})_{25\ m}$
$(E_P + E_K)_{Top/Bo} = (E_P + E_K)_{25\ m}$
$(mgh + \frac{1}{2}mv^2)_{Top/Bo} = (mgh + \frac{1}{2}mv^2)_{25\ m}$
$(9,8)h + 0 = 0 + (\frac{1}{2})(12)^2$
$\Delta h = 7,35$ m

OPTION 6/*OPSIE 6*
A-B OR/*OF* B-C
$W_{nc} = \Delta K + \Delta U$
$W_{nc} = \Delta K + mg(h_f - h_i)$
$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
$0 = \frac{1}{2}(0^2 - 12^2) + (9,8)\Delta h$
$\Delta h = 7,35$ m

OPTION 7/*OPSIE 7*
A-B OR/*OF* B-C
$W_{net} = \Delta E_k$
$w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(9,8)\Delta y\cos 180° = 0 - \frac{1}{2}(12)^2$
$\Delta y = 7,35$ m

OPTION 8/*OPSIE 8*
A-B:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f^2 = v_i^2 + 2a\Delta y$
$0^2 = 12^2 + 2(-9,8)\Delta y$
$\Delta y = 7,35$ m

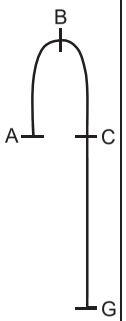
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f^2 = v_i^2 + 2a\Delta y$
$0^2 = (-12)^2 + 2(9,8)\Delta y$
$\Delta y = -7,35$ m

OPTION 9/*OPSIE 9*
B-C:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f^2 = v_i^2 + 2a\Delta y$
$(-12)^2 = 0^2 + 2(-9,8)\Delta y$
$\Delta y = -7,35$ m

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f^2 = v_i^2 + 2a\Delta y$
$(12)^2 = 0^2 + 2(9,8)\Delta y$
$\Delta y = 7,35$ m

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$7,35 = \left(\frac{12 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,23$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-7,35 = \left(\frac{-12 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,23$ s ✓



OPTION 10/*OPSIE 10*

A-B:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\frac{12 + 0}{2}\right)\Delta t$

$\Delta y = 6\Delta t$

$v_f^2 = v_i^2 + 2a\Delta y$

$0 = (12)^2 + 2(-9,8)(6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\frac{-12 + 0}{2}\right)\Delta t$

$\Delta y = -6\Delta t$

$v_f^2 = v_i^2 + 2a\Delta y$

$0 = (-12)^2 + 2(9,8)(-6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

OPTION 11/*OPSIE 11*

B-C:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\frac{0 - 12}{2}\right)\Delta t$

$\Delta y = -6\Delta t$

$v_f^2 = v_i^2 + 2a\Delta y$

$-12 = (0)^2 + 2(-9,8)(-6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\frac{12 + 0}{2}\right)\Delta t$

$\Delta y = 6\Delta t$

$v_f^2 = v_i^2 + 2a\Delta y$

$12^2 = 0^2 + 2(9,8)(6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

OPTION 12/*OPSIE 12*

A-B:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

$F_{net}\Delta t = m\Delta v$
$F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een*

$-(9,8)\Delta t = 0 - 12$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

$F_{net}\Delta t = m\Delta v$
$F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een*

$(9,8)\Delta t = 12 - 0$ ✓

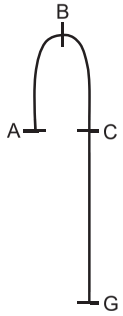
$\Delta t = 1,22$ s ✓

(3)

3.2.2

Marking criteria/*Nasienkriteria*

- Formula with v_f./*Formule met v_f.* ✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Correct final answer/*Korrekte finale antwoord*:
  25,18 $m\cdot s^{-1}$ ✓ (25,03 $m\cdot s^{-1}$ to/*tot* 25,59 $m\cdot s^{-1}$)
- Correct direction (only if numerical value is given)./*Korrekte rigting (slegs indien numeriese waarde gegee is).*✓



OPTION 1/*OPSIE 1*

A-G: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*:**	**A-G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*:**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (12)^2 + 2(-9,8)(-25)$ ✓	$v_f^2 = (-12)^2 + 2(9,8)(25)$ ✓
$v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*	$v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*

OPTION 2/*OPSIE 2*

C-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF**	**C-G:** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (-12)^2 + 2(-9,8)(-25)$ ✓	$v_f^2 = (12)^2 + 2(9,8)(25)$ ✓
$v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*	$v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*

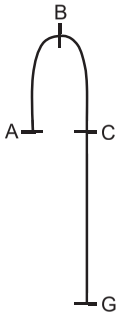
OPTION 3/*OPSIE 3*

B-G **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF**	**B-G** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (0)^2 + 2(-9,8)(-32,35)$ ✓	$v_f^2 = (0)^2 + 2(9,8)(32,35)$ ✓
$v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*	$v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*

OPTION 4/*OPSIE 4*

A-G:

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*



$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$-25 = 12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$

$\Delta t = 3,79$ s

A-G

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$-25 = \left(\frac{12 + v_f}{2}\right)3,79$

$v_f = -25,18\ m\cdot s^{-1}$

$\therefore v_f = 25,18\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

B-G

$v_f = v_i + a\Delta t$ ✓

$v_f = 0 + (-9,8)(3,79 - 1,22)$ ✓

$v_f = -25,19\ m\cdot s^{-1}$

$v_f = 25,19\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

C-G

$v_f = v_i + a\Delta t$ ✓

$v_f = -12 + (-9,8)(1,35)$ ✓

$v_f = -25,19\ m\cdot s^{-1}$

$v_f = 25,19\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

A-G:

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$25 = -12\Delta t + \frac{1}{2}(9,8)\Delta t^2$

$\Delta t = 3,79$ s

A-G

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$25 = \left(\frac{-12 + v_f}{2}\right)3,79$ ✓

$\therefore v_f = 25,18\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

B-G

$v_f = v_i + a\Delta t$ ✓

$= 0 + (9,8)(3,79 - 1,22)$ ✓

$v_f = 25,19\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

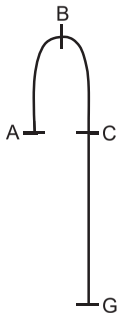
C-G

$v_f = v_i + a\Delta t$ ✓

$v_f = 12 + (9,8)(3,79 - 2(1,22))$ ✓

$v_f = 25,19\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

OPTION 5/*OPSIE 5*



C-G:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$-25 = -12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$

$\Delta t = 1,34$ s

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$-25 = \left(\frac{-12 + v_f}{2}\right)1,34$ ✓

$v_f = -25,18\ m\cdot s^{-1}$

$\therefore v_f = 25,18\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

C-G:

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$25 = 12\Delta t + \frac{1}{2}(9,8)\Delta t^2$

$\Delta t = 1,34$ s

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$25 = \left(\frac{12 + v_f}{2}\right)1,34$ ✓

$v_f = 25,18\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

OPTION 6/*OPSIE 6*

$(E_{mech/meg})_i = (E_{mech/meg})_f$
$(E_P + E_K)_i = (E_P + E_K)_f$
$(mgh + \frac{1}{2}mv^2)_i = (mgh + \frac{1}{2}mv^2)_f$
} ✓Any one/ *Enige een*

$m(9,8)(25) + \frac{1}{2}m(12^2) = 0 + \frac{1}{2}mv_f^2$ ✓

$v_f = 25,18\ m\cdot s^{-1}$✓ downwards/*afwaarts* ✓

OPTION 7/*OPSIE 7*

$W_{nc} = \Delta E_k + \Delta E_p$
$= (E_{kf} - E_{ki}) + (E_{pf} - E_{pi})$
$= (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) + (mgh_f - mgh_i)$ ✓Any one/*Enige een*
$0 = [\frac{1}{2}mv_f^2 - \frac{1}{2}m(12)^2] + [0 - m(9,8)(25)]$ ✓
$v_f = 25,18\ m\cdot s^{-1}$✓ downwards/*afwaarts* ✓

OPTION 8/*OPSIE 8*

$W_{net} = \Delta E_k$
$= (E_{kf} - E_{ki})$
$= (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$ ✓Any one/*Enige een*
$m(9,8)(25) = \frac{1}{2}mv_f^2 - \frac{1}{2}m(12)^2$ ✓
$v_f = 25,18\ m\cdot s^{-1}$✓ downwards/*afwaarts* ✓

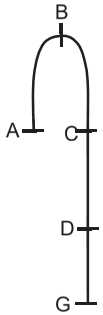
(4)

3.2.3 **POSITIVE MARKING FROM QUESTION 3.2.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2.2.

Marking criteria/*Nasienkriteria*
- Substitution into formula to calculate v at the top of the door ✓
  Vervanging in formule om v bokant die deur te bereken.
- Formula to calculate Δt from top to bottom of door.✓
  Formule om Δt te bereken van bokant tot onderkant van deur.
- Substitution to calculate Δt. ✓
  Vervanging om Δt *te bereken*.
- Final answer/*Finale antwoord*: 0,07 to/*tot* 0,08 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*



A-D:
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (12)^2 + 2(-9,8)(-23,1)$ ✓
$v_f = 24,43\ m\cdot s^{-1}$

C-D:
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-12)^2 + (2)(-9,8)(-23,1)$ ✓
$v_f = 24,43\ m\cdot s^{-1}$

D-G:
$v_f^2 = v_i^2 + 2a\Delta y$
$(-25,18)^2 = (v_i)^2 + 2(-9,8)(-1,9)$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

B-D
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = 0 + 2(-9,8)(-30,447)$ ✓
$= 24,43\ m\cdot s^{-1}$

D-G:
$E_{(mech\ top/meg\ bo)} = E_{(mech\ bot/meg\ ond)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bot/ond}$
$(mgh + \frac{1}{2}mv^2)_{top/bo} = (mgh + \frac{1}{2}mv^2)_{bot/ond}$
$m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 = 0 + \frac{1}{2}m(25,18)^2$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

D-G:
$v_f = v_i + a\Delta t$ ✓
$-25,18 = -24,43 + (-9,8)\Delta t$ ✓
$\Delta t = 0,08$ s ✓

D-G:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-1,9 = -24,43\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 0,08$ s ✓

D-G:
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-1,9 = \left(\frac{-24,43 - 25,18}{2}\right)\Delta t$ ✓
$\Delta t = 0,08$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



A-D:
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-12)^2 + 2(9,8)(23,1)$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

C-D:
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (12)^2 + (2)(9,8)(23,1)$ ✓
$v_f = 24,43\ m\cdot s^{-1}$

D-G:
$v_f^2 = v_i^2 + 2a\Delta y$
$(25,18)^2 = (v_i)^2 + 2(9,8)(1,9)$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

B-D
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = 0 + 2(9,8)(30,447)$ ✓
$= 24,43\ m\cdot s^{-1}$

D-G:
$E_{(mech\ top/meg\ bo)} = E_{(mech\ bot/meg\ ond)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bot/ond}$
$(mgh + \frac{1}{2}mv^2)_{top/bo} = (mgh + \frac{1}{2}mv^2)_{bot/ond}$
$m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 = 0 + \frac{1}{2}m(25,18)^2$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

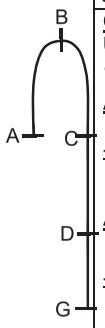
D-G:
$v_f = v_i + a\Delta t$ ✓
$25,18 = 24,43 + (9,8)\Delta t$ ✓
$\Delta t = 0,08$ s ✓

D-G:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$1,9 = 24,43\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 0,08$ s ✓

D-G:
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$1,9 = \left(\frac{24,43 + 25,18}{2}\right)\Delta t$ ✓
$\Delta t = 0,08$ s ✓

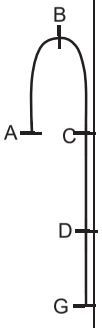
Marking criteria OPTION 2 and 3/*Nasienkriteria OPSIE 2 en 3*

- Either one of the formula to calculate Δt./*Enige een van die formules om Δt te bereken.* ✓
- Substitute into formula to calculate time from A to G or C to G/*Vervanging in formule om tyd te bereken tussen A tot G of C tot G* ✓
- Substitute into formula to calculate time from A to D or C to D/ *Vervanging in formule om tyd te bereken tussen A tot D of C tot D* ✓
- Final answer/*Finale antwoord*: 0,07 s ✓ (0,07s to/*tot* 0,08s)



OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF:*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:***
A-G:	**A-G:**
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$-25,18 = 12 + (-9,8)\ \Delta t$ ✓	$25,18 = -12 + (9,8)\ \Delta t$ ✓
$\Delta t = 3,79$ s	$\Delta t = 3,79$ s
✓Any one/ *Enige een*	✓Any one/ *Enige een*
A-D:	**A-D:**
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-23,1 = (12)\Delta t + ½(-9,8)\Delta t^2$ ✓	$23,1 = (-12)\Delta t + ½(9,8)\Delta t^2$ ✓
$\Delta t = 3,72$ s	$\Delta t = 3,72$ s
Time from top to bottom of door/*Tyd van bokant tot onderkant van deur:*	Time from top to bottom/*Tyd van bokant tot onderkant van deur:*
D-G:	**D-G:**
3,79 – 3,72 = 0,07 s ✓	3,79 – 3,72 = 0,07 s ✓



OPTION 3/*OPSIE 3*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF:*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:***
C-G:	**C-G:**
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$-25,18 = -12 + (-9,8)\ \Delta t$ ✓	$25,18 = 12 + (9,8)\ \Delta t$ ✓
$\Delta t = 1,34$ s	$\Delta t = 1,34$ s
✓Any one/ *Enige een*	✓Any one/ *Enige een*
C-D:	**C-D:**
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-23,1 = (-12)\Delta t + ½(-9,8)\Delta t^2$ ✓	$23,1 = (12)\Delta t + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,27$ s	$\Delta t = 1,27$ s
Time from top to bottom of door/*Tyd van bokant tot onderkant van deur:*	Time from top to bottom of door/*Tyd van bokant tot onderkant van deur:*
D-G:	**D-G:**
1,34 – 1,27 = 0,07 s ✓	1,34 – 1,27 = 0,07 s ✓

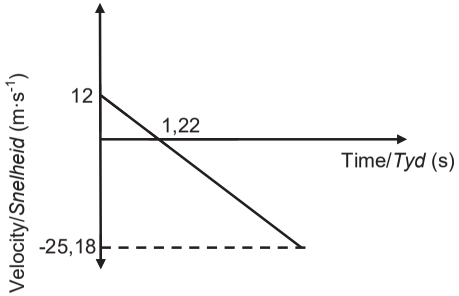
OPTION 4/*OPSIE 4*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF:*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:***
G-D:	**G-D:**
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
$1,9$ ✓$= \underline{25,18\Delta t + ½(-9,8)\Delta t^2}$ ✓	$-1,9$ ✓$= \underline{-25,18\Delta t + ½(9,8)\Delta t^2}$ ✓
$\Delta t = 0,08$ s ✓ (0,077 s)	$\Delta t = 0,08$ s ✓ (0,077 s)

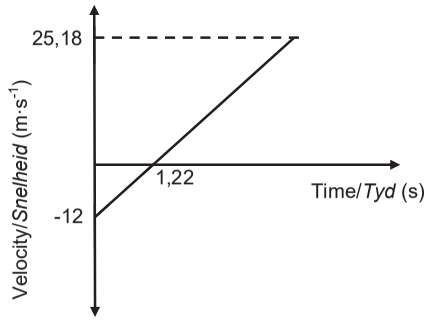
(4)

3.3 **POSITIVE MARKING FROM QUESTION 3.2.1 AND QUESTION 3.2.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2.1 EN VRAAG 3.2.2.

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



Criteria for graph/*Kriteria vir grafiek*	
Straight line starting at v = 12 m·s^{-1} with negtive final velocity or straight line starting at v = -12 m·s^{-1} with positive final velocity. /*Reguitlyn wat begin by v = 12 m·s^{-1}met negatiewe finale snelheid of reguitlyn wat begin by v = -12 m·s^{-1}*met positiewe finale snelheid.	✓
Straight line cuts time axis at time calculated in Question 3.2.1/ *Reguitlyn sny tydas by die tyd bereken in Vraag 3.2.1.*	✓
Correct final velocity as calculated in Question 3.2.2 is indicated./*Korrekte finale snelheid soos uitgewerk in Vraag 3.2.2 is aangedui.*	✓

(3)
[16]

QUESTION 4/*VRAAG 4*

4.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

In an isolated/closed system the total (linear) momentum is conserved/remains constant. ✓✓
In 'n geïsoleerde/geslote sisteem bly die totale (lineêre) momentum behoue/konstant.

(2)

4.2.1

OPTION 1/*OPSIE 1*
EAST AS POSITIVE/*OOS AS POSITIEF*

$\sum p_i = \sum p_f$
$m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ } ✓Any one/*Enige een*
$(1,2)(8)$ ✓ $+ (0,5)(0) = (1,2)(4) + (0,5)(v_{fy})$ ✓
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

WEST AS POSITIVE/*WES AS POSITIEF*

$\sum p_i = \sum p_f$
$m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ } ✓ Any one/*Enige een*
$(1,2)(-8)$ ✓ $+ (0,5)(0) = (1,2)(-4) + (0,5)(v_{fy})$ ✓
$v_{fy} = -9,6\ m.s^{-1}$
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

OPTION 2 /*OPSIE 2*
EAST AS POSITIVE/*OOS AS POSITIEF*

$\Delta p_x = -\Delta p_y$
$m(v_{xf} - v_{xi}) = -m(v_{yf} - v_{yi})$ } ✓ Any one/*Enige een*
$1,2(4 - 8)$ ✓ $= -0,5(v_f - 0)$ ✓
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

WEST AS POSITIVE/*WES AS POSITIEF*

$\Delta p_x = -\Delta p_y$
$m(v_{xf} - v_{xi}) = -m(v_{yf} - v_{yi})$ } ✓ Any one/*Enige een*
$1,2(-4 + 8)$ ✓ $= -0,5(v_f - 0)$ ✓
$v_{fy} = -9,6\ m.s^{-1}$
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

(4)

4.2.2

OPTION 1/*OPSIE 1*

EAST POSITIVE/*OOS POSITIEF:*
For X/*Vir X:*
$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*
$F_{net}(0,1) = 1,2(4 - 8)$ ✓
$F_{net} = -48$ N ✓
$\therefore F_{net} = 48$ N ✓

WEST POSITIVE/*WES POSITIEF:*
For X /*Vir X:*
$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*
$F_{net}(0,1) = 1,2(-4 + 8)$ ✓
$\therefore F_{net} = 48$ N ✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM QUESTION 4.2.1.
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

EAST AS POSITIVE
OOS AS POSITIEF
For Y/*Vir Y:*
$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*
$F_{net}(0,1) = 0,5(-9,6 - 0)$ ✓
$F_{net} = -48$ N
$\therefore F_{net} = 48$ N ✓

WEST AS POSITIVE
WES AS POSITIEF
For Y/*Vir Y:*
$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*
$F_{net}(0,1) = 0,5(9,6 - 0)$ ✓
$F_{net} = 48$ N ✓

OPTION 3/*OPSIE 3*

EAST AS POSITIVE for X
OOS AS POSITIEF vir X
$v_f = v_i + a\Delta t$
$-4 = -8 + a(0,1)$
$a = -40\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$F_{net} = (1,2)(-40)$ ✓
$F_{net} = -48$ N
$\therefore F_{net} = 48$ N ✓

WEST AS POSITIVE for X
WES AS POSITIEF vir X
$v_f = v_i + a\Delta t$
$4 = 8 + a(0,1)$
$a = 40\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$F_{net} = (1,2)(40)$ ✓
$F_{net} = 48$ N✓

OPTION 4/*OPSIE 4*

EAST AS POSITIVE for X
OOS AS POSITIEF vir X
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$\Delta x = \left(\frac{8 + 4}{2}\right)(0,1)$
$\Delta x = 0,6$ m
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓
$F_{net}(0,6)\cos 180^o = \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2$ ✓
$F_{net} = 48$ N ✓

WEST AS POSITIVE for X
WES AS POSITIEF vir X
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$\Delta x = \left(\frac{-8 - 4}{2}\right)(0,1)$
$\Delta x = -0,6$ m
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓
$F_{net}(0,6)\cos 0^o = \frac{1}{2}(1,2)(-4)^2 - \frac{1}{2}(1,2)(-8)^2$ ✓
$F_{net} = -48$ N ✓
$\therefore F_{net} = 48$ N ✓

OPTION 5/*OPSIE 5*

$\text{Gradient} = \frac{\Delta y}{\Delta x}$
$= \frac{\Delta v}{\Delta t}$
$= \frac{4 - 8}{0,1}$
$= -40\ m\cdot s^{-2}$

$F_{net} = ma$ ✓
$F_{net} = (1,2)(-40)$ ✓
$F_{net} = -48$
$F_{net} = 48$ N ✓

(3)

4.3 **POSITIVE MARKING FROM QUESTION 4.2.1/**
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

OPTION 1/*OPSIE 1*

Inelastic/*onelasties* ✓

$E_k = ½mv^2$ ✓

$\sum E_{ki} = ½m_Xv_{Xi}^2 + ½m_Yv_{Yi}^2$
$= ½(1,2)(8)^2 + 0$ ✓
$= 38,4$ J

$\sum E_{kf} = ½m_Xv_{Xf}^2 + ½m_Yv_{Yf}^2$
$= ½(1,2)(4)^2 + ½(0,5)(9,6)^2$ ✓
$= 32,64$ J

$\sum E_{ki} \neq \sum E_{kf}$ ✓

OPTION 2/*OPSIE 2* (Change in E_{ktotal} total /*verandering in* $E_{ktotaal}$))

Inelastic/onelasties✓

$E_k = ½mv^2$ ✓

$\Delta E_k(X) = ½mv_f^2 - ½mv_i^2$
$= ½(1,2)(4)^2 – ½(1,2)(8)^2$ ✓
$= - 28,8$ J

$\Delta E_k(Y) = ½mv_f^2 - ½mv_i^2$
$= ½(0,5)(9,6)^2 – ½(0,5)(0)^2$ ✓
$= 23,04$ J

$\Delta E_k(X) \neq \Delta E_k(Y)$ ✓

Note/*Aantekening*:
If candidate starts with conservation of kinetic energy/*Indien kandidaat begin met behoud van kinetiese energie:* max/*maks* $\frac{4}{5}$

(5)
[14]

QUESTION 5/*VRAAG 5*

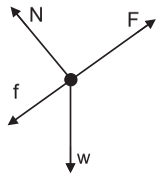
5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

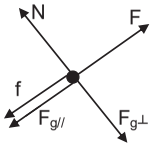
A force is non-conservative if the work done by the force on an object (which is moving between two points) depends on the path taken. ✓✓
'n Krag waarvoor die arbeid wat verrig word deur die krag op 'n voorwerp (wat tussen twee punte beweeg,) afhanklik is van die pad wat gevolg word.
OR/*OF*
A force is non-conservative if the work it does in moving an object around a closed path is non-zero.
'n Krag is nie-konserwatief wanneer die arbeid wat dit verrig om 'n voorwerp in 'n geslote pad te beweeg, nie nul is nie. (2)

Note/*Aantekening:*
-If work done is ommited/ Indien arbeid verrig uitgelaat word: $\frac{0}{2}$

5.2



OR/*OF*



Accepted labels/*Aanvaarde benoemings*	
w	F_w/ F_g/ mg /117,6 N / gravitational force / *gravitasiekrag* / weight / *gewig*
F	F_A /Applied force / T /*Toegepaste krag*/ F_T
f	F_f / f_k / (kinetic) Friction / *(kinetiese) wrywing* / F_w
N	F_N/ Normal / *Normaal*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- If w is not shown but $F_{//}$ and $F_{g\perp}$ are shown, give 1 mark for both./*Indien w nie aangetoon is nie maar $F_{//}$ en $Fg_\perp$ is getoon, ken 1 punt toe vir beide.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* *Max/Maks* $\frac{3}{4}$
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* $\frac{3}{4}$ •
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{3}{4}$

(4)

5.3

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta E_k + \Delta E_p$
$W_{nc} = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$ } ✓ Any one/Enige een
$= \frac{1}{2}(12)(2,25^2 - 0)$ ✓ + $(12)(9,8)(4,5 - 0)$ ✓
$= 559,58$ J ✓

OPTION 2/*OPSIE 2*

$W_{Fg//} = F_{g//}\Delta x\cos$
$= (mg\sin\theta)\Delta x\cos\theta$
$= (12)(9,8)\left(\frac{4,5}{\Delta x}\right)\Delta x\cos180°$
$= -529,2$ J

$W_{Fg} = F_g\Delta x\cos(90° + \theta)$
$= mg\Delta x(-\sin\theta)$
$= (12)(9,8)\left(\frac{-4,5}{\Delta x}\right)\Delta x$
$= -529,2$ J

$W_{net} = \Delta Ek$
$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$= \frac{1}{2}(12)(2,25)^2 - 0^2$ ✓
$= 30,375$ J

$W_{net} = W_{nc} + W_c$ ✓
$30,375 = W_{nc} + (-529,2)$ ✓
$W_{nc} = 559,575$ J ✓ (559,58 J)

OPTION 3/*OPSIE 3*

$\sin\theta = \frac{4,5}{\Delta x}$

$\Delta x = \frac{4,5}{\sin\theta}$

$W_{net} = \Delta E_k$
$W_F + W_f + W_w = \Delta E_k$
$W_{nc} + (mg\sin\theta)\Delta x(\cos\beta) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
} ✓Any one/ *Enige een*

$W_{nc} + (12)(9,8)\left(\frac{4,5}{\sin\theta}\right)\sin\theta\cos180°$ ✓ $= \frac{1}{2}(12)(2,25)^2 - 0^2$ ✓

$W_{nc} = 559,58$ J ✓

(4)

5.4 **POSITIVE MARKING FROM QUESTION 5.3.**
POSITIEWE NASIEN VANAF VRAAG 5.3.

Marking criteria for OPTION 1 /*Nasienkriteria vir OPSIE 1*

- Formula for W_{nc} /*Formule vir* W_{nc} ✓
- Correct substitution of 559,58 J in W_{nc} along inclined plane ✓
  Korrekte vervanging van 559,58 J in W_{nc} *langs die skuinsvlak*
- Correct force equation and substitution of 0 for F_{net} **OR** F = f_2 on horizontal plane✓
  Korrekte kragvergelyking en vervanging van 0 vir F_{net} ***OF*** *F =* f_2 *op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2).✓
  Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ *vir* f_2*).*
- Correct answer/*Korrekte antwoord*: 13,32 m.✓

OPTION 1/*OPSIE 1*

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$W_{nc} = W_F + W_f$
$W_{nc} = F\Delta x\cos0° + f_1\Delta x\cos180°$ } ✓ Any one/*Enige een*
$559,58 = F\Delta x\cos0° + f_1\Delta x\cos180°$
$559,58$ ✓ $= (F - f_1)\Delta x$ .....(1)

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓ **OR/*OF*** $F = f_2$
$F - (f_1 + 42)$ ✓ $= 0$
$F - f_1 = 42$.....(2)

Substitute/*Vervang* (2) into/*in* (1):
$559,58 = 42\Delta x$
$\Delta x = 13,32$ m ✓

Marking criteria for OPTION 2 and 3 /*Nasienkriteria vir OPSIE 2 en 3*

- Correct force equation and substitution of 0 for F_{net} **OR** F = f_2 on horizontal plane✓
  Korrekte kragvergelyking en vervanging van 0 vir F_{net} ***OF*** *F =* f_2 *op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2).✓
  Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ *vir* f_2*).*
- Formula for W_{nc} **OR** W_{net} /*Formule vir* W_{nc} ***OF*** W_{net}✓
- Correct substitution into equation for W_{nc} **OR** W_{net} on the horizontal plane✓
  Korrekte vervanging in W_{nc} ***OF*** W_{net} *vergelyking langs die skuinsvlak*
- Correct answer/*Korrekte antwoord*: 13,32 m.✓

OPTION 2/*OPSIE 2*

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓ **OR/*OF*** $F = f_2$
$F - (f_1 + 42)$ ✓ $= 0$
$F = f_1 + 42$

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$W_{nc} = \Delta E_K + \Delta E_P$
$(F - f_1)\Delta x\cos\theta = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$
} ✓ Any one/ *Enige een*

$(f_1 + 42 - f_1)\Delta x\cos0° = [\frac{1}{2}(12)(2,25)^2 - 0^2] + [(12)(9,8)(4,5) - 0]$ ✓

$\Delta x = 13,32$ m ✓ (13,32 m)

OPTION 3/*OPSIE 3*

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓ **OR/*OF*** $F = f_2$
$F - (f_1 + 42)$ ✓$= 0$
$F = f_1 + 42$

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$W_{net} = \Delta E_K$
$(F - f_1 - F_{g//})\Delta x\cos\theta = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2]$ } ✓ Any one/ *Enige een*

$[(42) - (12)(9,8)\left(\frac{4,5}{\Delta x}\right)]\ \Delta x\cos 0^o = \frac{1}{2}(12)(2,25)^2$ ✓$- 0^2$

$\Delta x = 13,323214$ m ✓ (13,32 m)

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta E_K + \Delta E_P$
$W_{nc} = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$ } ✓ Any one/ *Enige een*

$(f_1 + 42 - f_1)$✓$\Delta x\cos 0°$ ✓$= 559,575$ ✓
$(42)\Delta x\cos 0° = 559,575$
$\Delta x = 13,323214$ m ✓ (13,32 m)

Marking criteria for OPTION 5/*Nasienkriteria vir OPSIE 5*

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane✓/ *Korrekte kragvergelyking en vervanging van 0 vir F_{net}* ***OF*** *$F = f_2$ op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2).✓ *Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).*
- Correct substitution to calculate a./*Korrekte vervanging om a te bereken.* ✓.
- Substitution to calculate F_{net}./*Vervanging om F_{net} te bereken.* ✓
- Correct answer/*Korrekte antwoord*: 13,32 m.✓

OPTION 5/*OPSIE 5*

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓ **OR/*OF*** $F = f_2$
$F - (f_1 + 42)$ ✓$= 0$
$F = f_1 + 42$ .....(1)

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$v_f^2 = v_i^2 + 2a\Delta x$
$2,25^2 = 0 + 2a\Delta x$ ✓
$a = \frac{2,53}{\Delta x}$

$F_{net} = ma$
$F - F_{g//} - f_1 = ma$
$F - mg\sin\theta - f_1 = 12a$ .....
$F - (12)(9,8)\sin\theta - f_1 = 12\left(\frac{2,53}{\Delta x}\right)$ ✓....(2)

Substitute/*Vervang* (2) into/*in* (1):
$42 - (12)(9,8)\left(\frac{4,5}{\Delta x}\right) = 30,38$
$\Delta x = 13,32$ m ✓

(5)
[15]

QUESTION/*VRAAG 6*

6.1 Doppler Effect/*Doppler-effek* ✓ (1)

6.2 Measurement of foetal heartbeat./*Meting van die hartklop van 'n fetus.*✓

OR/*OF*
Measurement of blood flow./*Meting van bloedvloei.* ✓

OR/*OF*
Doppler flow meter/*Doppler vloeimeter* ✓
(1)

6.3 $f_L \propto f_s$ ✓

OR/*OF*
Directly (proportional)/*Direk (eweredig)* (1)

6.4

Marking criteria/*Nasienkriteria*

- Doppler formula/*Doppler formule* ✓
- Correct substitution for v and v_S./*Korrekte vervanging van v en v_S.* ✓
- Substitution for $\frac{f_L}{f_S} = 1{,}06$ **OR** $f_L = 1{,}06\ f_s$ **OR** any set of values for f_L and f_S so that $f_L = 1{,}06\ f_S$ / *Vervanging van* $\frac{f_L}{f_S} = 1{,}06$ ***OF*** $f_L = 1{,}06\ f_s$ ***OF*** *enige stel waardes vir* f_L *en* f_S *sodat* $f_L = 1{,}06\ f_S$ ✓✓
- Final answer/*Finale antwoord:* 20,4 $m \cdot s^{-1}$ ✓

OPTION 1/*OPSIE 1*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_S$

$\frac{f_L}{f_s} = \frac{v \pm v_L}{v \pm v_s}$

✓✓ $1{,}06 = \left(\frac{340 + v_L}{340}\right)$ ✓

$v_L = 20{,}4\ m \cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$\text{Gradient} = \frac{0 - f_L}{0 - f_S}$

✓✓ $1{,}06 = \frac{0 - f_L}{0 - f_S}$

$f_L = 1{,}06\ f_S$

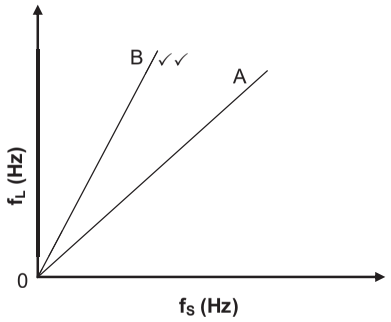
$f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_S$

$1{,}06\ f_S = \left(\frac{340 + v_L}{340}\right) f_S$ ✓

$v_L = 20{,}4\ m \cdot s^{-1}$ ✓

(5)

6.5



Marking criteria/*Nasienkriteria*	
Graph is a straight line starting at the origin./ Grafiek is 'n reguitlyn wat by die oorsprong begin.	✓
Gradient of B is greater than gradient of A./ *Gradiënt van B is groter as gradiënt van A.*	✓

(2)
[10]

QUESTION 7/VRAAG 7

7.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The magnitude of the electrostatic force exerted by one point charge on another is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓
Die grootte van die elektrostatiese krag wat een puntlading op 'n ander uitoefen, is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

7.2 Negative/*negatief* ✓ (1)

7.3



Accepted labels/*Aanvaarde byskrifte*	
F_E	$F_{electrostatic}$/ F/ $F_{M\ ON\ N}$/ electrostatic force/ F_M *$F_{elektrostaties}$/ F/ $F_{M\ OP\ N}$/ elektrostatiese krag/ F_M*
w	F_g / w/ mg/ gravitational force / F_w/ weight/ gravity F_g / w/ mg/ *gravitasiekrag*/ F_w/ *gewig*/ *swaartekrag*

Notes/*Aantekeninge*:
- Do not penalise for length of arrows./*Moenie vir lengte van die pyltjie penaliseer nie*.
- Any other additional force(s)/*Enige addisionele krag(te)*: Max/*Maks* $^1/_2$
- If arrows are omitted but correctly labelled/*Indien pyltjies weggelaat is, maar korrek benoem*: Max/*Maks* $^1/_2$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^1/_2$

(2)

7.4

Marking criteria/*Nasienkriteria*
- Correct substitution to calculate weight of M./*Korrekte vervanging om gewig van M te bereken.* ✓
- Coulomb's formula/*Coulomb se formule* ✓
- Substitute/*Vervang* $F_{net} = 0/ mg = \frac{kQ_MQ_N}{r^2}$ (equating forces)/ $0,02 = \frac{kQ_MQ_N}{r^2}$ (equating forces)✓
- Correct substitution into $\frac{kQ_MQ_N}{r^2}$/*Korrekte vervanging in* $\frac{kQ_MQ_N}{r^2}$ ✓
- Correct final answer (accept negative value)/*Korrekte finale antwoord (aanvaar negatiewe waarde)*: $2,33 \times 10^{-6}$ C to/*tot* $2,32 \times 10^{-6}$ C✓

$F_g = mg$
$= (2,04 \times 10^{-3})(9,8)$ ✓
$= 0,02$ N

$F = \frac{kQ_MQ_N}{r^2}$ ✓

$F_{net} = mg - \frac{kQ_MQ_N}{r^2}$

$0 = 0,02 - \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓

$Q_M = 2,33 \times 10^{-6}$ C ✓

IF/*INDIEN*:

$F = \frac{kQ_MQ_N}{r^2}$ ✓

$2,04 \times 10^{-3})(9,8)$ ✓✓ $= \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓

$Q_M = 2,33 \times 10^{-6}$ C ✓

(5)

7.5.1 Equal/*Gelyk* ✓

OR/*OF*
Same/*Dieselfde* (1)

7.5.2 Opposite **OR** upwards/*Teenoorgesteld* ***OF*** *opwaarts*✓ (1)

7.6 **POSITIVE MARKING FROM QUESTION 7.4.**
POSITIEWE NASIEN VANAF VRAAG 7.4.

Marking criteria/*Nasienkriteria*
- Formula for E./*Formule vir E.* ✓
- Correct substitution for M **OR** N./*Korrekte vervanging vir M* ***OF*** *N.* ✓
- Subtraction of $E_M - E_N$ **OR** $E_N - E_M$ /*Aftrekking van* $E_M - E_N$ ***OF*** $E_N - E_M$. ✓
- Correct final answer/*Korrekte finale antwoord:* $5,31 \times 10^4$ N.C^{-1} to/*tot* $5,37 \times 10^4$ N·C^{-1}✓
- Correct direction/*Korrekte rigting*: upwards/*opwaarts* ✓

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*

$E = \frac{kQ}{r^2}$ ✓

$E_{net} = \left(\frac{(9 \times 10^9)(2,33 \times 10^{-6})}{(0,4)^2}\right)$ ✓ $- \left(\frac{(9 \times 10^9)(8,6 \times 10^{-8})}{(0,1)^2}\right)$ ✓

$E_{net} = 131\ 062,5 - 77\ 400$
$= 53\ 662,5$ N·C^{-1} ✓ ($5,36 \times 10^4$ N.C^{-1}) upwards/towards M
opwaarts/na M ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*

$E_{net} = \frac{kQ}{r^2}$ ✓

$E_{net} = \left(\frac{(9 \times 10^9)(8,6 \times 10^{-8})}{(0,1)^2}\right)$ ✓ $- \left(\frac{(9 \times 10^9)(2,33 \times 10^{-6})}{(0,4)^2}\right)$ ✓

$E_{net} = 77\ 400 - 131\ 062,5$
$= -5,37 \times 10^4$ N·C^{-1}
$\therefore E_{net} = 53\ 662,5$ N·C^{-1} ✓ ($5,36 \times 10^4$ N.C^{-1}) upwards/towards M
opwaarts/na M ✓

(5)
[17]

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided temperature and all other physical conditions are constant). ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly).

OR/*OF*
The ratio of potential difference to current is constant at constant temperature.
Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided temperature and all other physical conditions are constant).
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly). (2)

NOTE/*LET WEL*
Do not award the mark for addition of 4 if any other value is added to R_p/ *Moenie die punt vir bytel van 4 toeken indien enige ander waarde by R_p bygetel word nie.*

8.2.1

OPTION 1/*OPSIE 1*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_p} = \frac{1}{1} + \frac{1}{5}$ ✓

$R_p = 0,83\ \Omega$

$R_T = 0,83 + 4$ ✓
$= 4,83\ \Omega$ ✓

OPTION2/*OPSIE2*

$R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓

$R_p = \frac{(1)(5)}{1 + 5}$ ✓

$R_p = 0,83\ \Omega$

$R_T = 0,83 + 4$ ✓
$= 4,83\ \Omega$ ✓

(4)

8.2.2 **POSITIVE MARKING FROM QUESTION 8.2.1.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1.

OPTION 1/*OPSIE 1*

$R = \frac{V}{I}$ ✓

$4,83 = \frac{V}{3,5}$ ✓

$V = 16,91\ V$ ✓ (16,92 V)

OPTION 2/*OPSIE 2*

$R_p = \frac{V_2}{I}$ ✓

$0,83 = \frac{V}{3,5}$

$V_2 = 2,91\ V$

$R_{4\Omega} = \frac{V_{4\Omega}}{I}$ ✓ Any one/*Enige een*

$4 = \frac{V_{4\Omega}}{3,5}$

$V_{4\Omega} = 14\ V$

$V_1 = V_2 + V_{4\Omega}$
$V_1 = 2,91 + 14$
$= 16,91\ V$ ✓ (16,92 V)

(3)

8.2.3 Smaller than/*Kleiner as* ✓ (1)

8.3.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

Maximum work done by the battery per unit charge. ✓✓
Maksimum arbeid verrig deur die battery per eenheidslading.

OR/*OF*
Maximum energy supplied by the battery per unit charge.
Maksimum energie verskaf deur die battery per eenheidslading.

OR/*OF*
The total amount of electric energy supplied by the battery per coulomb/per unit charge.
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheidslading. (2)

8.3.2 No/*Nee* ✓ (1)

8.3.3 The battery has internal resistance.✓
Die battery het interne weerstand.

OR/*OF*
Some energy per coulomb of charge/volts is used to overcome internal resistance.
'n Gedeelte van die energie per coulomb lading/volts word gebruik om interne weerstand te oorkom.

OR/*OF*
There is a potential drop/lost volts inside the battery.
Daar is 'n potensiaalval/verlore volts binne-in die battery.

OR/*OF*
$\varepsilon = V_{ext} + V_{int}$

OR/*OF*
$\varepsilon > V_{ext}$ (1)

8.4.1 Decreases/*Verlaag* ✓ (1)

8.4.2 Increases/*Verhoog* ✓ (1)

8.5 When the voltmeter is connected:
- No/very little current through the 1 Ω branch **OR** Branch with 1 Ω resistor is disabled/bypassed **OR** A voltmeter has a very high resistance **OR** The resistance of the parallel branch increases. ✓
- (Total) resistance of the circuit increases. ✓
- Current in circuit decreases. ✓
- $V_{internal}$/ Internal volts/ V_{lost} decreases. ✓

Therefore, external volts increase for a constant emf.

Wanneer die voltmeter geskakel word:
- *Geen/baie min stroom deur die 1 Ω-tak **OF** Tak met 1 Ω-weerstand is uitgeskakel **OF** Voltmeter het baie hoë weerstand **OF** Die weerstand van die parallelle tak neem toe.*
- *(Totale) weerstand van die stroombaan neem toe.*
- *Stroom in stroombaan neem af.*
- *V_{intern}/ Interne volts/ $V_{verlore}$ neem af.*

Dus neem die eksterne volts toe vir konstante emf. (4)
[20]

QUESTION 9/*VRAAG 9*

9.1.1 Split ring/commutator/*Splitring/kommutator* ✓ (1)

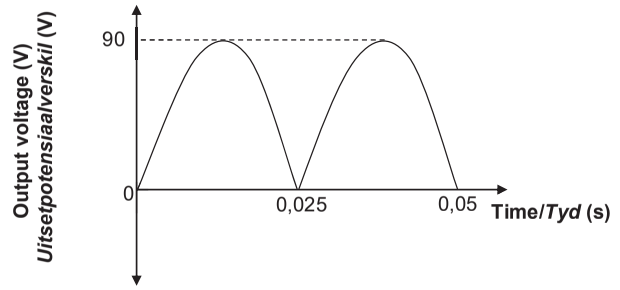
9.1.2 **Y** to/*na* **X** **OR/*OF*** 0 /no current/*geen stroom nie*✓ (1)

9.1.3 $T = \frac{1}{f}$

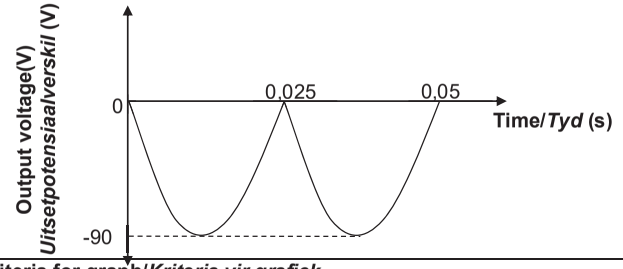
$T = \frac{1}{20}$

$T = 0{,}05$ s ✓ (1)

9.1.4 **POSITIVE MARKING FROM QUESTION 9.1.3.**
POSITIEWE NASIEN VANAF VRAAG 9.1.3.



OR/*OF*



Criteria for graph/*Kriteria vir grafiek*	
Correct shape with one full cycle./*Korrekte vorm met 1 volledige siklus.*	✓
Curve starts at zero to first peak./*Kurwe begin by nulpunt tot eerste piek.*	✓
Any one of the correct time values at the correct position./*Enige een van die korrekte tyd waardes op die korrekte posisie.*	✓
Maximum voltage of 90 V OR -90 V/ *Maksimum potensiaalverskil van 90 V OF -90 V*	✓
NOTE/*LET WEL*: - 1 mark for half cycle/incomplete cycle or more than one cycle *-1 punt vir halwe siklus/onvoltooide siklus of meer as een siklus*	

(4)

9.2

Marking criteria/*Nasienkriteria*

- Formula to calculate W_{ave} (do not penalise if subscripts are ommited)./ *Formule om W_{gem} te bereken (moenie penaliseer indien onderskrifte uitgelaat is nie).* ✓
- Substitution of 220 and 32 in correct equation. ✓ *Vervanging van 220 en 32 in die korrekte vergelyking.*
- Substitution of 120 for Δt/*Vervanging van 120 in* Δt. ✓
- Correct answer in range: 181 500 J to 181 764 J ✓ *Korrekte antwoord in gebied: 181 500 J tot 181 764 J* ✓

OPTION 1/*OPSIE 1*

$W_{ave} = \frac{V_{rms}^2 \Delta t}{R}$ ✓

$= \frac{220^2 (120)}{32}$ ✓

$= 181\ 500$ J ✓

OPTION 2/*OPSIE 2*

$R = \frac{V_{rms}}{I_{rms}}$ ✓

$32 = \frac{220}{I_{rms}}$

$I_{rms} = 6,88$ A $(6,875$ A$)$

$W_{ave} = V_{rms} I_{rms} \Delta t$ ✓
$= (220)(6,88)(120)$ ✓
$= 181\ 632$ J ✓

OR/OF

$W_{ave} = I_{rms}^2 R \Delta t$ ✓
$= (6,88)^2 (32)(120)$ ✓
$= 181\ 764,10$ J ✓

OPTION 3/*OPSIE 3*

$R = \frac{V_{rms}}{I_{rms}}$ ✓

$32 = \frac{220}{I_{rms}}$ ✓

$I_{rms} = 6,88$ A $(6,875$ A$)$

$P_{ave} = V_{rms} I_{rms}$
$= (220)(6,88)$
$= 1\ 513,6$ W
$(1,51 \times 10^3$ W$)$

$P_{ave} = I_{rms}^2 R$
$= (6,88)^2 (32)$
$= 1\ 514,7$ W $(1\ 512,5$ W$)$
$(1,51 \times 10^3$ W$)$

OPTION 4/OPSIE 4

$P_{ave} = \frac{V_{rms}^2}{R}$

$P_{ave} = \frac{220^2}{32}$ ✓

$P_{ave} = 1\ 512,5$ W
$(1,51 \times 10^3$ W$)$

$P = \frac{W}{\Delta t}$ ✓

$1\ 513,6 = \frac{W}{120}$ ✓

$W = 181\ 632$ J ✓ $(1,82 \times 10^5$ J$)$

(4)
[11]

QUESTION 10/*VRAAG 10*

10.1 Light has a particle nature/is quantized ✓
Lig het 'n deeltjie geaardheid/is gekwantiseerd (1)

10.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓
Die minimum energie (van invallende fotone) wat elektrone kan vrystel vanuit 'n metaal/oppervlak. (2)

10.3

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$
$hf = hf_0 + \frac{1}{2} m v_{max}^2$
$E = W_0 + \frac{1}{2} m v_{max}^2$
✓ Any one/ *Enige een*

$(6,63 \times 10^{-34})(5,96 \times 10^{14})$ ✓ $= 3,42 \times 10^{-19} + E_{k(max)}$ ✓
$E_{k(max)} = 5,30 \times 10^{-20}$J ✓ $(5,32 \times 10^{-20}$ J$)$ (4)

10.4 $q = I\Delta t$
$= (0,012)(10)$ ✓
$= 0,12$ C

$n = \frac{Q}{e}$

$n = \frac{0,12}{1,6 \times 10^{-19}}$ ✓✓

$n = 7,5 \times 10^{17}$ (electrons/*elektrone*)

number of photons/*aantal fotone* $= n = 7,5 \times 10^{17}$ ✓ (4)

10.5 Increases/*Verhoog* ✓

More photons strike the surface of the metal per unit time/ at a higher rate ✓ hence more (photo) electrons ejected per unit time ✓(resulting in increased current).
Meer fotone tref die oppervlak van die metaal per eenheidstyd/ teen 'n hoër tempo, gevolglik word meer (foto)elektrone per eenheidstyd vrygestel (wat tot 'n verhoogde stroom lei). (3)
[14]

TOTAL/*TOTAAL*: 150

Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2022

PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: 150

This marking guideline consists of 18 pages./
Hierdie nasienriglyn bestaan uit 18 bladsye.

QUESTION/*VRAAG* 1: MULTIPLE-CHOICE QUESTIONS/ *MEERVOUDIGEKEUSE-VRAE*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 D ✓✓ (2)

1.6 A ✓✓ (2)

1.7 C ✓✓ (2)

1.8 C ✓✓ (2)

1.9 B ✓✓ (2)

1.10 D ✓✓ (2)
[20]

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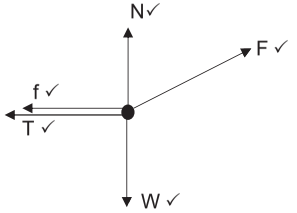
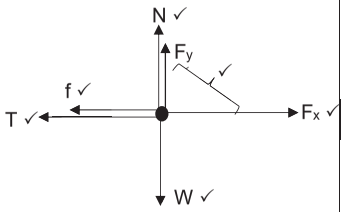
QUESTION/*VRAAG* 2

2.1 (If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase)
When a resultant/net force acts on an object, it accelerates in the direction of the force. The acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓

(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase)
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel dit in die rigting van die krag. Die versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp. (2)

2.2

OPTION 1/*OPSIE* 1	OPTION 1/*OPSIE* 2
	

Alternative labels:	***Alternatiewe byskrifte***
W / W_g / F_g	*W / W_g / F_g*
N / F_N / F_{normal}	*N / F_N / $F_{Normaal}$*
f / F_f / $F_{friction}$	*f / F_w / $F_{wrywing}$*
T / F_{string} / F_s	T / F_{tou} / F_T
F / F_{app}	F / $F_{toegepas}$

Marking criteria	***Nasienkriteria***
• Mark awarded for arrow and label. • Do not penalise for length of arrows since drawing not drawn to scale. • Any additional force(s) ¾ • If force(s) do not make. contact with the body – max. ¾.	• Punt word vir byskrif en pyltjie toegeken. • Moenie vir die lengte van die pyltjies penaliseer nie aangesien skets nie volgens skaal geteken is nie. • Enige addisionele krag(te) ¾ • Indien krag(te) nie kontak met die voorwerp maak nie – maks. ¾.

(5)

2.3.1 $f_k = \mu_k N$ ✓ Any one/*Enige een*
$f_k = \mu(mg - F\sin\theta)$ ✓
$f_k = [0,16\ (8 \times 9,8 - 55\sin 15^\circ)$ ✓] ✓
$f_k = 10,27$ N ✓ (4)

2.3.2 **Positive marking from QUESTION 2.3.1 / *Positiewe nasien vanaf VRAAG 2.3.1***

3-kg block / *blok*
$F_{net} = ma$
$T - f - F_{//} = ma$
$T - f - mg\sin\theta = ma$
$F\cos\theta - T - f = ma$
Any one ✓ *Enige een*

$T - 5 - (3 \times 9,8 \times \sin 30^\circ)$ ✓ $= 3a$

$T - 19,7 = 3a$
$T = 3a + 19,7$… (1)

8-kg block / *blok*
$F\cos\theta - T - f = ma$

$[55\cos 15^\circ - T - 10,27]$ ✓ $= 8a$
$42,8559 - T = 8a$
$42,86 - T = 8a$ … (2)

Any one/ ✓ *Enige een*

(1) = (2)
$42,86 - (3a + 19,7) = 8a$
$a = 2,11$ m.s^{-2} …(3)

(3) in (1):
$T = 19,7 + 3 \times 2,11$ ✓
$T = 26,03$ N ✓ (6)

[17]

QUESTION/*VRAAG* 3

3.1 (If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase)
Motion of an object upon which the only force acting is the force of gravity. ✓✓
(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase)
Beweging van 'n voorwerp waarop die enigste krag wat daarop inwerk, die gravitasiekrag is. (2)

3.2.1

UPWARD POSITIVE/ *OPWAARTS POSITIEF*	UPWARD NEGATIVE/ *OPWAARTS NEGATIEF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = 0^2 + 2(-9,8)(-8)$ ✓	$v_f^2 = 0^2 + 2(9,8)(8)$ ✓
$v_f = 12,52\ m.s^{-1}$ ✓	$v_f = 12,52\ m.s^{-1}$ ✓

(3)

3.2.2

UPWARD POSITIVE/*OPWAARTS POSITIEF*

$v_f = v_i + a\Delta t$
$-12,52 = 0 + (-9,8)(\Delta t)$ ✓
$\Delta t = 1,28$ s

$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
-8✓$= v_i\ (1,28-0,6) + ½(-9,8)(1,28-0,6)$ ✓

$-8 = v_i\ (0,68) + ½(-9,8)(0,68)$

$\therefore v_i = 8,43\ m.s^{-1}$ ✓

UPWARD NEGATIVE/*OPWAARTS NEGATIEF*

$v_f = v_i + a\Delta t$
$12,52 = 0 + (9,8)(\Delta t)$ ✓
$\Delta t = 1,28$ s
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
8 ✓$= v_i\ (1,28-0,6) + ½(9,8)(1,28-0,6)^2$ ✓

$8 = v_i\ (0,68) + ½(9,8)(0,68)^2$

$\therefore v_i = 8,43\ m.s^{-1}$ ✓ (5)

3.3

OPTION 1/*OPSIE* 1 **UPWARD POSITIVE/** ***OPWAARTS POSITIEF***	**UPWARD NEGATIVE/** ***OPWAARTS NEGATIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0^2 = v_i^2 + 2(-9,8)(6,5)$ ✓	$0^2 = v_i^2 + 2(9,8)(-6,5)$ ✓
$v_f = 11,29\ m.s^{-1}$ upwards/*opwaarts* ✓	$v_f = 11,29\ m.s^{-1}$ upwards/*opwaarts* ✓

OPTION 2/*OPSIE* 2
UPWARD POSITIVE/*OPWAARTS POSITIEF*
$E_{mech(f)} = E_{mech(i)}$] (Any one/*Enige een*)
$(mgh_f + ½mv_f^2) = (mgh_i + ½mv_i^2)$] ✓
$m(-9,8)(6,5) + ½m(0^2) = m(-9,8)(0) + ½m\ v_i^2$ ✓
$v_i = 11,29\ m.s^{-1}$ ✓

UPWARD NEGATIVE/*OPWAARTS NEGATIEF*
$E_{mech(f)} = E_{mech(i)}$] (Any one/*Enige een*)
$(mgh_f + ½mv_f^2) = (mgh_i + ½mv_i^2)$] ✓
$m(9,8)(-6,5) + ½m(0^2) = m(9,8)(0) + ½m\ v_i^2$ ✓
$v_i = 11,29\ m.s^{-1}$ ✓

OPTION 3/*OPSIE* 3
UPWARD POSITIVE/*OPWAARTS POSITIEF*
$W_{NC} = \Delta E_K + \Delta E_P$] Any one/*Enige een*)
$0 = (½mv_f^2 - ½mv_i^2) + (mgh_f + mgh_i)$] ✓
$0 = (½m + ½m(0^2) = m(-9,8)(6,5) + m(-9,8)\ 0$ ✓
$v_i = 11,29\ m.s^{-1}$ ✓

UPWARD NEGATIVE/*OPWAARTS NEGATIEF*
$W_{NC} = \Delta E_K + \Delta E_P$] Any one/*Enige een*)
$0 = (½mv_f^2 - ½mv_i^2) + (mgh_f + mgh_i)$] ✓
$0 = (½m\ 0^2 + ½m(v_i^2) = m(9,8)(-6,5) + m(9,8)\ 0$ ✓
$v_i = 11,29\ m.s^{-1}$ ✓

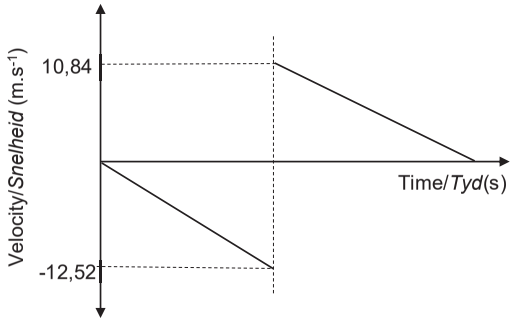
OPTION 4/*OPSIE* 4
UPWARD POSITIVE/*OPWAARTS POSITIEF*
$W_{NETT} = \Delta E_K$] Any one/*Enige een*)
$F_G.\Delta x.\cos\Theta = (½mv_f^2 - ½mv_i^2)$]
$mg.\Delta x.\cos\Theta = (½mv_f^2 - ½mv_i^2)$] ✓
$m(-9,8)(6,5)\cos 180^\circ = ½m(0^2 - v_i^2)$ ✓
$v_i = 11,29\ m.s^{-1}$ ✓

UPWARD NEGATIVE/*OPWAARTS NEGATIEF*
$W_{NETT} = \Delta E_K$] Any one/*Enige een*)
$F_G.\Delta x.\cos 0 = (½mv_f^2 - ½mv_i^2)$]
$mg.\Delta x.\cos 0 = (½mv_f^2 - ½mv_i^2)$] ✓
$m(9,8)(-6,5)\cos 180^\circ = ½m(0^2 - v_i^2)$ ✓
$v_i = 11,29\ m.s^{-1}$ ✓

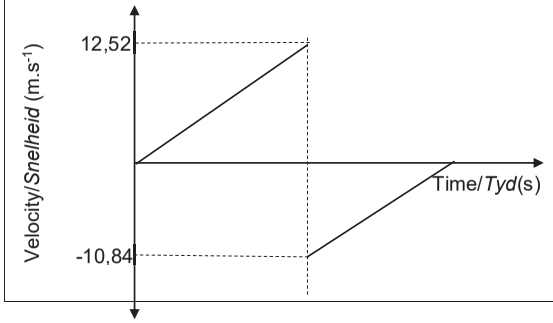
3.4

	MARKING CRITERIA/*NASIENKRITERIA*	
✓	Correct shape (Straight line)	*Korrekte vorm (Reguitlyn)*
✓	Similar gradients	*Dieselfde gradiënte*
✓	Final velocity indicated and bounce off velocity indicated	*Eindsnelheid aangedui en terugbons-snelheid aangedui*

UPWARDS POSITIVE/*OPWAARTS POSITIEF*



DOWNWARDS POSITIVE/*AFWAARTS POSITIEF*



(3)
[17]

QUESTION/*VRAAG 4*

4.1 Zero/*nul* or/ *of* 0 m.s^{-1} ✓ (1)

4.2 $\sum p_i = \sum p_f$
$m_A v_i + m_B v_i = (m_A + m_B)v_f$ } Any one/*Enige een* ✓
$52\ v_{ig} + 5 \times 0$ ✓$= (52 + 5) \times 2,4$ ✓
$v_i = 2,63$ m.s^{-1} ✓ (4)

4.3 Force of hands-on brick upwards, ✓ force of brick on hands downwards. ✓
Force of girl on earth/weight of girl downwards, ✓ force of Earth on girl upwards. ✓
Krag van hand op baksteen opwaarts, krag van baksteen op hande afwaarts. Krag van meisie op aarde/gewig van meisie afwaarts, krag van Aarde op die meisie opwaarts. (2)

4.4

OPTION 1/*OPSIE* 1	OPTION 2/*OPSIE* 2
$\Delta y = \frac{v_f + v_i}{2}\Delta t$ $2 = \frac{0+(2,4)}{2}$ ✓$\times \Delta t$ $\Delta t = 1,67$ s $F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ } Any one/*Enige een* ✓ $\underline{F_{net} \times 1,67} = (52 + 5)$ ✓$\underline{(0 - 2,4)}$ ✓ $F_{net} = -81,92$ $F_{net} = 81,92$ N ✓	$v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = 2,4^2 + 2 \times a \times 2$ ✓ $a = -1,44$ m.s^{-2} $F_{net} = ma$ ✓ $F_{net} = (52 + 5)$ ✓ $(-1,44)$ ✓ $F_{net} = -82,08$ $F_{net} = 82,08$ N ✓

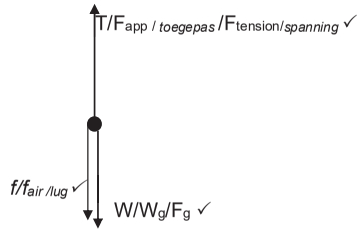
(5)
[12]

QUESTION/*VRAAG* 5

5.1 (If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase)
The net work done on an object is equal to the change in the object's kinetic energy. ✓✓
The work done on an object by a net force is equal to the change in kinetic energy of the object. ✓✓

(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase)
Die netto arbeid verrig op 'n voorwerp is gelyk aan die verandering in die kinetiese energie van die voorwerp.
Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp. (2)

5.2



(3)

5.3 Tension force (of the rope) / *Spanningskrag (van die tou)*
Air resistance / *Lugweerstand*
} Any one/*Enige een* ✓ (1)

5.4

OPTION 1/*OPSIE* 1
$W_{Fg} = F_g.\Delta x \cos\theta$ ✓ $W_{Fg} = (75 \times 9,8) \times 12 \cos 180^\circ$ ✓ $W_{Fg} = -8\ 820$ J ✓

OPTION 1/*OPSIE* 2
$W_{Fg} = -\Delta E_p$ $W_{Fg} = -[mg(h_2 - h_1)]$ $W_{Fg} = -mg\Delta h$ } Any one/*Enige een* ✓ $W_{Fg} = -[75 \times 9,8\ (12 - 0)]$ ✓ $W_{Fg} = -8\ 820$ J ✓

(3)

5.5 **Positive marking from QUESTION 5.2/*Positiewe nasien vanaf VRAAG 5.2***

OPTION 1/*OPSIE* 1
$W_{net} = \Delta E_k$ $W_f + W_F + W_{Fg} = \Delta E_k$ $f \times \Delta x \cos\theta + F\Delta x\cos\theta + F_g\Delta x\cos\theta = \Delta E_k$ } Any one/*Enige een* ✓ $1\ 540 \times 12\cos 180^\circ$ ✓ + $2\ 400 \times 12\cos 0^\circ + (-8\ 820)$ ✓ = $\frac{1}{2} \times 75 \times v_f^2 - 0$ ✓ $v_f = 6,32$ m.s^{-1} ✓

OPTION 2/*OPSIE* 2
$W_{nc} = \Delta E_p + \Delta E_k$ $W_f + W_F = \Delta E_p + \Delta E_k$ $f \times \Delta x \cos\theta + F\Delta x\cos = mg(h_2 - h_1) + \Delta E_k$ } Any one/*Enige een* ✓ $62,5 \times 24 \cos 180^\circ$ ✓ $2\ 400 \times 12 \cos 0^\circ$ ✓ = $75 \times 9,8(12 - 0) + \frac{1}{2} \times 75 \times v_f - 0$ ✓ $m = 6,32$ m.s^{-1} ✓

(5)
[14]

QUESTION/*VRAAG* 6

6.1 (If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase)
The (apparent) change in frequency observed by a listener because the listener and source of sound have different velocities relative to the medium of sound propagation ✓✓

(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase)
Die (skynbare) verandering in frekwensie wat deur 'n luisteraar waargeneem word want die luisteraar en die klankbron verskillende snelhede het relatief tot die medium wat die klank veroorsaak.

OR/*OF*

The (apparent) change in frequency observed by a listener due to relative motion between the sound source and the listener. ✓✓

Die (skynbare) verandering in die frekwensie wat 'n luisteraar waarneem as gevolg van relatiewe beweging tussen die klankbron en die luisteraar. (2)

6.2 When the source moves towards a stationary observer, the wave in front of the source is compressed ✓ resulting in a shorter wavelength and a higher frequency ✓ (speed of sound constant).
Wanneer die bron nader aan 'n stilstaande waarnemer beweeg word die golf voor die bron saamgepers wat veroorsaak dat die golflengte korter is en die frekwensie hoër is terwyl die (spoed van klank konstant bly). (2)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓
$1,02\ f_s$ ✓ $= \frac{343}{343 - v_s}$ ✓ $\times f_s$ ✓
$v_s = 6,73$ m.s^{-1} ✓
(Accept any set of values for frequency that indicates that f_L is 2% higher than f_s)
(Aanvaar enige stel waardes vir frekwensie wat aandui dat f_L 2% hoër is as f_s) (5)

6.4 $v = \lambda f$ ✓
$343 = \lambda \times 720$ ✓
$\therefore \lambda = 0,48$ m (0,476 m) ✓ (3)

6.5 Used to measure the direction and speed of blood flow in arteries and veins.
Used to measure the heartbeat of a foetus in the womb. (Any one) ✓

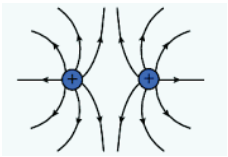
Gebruik om die rigting en spoed van bloedvloei in die are te meet.
Word gebruik om die hartklop van 'n fetus in die baarmoeder te meet.
(Enige een) (1)
[13]

QUESTION/*VRAAG* 7

7.1 (If any of the underlined key words/phrases in the correct context are omitted:
-1 mark per word/phrase)
The electrostatic force per unit positive charge placed at the point. ✓✓

(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase)
Die elektrostatiese krag per eenheid positiewe lading wat by die punt geplaas word. (2)

7.2



Marking criteria /*Nasienkriteria*		
✓	Correct shape	*Korrekte vorm*
✓	Direction of field lines	*Rigting van veldlyne*
✓	Field lines touch surface of point charge and do not cross	*Veldlyne raak oppervlakte van puntlading en kruis nie*

(3)

7.3 $E = \frac{kQ}{r^2}$ ✓

$E_1 = \frac{(9 \times 10^9)(5 \times 10^{-6})}{(0,1)^2}$ ✓

$E_1 = 4,5 \times 10^6$ N.C^{-1} left

$E_2 = \frac{(9 \times 10^9) \times Q}{(0,4)^2}$ ✓ left

$E_{net} = E_1 + E_2$

$4,70 \times 10^6 = 4,5 \times 10^6$ ✓ $+ \frac{(9 \times 10^9) \times Q}{(0,4)^2}$ ✓

$2 \times 10^5 = \frac{(9 \times 10^9) \times Q}{(0,4)^2}$ ✓

$Q_T = 3,56 \times 10^{-6}$ C ✓ (6)

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7.4

OPTION 1/*OPSIE 1*

$E = \frac{F}{q}$ ✓

$4,70 \times 10^6$ ✓ $= \frac{F}{-2 \times 10^{-6}}$ ✓

$F = - 9,4$

$F = 9,4$ N to the right ✓

OPTION 2/*OPSIE 2*

$F_E = \frac{kQ_1Q_2}{r^2}$ ✓

$F1 = \frac{(9 \times 10^9)(5 \times 10^{-6})(2 \times 10^{-6})}{(0,1)^2}$ ✓ right

$F_1 = 9$ N

$F_2 = \frac{(9 \times 10^9)(3,56 \times 10^{-6})(2 \times 10^{-6})}{(0,4)^2}$ ✓ right

$F_2 = 0,4$

$F_{net} = F_1 + F_2$

$F_{net} = 9 + 0,4$ ✓

$F_{net} = 9,4$ N to the right ✓ (4)
[15]

QUESTION/*VRAAG* 8

8.1 (If any of the underlined key words/phrases in the correct context are omitted:
-1 mark per word/phrase)
The total energy per coulomb of charge that a battery can supply. ✓✓

(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase)
Die totale energie per coulomb lading wat 'n battery kan lewer. (2)

8.2.1 1,4 V ✓ (1)

8.2.2 Gradient/*Gradiënt* $= \frac{\Delta V}{\Delta I} = \frac{1,4 - 0}{0 - 2,5}$ ✓ $= -0,56$
Gradient/*Gradiënt* $= - r = -0,56$ ✓
$r = 0,56\ \Omega$ ✓ (3)

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8.3.1 $V_{int} = \varepsilon - V$
$V_{int} = 15 - 13,5$ ✓
$V_{int} = 1,5$ V
$r = \frac{V}{I}$ ✓
$0,5 = \frac{1,5}{I}$ ✓
I = 3 A
$V_s = IR_s$
$V_s = 3 \times 3$✓ = 9 V
$V_p = 13,5 - 9 = 4,5$ V
$R = \frac{V}{I}$
$4 = \frac{4,5}{I}$ ✓
I = 1,125 A ✓ (6)

8.3.2

OPTION 1/*OPSIE 1*
Positive marking from QUESTION 8.3.1/*Positiewe nasien vanaf VRAAG 8.3.1*
I = 3 – 1,125 ✓ = 1,875 A
$R = \frac{V}{I}$
$R = \frac{4,5}{1,875}$ ✓

R = 2,4 Ω ✓

OPTION 2 / *OPSIE 2*
Positive marking from QUESTION 8.3.1/*Positiewe nasien vanaf VRAAG 8.3.1*
$V_{ext/\,eks} = I\,R_{ext/\,eks}$
$13,5 = 3 \times R_{ext/\,eks}$
$\therefore R_{ext/eks} = 4,5\ \Omega$ ✓

$R_{ext/eks} = R_p + 3$
$4,5 = R_p + 3$
$\therefore R_p = 1,5\ \Omega = \frac{3}{2}\ \Omega$ ✓

$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{4}$
$\frac{2}{3} = \frac{1}{R} + \frac{1}{4}$
$\therefore R = 2,4\ \Omega$ ✓ (3)

[15]

QUESTION/*VRAAG* 9

9.1 AC generator. ✓ It has slip rings. ✓
WS generator. Dit het sleepringe. (2)

9.2 Y to/*na* X ✓✓ (2)

9.3 9.3.1 The rms potential difference is the AC potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference. ✓✓
(If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase)

Die wgk potensiaalverskil is die WS-potensiaalverskil wat dieselfde hoeveelheid energie produseer/opwek as 'n ekwivalente GS-potensiaalverskil.
(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/frase). (2)

9.3.2 $P_{average/gem} = \frac{V^2_{rms/wgk}}{R}$ ✓
$1\,200 = \frac{220^2}{R}$ ✓

R = 40,33 Ω ✓ (3)

9.3.3 $P_{average/gem} = V_{rms/\,wgk}\, I_{rms/wgk}$ ✓
$1\,200 = I_{rms/\,wgk} \times 220$ ✓
$I_{rms/wgk} = 5,45$ A
$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓
$5,45 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓
$I_{max/maks} = 7,71$ A ✓ (5)

[14]

QUESTION/*VRAAG* 10

10.1 (If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase)
The photo-electric effect is the process where electrons are released from a (metal) surface ✓when light of appropriate frequency is shone on the surface. ✓
(Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 per woord/fase)
Die foto-elektriese effek is die proses waardeur elektrone uit 'n (metaal) oppervlak vrygestel word wanneer lig van geskikte frekwensie invallend op die oppervlak is. (2)

10.2 The minimum energy of light needed to emit (photo) electrons from a metal surface. ✓✓
Die minimum energie van lig wat nodig is om (foto) elektrone uit 'n metaal oppervlakte vry te stel. (2)

10.3

OPTION 1/*OPSIE* 1

$W_0 = \frac{hc}{\lambda_0}$ ✓

$W_0 = \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{(555 \times 10^{-9})}$ ✓

$W_0 = 3,58 \times 10^{-19}$ J ✓

OPTION 2/*OPSIE* 2

$E = W_0 + E_{k(max)/(maks)}$

$\frac{hc}{\lambda} = W_0 + E_{k(max)/(maks)}$ Any one/*Enige een* ✓

$\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{(555 \times 10^{-9})} = W_0 + 0$ ✓

$W_0 = 3,58 \times 10^{-19}$ J ✓ (3)

10.4 Increases. ✓ With light of higher intensity more photons strike the metal surface per second. Thus more (photo) electrons are emitted per second, resulting in a bigger current ✓

Neem toe. Indien die lig 'n hoër intensiteit het, sal meer fotone die metaal oppervlate per sekondes tref. Dus word meer (foto) elektrone per sekonde vrygestel wat 'n groter stroom gee. (2)

10.5 $E = W_0 + E_{k(max)/(maks)}$

$hf = W_0 + E_{k(max)/(maks)}$

$hf = W_0 + + \frac{1}{2} mv_{(max/maks)}^2$ Any one/*Enige een* ✓

$\underline{6,63 \times 10^{-34} f}$ ✓ = $\underline{3,58 \times 10^{-19}}$ ✓ + $\frac{1}{2} \times 9,11 \times 10^{-31} \times (5 \times 10^6)^2$ ✓

$f = 1,72 \times 10^{16}$ Hz ✓ (4)

[13]

TOTAL/*TOTAAL*: 150

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NATIONAL SENIOR CERTIFICATE / *NASIONALE SENIOR SERTIFIKAAT*

GRADE / *GRAAD* 12

JUNE / *JUNIE* 2022

PHYSICAL SCIENCES P1 MARKING GUIDELINE *FISIESE WETENSKAPPE V1 NASIENRIGLYN*

MARKS/ *PUNTE*: **150**

This marking guideline consists of 14 pages./
Hierdie nasienriglyn bestaan uit 14 bladsye.

QUESTION/*VRAAG 1*

1.1 C ✓✓ (2)

1.2 C ✓✓ (2)

1.3 B ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 C ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 C ✓✓ (2)

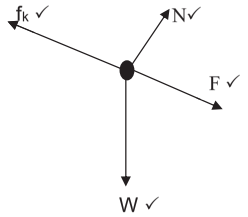
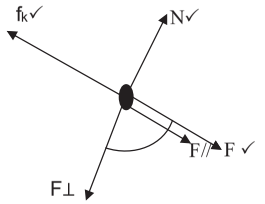
1.10 A ✓✓ (2)
[20]

QUESTION/*VRAAG 2*

2.1 When a resultant/net force acts on an object, it accelerates in the direction of the force. The acceleration is directly proportional to the force ✓and inversely proportional to the mass of the object. ✓

Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel dit in die rigting van die krag. Die versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp. (2)

2.2

OPTION 1 / *OPSIE 1*	OPTION 2 / *OPSIE 2*
	 F⊥ and / *en* F// ✓

Mark awarded for arrow and label / *Punt vir beide pyl en byskrif* toegeken.
Do not penalise for length of arrows since drawing is not drawn to scale
Moenie vir die lengte van die pyltjie penaliseer nie aangesien skets nie na skaal geteken is nie
Any other additional force(s) / *Enige ander addisionele kragte* $^3/_4$
If force(s) do not make contact with body. Max. $^3/_4$
Indien krag(te) nie met die voorwerp kontak maak nie. Maks. $^3/_4$ (4)

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2.3 The force that opposes the motion of an object and acts parallel to the surface. ✓✓

Die krag wat die beweging van 'n voorwerp teenstaan en parallel met die oppervlak inwerk. (2)

2.4.1 **OPTION 1 (Upwards on the plane is positive) / *OPSIE 1 (Teen die skuinsvlak op as positief)***

$F_{net} = ma$
$F_{net} = 0$ N
$f_k - F_R - F_{//} = 0$
$f_k - F_R - mg\sin\theta = 0$ } Any one/ *Enige een* ✓

$[f_k - 240 - \underline{(50)(9,8)\sin 12^\circ}✓] ✓ = 0$
$f_k = 341,88$ N ✓ (4)

2.4.2 **Positive marking from QUESTION 2.3 / *Positiewe nasien vanaf VRAAG 2.3***
Marking criteria / Nasienkriteria

$\mu_k = \frac{f_k}{N}$
$\mu_k = \frac{fk}{mg\ cos\ \theta}$ } Any one/ *Enige een* ✓

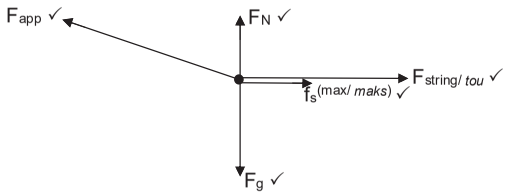
$\mu_k = [\frac{341,88}{(50\ x\ 9,8)\ cos\ 12^\circ✓}]$ ✓

$\mu_k = \underline{341,88}$
$\quad 479,29$
$\mu_k = 0,71$ ✓ (4)
[16]

QUESTION/*VRAAG* 3

3.1 Maximum static force of friction. ✓
Maksimum statiese wrywingskrag. (1)

3.2



Mark awarded for arrow and label / *Punt vir beide pyl en byskrif.*

Do not penalise for length of arrows since drawing is not drawn to scale.
Moenie vir die lengte van die pyltjie penaliseer nie aangesien nie na skaal geteken nie

Any other additional force(s) / *Enige ander addisionele krag(te)* $^4/_5$
If force(s) do not make contact with body. Max. $^4/_5$
Indien krag(te) nie met die voorwerp kontak maak nie. Maks. $^4/_5$ (5)

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3.3.1 **OPTION 1 / *OPSIE 1***

$F_{net} = ma$
$F_T - mg = ma$
$F_x - F_T - f_s^{(max)} = ma$ } Any one / *Enige een* ✓
$\underline{F_T - (5)(9,8)} = 0$ ✓
$\quad = 49$ N
$F_x = F_{app}\cos 30^\circ$
$\quad = \underline{65\cos 30^\circ}$ ✓
$\quad = 56,29$ N
$\underline{56,29 - 49} - f_s^{(max)} = 0$ ✓
$f_s^{(max)} = 7,29$ N ✓

OPTION 2/*OPSIE 2*

$F_{net} = ma$
$F_T - mg = ma$
$F_x - F_T - f_s^{(max)} = ma$ } Any one/ *Enige een* ✓
$[\underline{65\cos 30^\circ}$ ✓$- \underline{(5)(9,8)}$ ✓ $- f_s^{(max)} = 0]$ ✓
$56,29 - 49 - f_s^{(max)} = 0$
$f_s^{(max)} = 7,29$ N ✓ (5)

3.3.2 **Vertical forces on metal box are in equilibrium / *Vertikale kragte op metaalhouer is in ewewig*:**
$F_g - F_v - F_N = 0$ } Any one / *Enige een* ✓
$mg = F_{app}\sin 30^\circ - F_N$
$mg = [\underline{65\sin 30^\circ}$ ✓$- 36,1]$ ✓
$m \times 9,8 = 68,6$
$m = 7$ kg ✓ (4)
[15]

QUESTION 4 / *VRAAG 4*

4.1 There exists a force of attraction between any two masses in the universe. This force is directly proportional to the product of the masses ✓and inversely proportional to the square of the distance between their centres. ✓

Daar bestaan 'n aantrekkingskrag tussen enige twee massas in die heelal. Die krag is direk eweredig aan die produk van die massas en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

4.2 $F = \frac{Gm_1m_2}{d^2}$ ✓
$= \frac{(6,67 \times 10^{-11})(1,2 \times 10^{18})(3 \times 10^{18})}{(2 \times 10^{10})^2}$ ✓✓
$= 6,0 \times 10^6$ N ✓ (5)

4.3 LESS THAN ✓
Mass of planet P < Mass of planet Q ✓
$g \propto$ Mass

KLEINER AS

Massa van planeet P < Massa van planeet Q
$g \propto$ *Massa* (2)
[9]

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QUESTION/*VRAAG 5*

5.1 Motion of an object upon which the only force acting on it is gravitational force. ✓✓

Die beweging waartydens die enigste krag wat op 'n voorwerp inwerk, die gravitasiekrag is. (2)

5.2.1

UPWARDS IS POSITIVE / *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
$v_f = v_i + g\Delta t$ ✓ $0 = 20$ ✓ $+ (-9,8)\Delta t$ ✓ $\Delta t = 2,04$ s ✓	$v_f = v_i + g\Delta t$ ✓ $0 = -20$ ✓ $+ 9,8\Delta t$ ✓ $\Delta t = 2,04$ s ✓

(4)

5.2.2

OPTION 1 / *OPSIE 1*	
Positive marking from QUESTION 5.2.1 / *Positiewe nasien vanaf VRAAG 5.2.1*	
UPWARDS IS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
Total time / *Totale tyd* = 2,04 + 1,66 ✓ = 3,7 s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ $\Delta y = (20)(3,7)$ ✓ $+ \frac{1}{2}(-9,8)(3,7^2)$ ✓ $\Delta y = 6,92$ m ✓	Total time/ *Totale tyd* = 2,04 + 1,66 ✓ = 3,7 s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ $\Delta y = (-20)(3,7)$ ✓ $+ \frac{1}{2}(9,8)(3,7^2)$ ✓ $\Delta y = -6,919$ m $\Delta y = 6,92$ m ✓ (If answer left as negative, then loses last mark) *(As antwoord as negatief gelaat word, verloor dan laaste punt)*

OPTION 2 / *OPSIE 2*	
Positive marking from QUESTION 5.2.1 / *Positiewe nasien vanaf VRAAG 5.2.1*	
UPWARDS IS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
Time taken from B to ground *Tyd geneem van B na grond* $\Delta t = 2,04 - 1,66$ ✓ $= 0,38$ s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ $\Delta y = (20)(0,38)$ ✓ $+ \frac{1}{2}(-9,8)(0,38^2)$ ✓ $\Delta y = 6,89$ m ✓	Time taken from B to the ground *Tyd geneem van B na grond* $\Delta t = 2,04 - 1,66$ ✓ $= 0,38$ s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ $\Delta y = (-20)(0,38)$ ✓ $+ \frac{1}{2}(9,8)(0,38^2)$ ✓ $= -6,89$ m Height / *Hoogte* = 6,89 m above the ground / *bo die grond* ✓

OPTION 3 / *OPSIE 3*	**OPTION 3 / *OPSIE 3***
Positive marking from QUESTION 5.2.1 / *Positiewe nasien vanaf VRAAG 5.2.1*	
UPWARDS IS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
Calculate the maximum height: *Bereken die maksimum hoogte:* $v_f^2 = v_i^2 + 2g\Delta x$ ✓ Any one formula *Enige een formule* ✓ $0^2 = 20^2 + 2(-9,8).\Delta x$ ✓ $\Delta x = 20,41$ m Ball falls for 1,66 m / *Bal val vir 1,66 m* $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ $\Delta y = (0)(1,66) + \frac{1}{2}(-9,8)(1,66^2)$ ✓ $\Delta y = -13,05$ m Height of the balcony / *Hoogte van die balkon* = 20,41 – 13,51 ✓ Height of the balcony / *Hoogte van die balkon* = 6,91 m ✓	Calculate the maximum height: *Bereken die maksimum hoogte:* $v_f^2 = v_i^2 + 2g\Delta x$ Any one formula *Enige een formule* ✓ $0^2 = (-20)^2 + 2(9,8).\Delta x$ ✓ $\Delta x = 20,41$ m Ball falls for 1,66 m *Bal val vir 1,66 m* $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ $\Delta y = (0)(1,66) + \frac{1}{2}(9,8)(1,66^2)$ ✓ $\Delta y = 13,05$ m Height of the balcony/ *Hoogte van die balkon* = 20,41 – 13,51 ✓ Height of the balcony/ *Hoogte van die balkon* = 6,91 m ✓

(5)

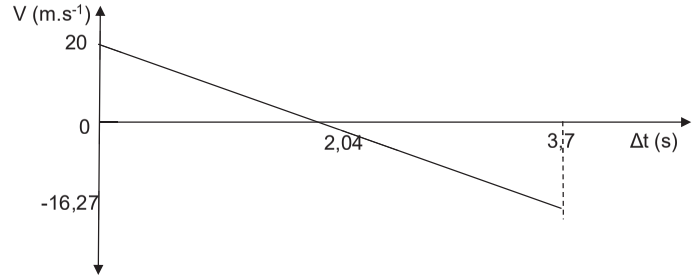
5.2.3

OPTION 1 / *OPSIE 1*	
Positive marking from QUESTION 5.2.1 / *Positiewe nasien vanaf VRAAG 5.2.1*	
UPWARDS IS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
$v_f = v_i + g\Delta t$ ✓ $v_f = 0 + (-9,8)(1,66)$ ✓ $v_f = 16,27$ m.s^{-1} ✓	$v_f = v_i + g\Delta t$ ✓ $v_f = 0 + 9,8(1,66)$ ✓ $v_f = 16,27$ m.s^{-1} ✓
OPTION 2 / *OPSIE 2*	
Positive marking from QUESTION 5.2.1/ *Positiewe nasien vanaf VRAAG 5.2.1*	
UPWARDS IS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
$v_f = v_i + g\Delta t$ ✓ $v_f = 20 + (-9,8)(3,7)$ ✓ $v_f = -16,26$ $v_f = 16,26$ m.s^{-1} ✓	$v_f = v_i + g\Delta t$ ✓ $v_f = -20 + 9,8(3,7)$ ✓ $v_f = 16,26$ m.s^{-1} ✓

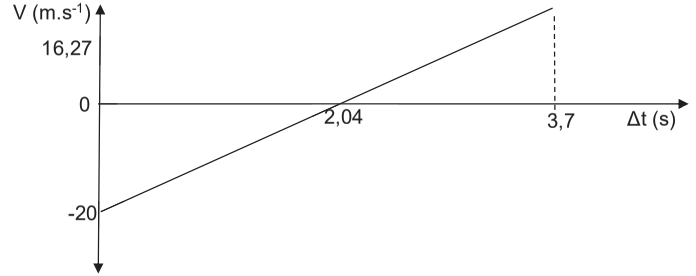
(3)

5.3 **Positive marking from QUESTION 5.2.3 / *Positief nasien vanaf VRAAG 5.2.3***

UPWARDS IS POSITIVE / *OPWAARTS AS POSITIEF*



DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF*



Marking criteria / *Nasienkriteria*	
Shape / *Vorm*	✓
Initial velocity / *Begin snelheid*	✓
Time at maximum height / *Tyd by maksimum hoogte*	✓
Velocity when man catches the ball / *Snelheid wanneer man bal vang*	✓
Time when man catches the ball / *Tyd wanneer man bal vang*	✓

(5)
[19]

QUESTION/*VRAAG 6*

6.1 The momentum of an object is the product of its mass and velocity. ✓✓
(2 or 0)

Die momentum van 'n voorwerp is die produk van sy massa en snelheid.
(2 of 0) (2)

6.2.1 $p = mv$ ✓
$p = 3200 \times 18$ ✓
$p = 56\ 700\ kg.m.s^{-1}$ ✓ (3)

6.2.2 $\Sigma p_i = \Sigma pf$ } Any one/*Enige een* ✓
$p_{Ti} + p_{Ci} = p_{Tf} + p_{Cf}$ }
$57600 + (12 \times 1800)$ ✓ $= (10 \times 3200) + 1800\ v_{Cf}$ ✓
$v_{Cf} = 26,22\ m.s^{-1}$ ✓ to the right / *regs* (or any indication of direction / *of enige aanduiding van rigting*) ✓ (5)

6.3 Inelastic. ✓(Only momentum is conserved) Kinetic energy is not conserved. ✓✓
Onelasties (Slegs momentum word behoue) Kinetiese energie is nie behoue nie. (3)

6.4 Airbags/seatbelts/Crumble zones (Any two ✓✓)
Accept headrests

Lugsakke/veiligheidsgordel/frommelsone (Enige twee)
Aanvaar hoofstutte (2)
[15]

QUESTION/*VRAAG 7*

7.1

UPWARDS IS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS IS POSITIVE / *AFWAARTS AS POSITIEF***
$v_f = v_i + g\Delta t$ ✓ $v_f = 0 + -9,8(0,35)$ ✓ $v_f = -3,43\ m.s^{-1}$ $v_f = 3,43\ m.s^{-1}$ ✓ downwards/*afwaarts* ✓	$v_f = v_i + g\Delta t$ ✓ $v_f = 0 + -9,8(0,35)$ ✓ $v_f = 3,43\ m.s^{-1}$ ✓ downwards/*afwaarts* ✓

(4)

7.2 Impulse is the product of the net force acting on an object and the time for which the net force acts on the object. ✓✓

Impuls is die produk van die netto krag wat op 'n voorwerp inwerk en die tyd wat die netto krag op die voorwerp inwerk. (2)

Positive marking from QUESTION 7.1 / *Positiewe nasien vanaf VRAAG 7.1*

7.3 $F_{net}.\Delta t = \Delta p$ } Any one / *Enige een* ✓
$F_{net}.\Delta t = mv_f - mv_i$ }
$F_{net} \times 0,69$ ✓ $= 45 \times 0 - 45 \times 3,43$ ✓
$F_{net} = 223,7\ N$ ✓ Upwards / *Opwaarts* ✓ (5)

7.4 $F_{net} = \frac{m\Delta v}{\Delta t}$

Δv remains the same. ✓
If the knees are not bent, the time to come to rest is very small (Δt decreases) ✓
F_{net} increases and can cause injury. ✓

$F_{net} = \frac{m\Delta v}{\Delta t}$
Δv bly dieselfde
As die knieë nie gebuig is nie, is die tyd om tot rus te kom baie klein (Δt verminder)
F_{netto} verhoog en kan beserings veroorsaak. (3)
[14]

QUESTION/*VRAAG* 8

8.1 In an isolated system, the total mechanical energy remains constant. ✓✓
In 'n geïsoleerde sisteem bly die totale meganiese energie konstant. (2)

8.2 $E_{mec(B)} = E_{mec(C)}$
$(E_p + E_k)_B = (E_p + E_k)_C$
$(mgh + \frac{1}{2}mv^2)_B = (mgh + \frac{1}{2}mv^2)_C$
} Any one / *Enige een* ✓
$(540)(9,8)(0) + \frac{1}{2}(540)v_B^2$ ✓$= \underline{(540)(9,8)(4,5 \sin 7,5^\circ)}$ ✓ $+ \frac{1}{2}(540)(0^2)$
$v_B = 3,39$ m.s^{-1} ✓ (4)

8.3 $f_k = \mu_k N$ ✓
$f_k = (0,8) \times (540)(9,8)$ ✓
$f_k = 4233,6$ N ✓ (3)

8.4 The net work done on an object is equal to the change in kinetic energy of the object. ✓✓

Die netto werk verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp. (2)

8.5.1 **Positive marking from QUESTION 8.2 / *Positiewe nasien van VRAAG 8.2.***
OPTION 1 / *OPSIE 1*
$W_{net} = \Delta E_k$
$W_f = \frac{1}{2}m(v_f^2 - v_i^2)$
} Any one / *Enige een* ✓
$W_f = \underline{\frac{1}{2} \times 540)(3,39)^2}$ ✓$- \underline{\frac{1}{2} \times 540(12^2)}$ ✓
$W_f = -35\,777,13$ J ✓

OPTION 2 / *OPSIE 2*
$W_{nc} = \Delta E_k + \Delta E_p$
$W_f = \frac{1}{2}m(v_f^2 - v_i^2) + 0$
} Any one / *Enige een* ✓
$W_f = \underline{\frac{1}{2} \times 540 \times 3,39^2}$ ✓$- \underline{\frac{1}{2} \times 540 \times 12^2}$ ✓
$W_f = -35\,777,13$ J ✓ (4)

8.5.2 **Positive marking from QUESTION 8.3 and 8.5.1**
Positiewe nasien vanaf VRAAG 8.3 en 8.5.1
$W_f = F_f.\Delta x.\cos\theta$ ✓
$-35777,13$ ✓$= (4233,6).\Delta x.\cos 180^\circ$ ✓
$\Delta x = 8,45$ m ✓ (4)
[19]

QUESTION/*VRAAG* 9

9.1 The change in frequency or pitch detected by a listener because the listener and the sound source have different velocity relative to the medium of sound propagation. ✓✓

Die verandering in frekwensie of toonhoogte van die klank waargeneem deur 'n luisteraar, omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het. (2)

9.2 $f_L = \frac{v \pm v_L}{v \pm v_S} . f_S$ ✓

875✓ $= \left(\frac{(340 + 0)}{(340 - v_s)}\right)$ ✓ 680 ✓

$v_s = 75,77$ m.s^{-1}

$v_s = 75,77 \times 3,6$ ✓
$v_s = 272,77$ km.h^{-1} ✓ (6)

9.3 Decreases ✓
As it moves away, wavelength increases ✓ but velocity remains constant. ✓
Frequency decreases.

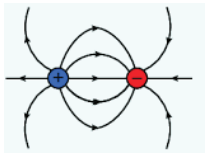
Afneem
Soos dit wegbeweeg, verleng die golflengte maar die snelheid bly konstant.
Frekwensie neem af. (3)

9.4 Measuring foetal heartbeat ✓
Monitoring and measuring of blood flow ✓

Meet fetus se hartklop
Monitering en meting van bloedvloei. (2)
[13]

QUESTION/*VRAAG* 10

10.1



Marking criteria / *Nasienkriteria*
Direction / *Rigting* ✓
Shape / *Vorm* ✓
Lines all touching charges and not crossing / *Lyne raak aan ladings en kruis nie* ✓

(3)

10.2 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9 \times 10^9)(4 \times 10^{-6})(4 \times 10^{-6})}{(0,75)^2}$ ✓ ✓

F = 0,256 N right / *regs* ✓ (4)

10.2 $Q_e = nq_e$ ✓

$4 \times 10^{-6} = n \times (1,6 \times 10^{-19})$ ✓

$n = 2,5 \times 10^{13}$ protons / *protone* ✓ (3)

[10]

TOTAL/ *TOTAAL*: 150

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basic education

Department:
Basic Education
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NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

This marking guidelines consists of 26 pages.
Hierdie nasienriglyne bestaan uit 26 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	B ✓✓	(2)
1.3	D ✓✓	(2)
1.4	B ✓✓	(2)
1.5	C ✓✓	(2)
1.6	D ✓✓	(2)
1.7	B or/*of* F✓✓	(2)
1.8	A or/*of* V_1✓✓	(2)
1.9	D ✓✓	(2)
1.10	D ✓✓	(2)
		[20]

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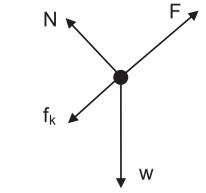
QUESTION 2/*VRAAG 2*

2.1

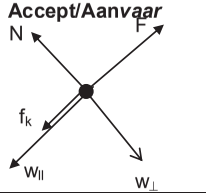
Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force/unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.
OR/*OF*
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net /unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto/ongebalanseerde krag daarop inwerk. (2)

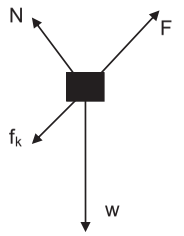
2.2



Accept/Aanvaar



Accept force diagram/
Aanvaar kragtediagram



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg /196 N / gravitational force *F_g / F_w / gewig / mg / 196 N / gravitasiekrag*
F	F_A / Applied force *F_T / Toegepaste krag*
f_k	(kinetic) Friction /*(kineties)wrywing* / F_f / f /18 N / F_w / f_w
N	F_N / Normal / *Normaal* / 169,74 N

Notes/*Aantekeninge:*
- Mark awarded for label and arrow, but penalise only once if arrows are omitted/*Punt toegeken vir benoeming en pyltjie, maar penaliseer slegs een keer indien pyle uitgelaat is.*
- Do not penalise for length of arrows, drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie, die tekening is nie volgens skaal nie.*
- Any other additional force(s) deduct 1 mark. / *Enige ander addisionele krag(te) trek 1 punt af.*
- If force(s) do not make contact with body deduct 1 mark. /*Indien krag(te) nie met die voorwerp kontak maak nie, trek 1 punt af.* (4)

2.3

OPTION 1/*OPSIE 1*
Positive up the incline/*Positief opwaarts teen skuinsvlak*
F_{net} = ma
F+ f_k + $w_{||}$ = ma
F+ (-f_k) + (-$w_{||}$) = ma
F - (f_k + $w_{||}$) = ma
✓Any one/*Enige een*
F - [18 + (20)(9,8)(sin30°)] ✓ = 0 ✓
F = 116 N ✓

NOTE/*LET WEL*
F_{net} = 0 ✓✓
F = f_k + $w_{||}$ ✓✓

OPTION 2/*OPSIE 2*
Positive up the incline/*Positief opwaarts teen skuinsvlak*
W_{net} = ΔE_k ✓
FΔxcos0° + fΔxcos180° + wΔxcos120° ✓= 0 ✓
FΔx = 18Δx + (20)(9,8)Δx(0,5)
F = 116 N ✓

NOTE/*LET WEL*
W_{net} = 0 ✓✓
FΔx = fΔx + wΔx(0,5) ✓✓ (4)

2.4 **POSITIVE MARKING FROM QUESTION 2.3 /**
POSITIEWE NASIEN VANAF VRAAG 2.3
116 N / f + $w_{||}$ ✓ Down the incline/opposite to direction of motion /*Teen die helling af / in teenoorgestelde rigting van beweging*✓

ACCEPT/*AANVAAR*:
Downwards/down/*Afwaarts/af* (2)

2.5 **POSITIVE MARKING FROM QUESTION 2.4 /**
POSITIEWE NASIEN VANAF VRAAG 2.4

OPTION 1/*OPSIE 1*
Up the incline positive/*Teen skuinsvlak op positief*
F_{net} = ma
-116 = 20a ✓
a = -5,80 m·s^{-2}

$v_f^2 = v_i^2 + 2a\Delta x$ ✓ $0 = (2)^2 + (2)(-5,8)\Delta x$✓ Δx = 0,34 m ✓	$v_f = v_i + \Delta t$ 0 = 2 + (-5,8)Δt Δt = 0,34 s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ (-116)Δt = (20)(0 – 2) Δt = 0,34 s $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= (2)(0,34) + \frac{1}{2}(-5,8)(0,34)^2$✓ = 0,34 m ✓	$v_f = v_i + \Delta t$ 0 = 2 + (-5,8)Δt Δt = 0,34 s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ (-116)Δt = (20)(0–2) Δt = 0,34 s $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{2 + 0}{2}\right)0,34$✓ = 0,34 m ✓

OPTION 1/*OPSIE 1*
Down the incline positive /*Teen skuinsvlak af positief*

$F_{net} = ma$
$116 = 20a$ ✓
$a = 5{,}80\ m{\cdot}s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓ $0 = (-2)^2 + (2)(5{,}8)\Delta x$ ✓ $\Delta x = -0{,}34$ m Distance = 0,34 m ✓ *Afstand*	$v_f = v_i + a\Delta t$ $0 = -2 + (5{,}8)\Delta t$ $\Delta t = 0{,}34$ s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ $(116)\Delta t = (20)(0 - (-2))$ $\Delta t = 0{,}34$ s $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= (-2)(0{,}34) + \frac{1}{2}(5{,}8)(0{,}34)^2$ ✓ $= -0{,}34$ m ✓ Distance/*Afstand* = 0,34 m ✓	$v_f = v_i + a\Delta t$ $0 = -2 + (5{,}8)\Delta t$ $\Delta t = 0{,}34$ s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ $(116)\Delta t = (20)(0-(-2))$ $\Delta t = 0{,}34$ s $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{-2 + 0}{2}\right)0{,}34$ ✓ $= -0{,}34$ m ✓ Distance/*Afstand* = 0,34 m ✓

OPTION 2/*OPSIE 2*
$W_{net} = \Delta E_K$
$F_{net}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(116)\Delta x\cos 180^\circ$ ✓$= \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$\Delta x = 0{,}34$ m ✓

OPTION 3/*OPSIE 3*
$W_{net} = \Delta E_K$
$W_f + W_{wll} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$f\Delta x\cos\theta + (mg\sin 30^\circ)\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(18)\Delta x\cos 180^\circ + (20)(9{,}8)\sin 30^\circ\Delta x\cos 180^\circ$ ✓$= \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$\Delta x = 0{,}34$ m ✓

OPTION 4/*OPSIE 4*
$W_{net} = \Delta E_K$
$W_f + W_w = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$f\Delta x\cos\theta + mg\Delta x\cos 120^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(18)\Delta x\cos 180^\circ + (20)(9{,}8)\Delta x\cos 120^\circ$ ✓$= \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$\Delta x = 0{,}34$ m ✓

OPTION 5/*OPSIE 5*
$W_{nc} = \Delta E_p + \Delta E_k$
$f\Delta x\cos\theta = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$18\Delta x\cos 180^\circ$ ✓ $= 20(9{,}8)\Delta x + \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$-18\Delta x = 196\Delta x\sin 30^\circ - 40$
$\Delta x = 0{,}34$ m ✓

(4)
[16]

QUESTION 3/*VRAAG 3*

3.1 No/*Nee* ✓
ANY ONE/*ENIGE EEN*:
- Gravitational force is not the only force acting on the balloon. /There are other forces acting on the balloon. ✓
  Gravitasiekrag is nie die enigste krag wat op die ballon inwerk nie./Daar is ander kragte wat op die ballon inwerk.
- Its acceleration is not 9,8 $m{\cdot}s^{-2}$/is zero.
  Sy versnelling is nie 9,8 $m{\cdot}s^{-2}$/is nul.
- It has constant velocity/no acceleration.
  Dit het 'n konstante snelheid/geen versnelling nie. (2)

3.2.1

OPTION 1/*OPSIE 1*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-62{,}68)^2 = v_i^2 + 2(-9{,}8)(-200)$ ✓ $v_i = 2{,}96\ m{\cdot}s^{-1}$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(62{,}68)^2 = v_i^2 + 2(9{,}8)(200)$ ✓ $v_i = -2{,}96\ m{\cdot}s^{-1}$ $= 2{,}96\ m{\cdot}s^{-1}$ ✓

OPTION 2/*OPSIE 2*
$(E_{mech/meg})_{200\ m} = (E_{mech/meg})_{bottom/onder}$
$(E_P + E_K)_{200\ m} = (E_P + E_K)_{bottom/onder}$ } ✓Any one/*Enige een*
$(mgh + \frac{1}{2}mv^2)_{200\ m} = (mgh + \frac{1}{2}mv^2)_{bottom/onder}$
$m(9{,}8)(200) + \frac{1}{2}m(v^2) = 0 + \frac{1}{2}m(62{,}68)^2$ ✓
$v_i = 2{,}96\ m{\cdot}s^{-1}$ ✓

NOTE/*LET WEL*
Mass may be omitted during substitution.
Massa mag uitgelaat word tydens vervanging.

OPTION 3/*OPSIE 3*
$W_{nc} = \Delta E_p + \Delta E_k$
$0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$0 = m(9{,}8)(0 - 200) + \frac{1}{2}m(62{,}68^2 - v_i^2)$ ✓
$v_i = 2{,}96\ m{\cdot}s^{-1}$ ✓

NOTE/*LET WEL*
Mass may be omitted during substitution.
Massa mag uitgelaat word tydens vervanging.

OPTION 4/*OPSIE 4*
$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$
$mg\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$m(9{,}8)(200) = + \frac{1}{2}m(62{,}68^2 - v_i^2)$ ✓
$v_i = 2{,}96\ m{\cdot}s^{-1}$ ✓

NOTE/*LET WEL*
Mass may be omitted during substitution.
Massa mag uitgelaat word tydens vervanging.

(3)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1/**
POSITIEWE NASIEN VANAF VRAAG 3.2.1

Marking criteria/*Nasienkriteria*
- Formula to calculate Δt of stone **A** ✓
  *Formule om Δt van klip **A** te bereken*
- Substitution to calculate Δt of stone **A** ✓
  *Vervanging om Δt van klip **A** te bereken*
- Final answer/*Finale antwoord*: 6,70 s ✓ **Accept/*Aanvaar:*** (6,69 to/*tot* 6,7)

NOTE: The calculation of Δt for **A** might be split up into two parts.
LET WEL: *Die berekening van Δt vir **A** kan in twee dele opgedeel word.*

OPTION 1/*OPSIE 1*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-62,68 = 2,96 + (-9,8)\Delta t$ ✓	$62,68 = -2,96 + 9,8\Delta t$ ✓
$\Delta t = 6,70$ s ✓ (6,698)	$\Delta t = 6,70$ s ✓ (6,698)
OPTION 2/*OPSIE 2*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$-200 = (2,96)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓	$200 = (-2,96)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 6,70$ s ✓ (6,697)	$\Delta t = 6,70$ s ✓ (6,697)
OPTION 3/*OPSIE 3*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-200 = \left(\frac{+2,96 + (-62,68)}{2}\right)\Delta t$ ✓	$200 = \left(\frac{-2,96 + 62,68}{2}\right)\Delta t$ ✓
$\Delta t = 6,70$ s ✓ (6,698)	$\Delta t = 6,70$ s ✓ (6,698)
OPTION 4/*OPSIE 4*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
From 200 m upwards:	From 200 m upwards:
Vanaf 200 m opwaarts:	*Vanaf 200 m opwaarts*:
$v_f = v_i + a\Delta t$ ✓	$v = v_i + a\Delta t$ ✓
$0 = 2,96 + (-9,8)\Delta t$ ✓	$0 = -2,96 + (9,8)\Delta t$ ✓
$\Delta t = 0,3$ s (0,302)	$\Delta t = 0,3$ s (0,302)
From max h downwards:	From max h downwards:
Vanaf maks h afwaarts:	*Vanaf maks h afwaarts*:
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$-62,68 = 0 + (-9,8)\Delta t$	$62,68 = 0 + (9,8)\Delta t$
$\Delta t = 6,40$ s (6,369)	$\Delta t = 6,40$ s (6,369)
$t_A = 0,3 + 6,40 = 6,7$ s ✓	$t_A = 0,3 + 6,40 = 6,7$ s ✓

OPTION 5/*OPSIE 5*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
From 200 m upwards:	From 200 m upwards:
Vanaf 200 m opwaarts:	*Vanaf 200 m opwaarts:*
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$0 = 2,96 + (-9,8)\Delta t$ ✓	$0 = -2,96 + (9,8)\Delta t$ ✓
$\Delta t = 0,3$ s (0,302)	$\Delta t = 0,3$ s (0,302)
From 200 m downwards:	From 200 m downwards:
Vanaf 200 m afwaarts:	*Vanaf 200 m afwaarts:*
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$-62,68 = -2,96 + (-9,8)\Delta t$	$62,68 = 2,96 + (9,8)\Delta t$
$\Delta t = 6,09$ s (6,094)	$\Delta t = 6,09$ s (6,094)
$t_A = 2(0,3) + 6,09 = 6,69$ s ✓	$t_A = 2(0,3) + 6,09 = 6,69$ s ✓
OPTION 6/*OPSIE 6*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$F_{net}\Delta t = m(v_f - v_i)$ ✓	$F_{net}\Delta t = m(v_f - v_i)$ ✓
$mg\Delta t = m(v_f - v_i)$	$mg\Delta t = m(v_f - v_i)$
$g\Delta t = v_f - v_i$	$g\Delta t = v_f - v_i$
$(-9,8)\Delta t = (-62,68) - (2,96)$ ✓	$(9,8)\Delta t = 62,68 - (-2,96)$ ✓
$\Delta t = 6,69$ s ✓	$\Delta t = 6,69$ s ✓

(3)

3.2.3 **POSITIVE MARKING FROM QUESTION 3.2.1 and QUESTION 3.2.2/**
POSITIEWE NASIEN VANAF VRAAG 3.2.1 en VRAAG 3.2.2

Marking criteria/*Nasienkriteria*
- Formula to calculate Δy of stone **B** ✓
  *Formule om Δy van klip **B** te bereken*
- Substitution of t = 1,7 s ✓ (t_A – 5)
  Vervanging van t = 1,7 s (t_A – 5)
- Substitution to calculate Δy of stone **B** ✓
  *Vervanging om Δy van klip **B** te bereken*
- Substitution to calculate Δy of balloon ✓
  Vervanging om Δy van ballon te bereken
- Calculating distance between balloon and stone **B** ✓
  Berekening van afstand tussen ballon en klip **B**
- Final answer/*Finale antwoord*: 14,16 m ✓ (14,11 to/*tot* 14,16)

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

Stone B/*Klip B*:

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$= \underline{2,96(6,7 - 5) + \frac{1}{2}(-9,8)(6,7 - 5)^2}$ ✓ (✓)

$= -9,13$ m (-9,09 to/*tot* -9,13)

Distance travelled by stone **B**: 9,13 m
*Afstand afgelê deur klip **B**: 9,13 m*

Hot-air balloon/*Lugballon*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= \underline{2,96(6,7 - 5)}$ ✓ + 0

$= 5,03$ m

Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B*** = $\underline{9,13 + 5,03}$ ✓

= 14,16 m ✓ (14,11 - 14,16)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

Stone B/*Klip B*:

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$= \underline{-2,96(6,7 - 5) + \frac{1}{2}(9,8)(6,7 - 5)^2}$ ✓ (✓)

$= 9,13$ m (9,09 to/tot 9,13)

Distance travelled by stone **B**: 9,13 m
*Afstand afgelê deur klip **B**: 9,13 m*

Hot-air balloon/*Lugballon*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= \underline{-2,96(6,7 - 5)}$ ✓ + 0

$= -5,03$ m

Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B*** = $\underline{9,13 + 5,03}$ ✓

= 14,16 m ✓ (14,11 - 14,16)

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

Stone B/*Klip B*:

$v_f = v_i + a\Delta t$

$= 2,96 + (-9,8)(6,70 - 5)$ (✓)

$= -13,7$ m·s^{-1}

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{(-13,7)^2 = (2,96)^2 + 2(-9,8)\Delta y}$ ✓

$\Delta y = -9,13$ m

Distance travelled by stone **B:** 9,13 m
*Afstand afgelê deur klip **B:** 9,13 m*

Hot-air balloon/*Lugballon*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= \underline{-2,96(6,70 - 5) + 0}$ ✓

$= -5,03$ m

Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13+ 5,03 ✓

= 14,16 m ✓ (14,11 - 14,16)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

Stone B/*Klip B*:

$v_f = v_i + a\Delta t$

$= -2,96 + (9,8)(6,70 - 5)$ (✓)

$= 13,7$ m·s^{-1}

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{(13,7)^2 = (-2,96)^2 + 2(9,8)\Delta y}$ ✓

$\Delta y = 9,13$ m

Distance travelled by stone **B:** 9,13 m
*Afstand afgelê deur klip **B:** 9,13 m*

Hot-air balloon/*Lugballon*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= \underline{-2,96(6,70 - 5) + 0}$ ✓

$= -5,03$ m

Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13+ 5,03 ✓

= 14,16 m ✓ (14,11 - 14,16)

OPTION 3/*OPSIE 3*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

Stone B/*Klip B*:

$v_f = v_i + a\Delta t$

$= 2,96 + (-9,8)(6,70 - 5)$ (✓)

$= -13,7$ m·s^{-1}

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \underline{\left(\frac{+2,96 + (-13,7)}{2}\right)(6,70 - 5)}$ ✓

$= -9,13$ m

Distance travelled by stone **B:** 9,13 m
*Afstand afgelê deur klip **B:** 9,13 m*

Hot-air balloon/*Lugballon*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= \underline{2,96(6,70 - 5) + 0}$ ✓

$= 5,03$ m

Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = $\underline{9,13 + 5,03}$ ✓

= 14,16 m ✓ (14,11 - 14,16)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

Stone B/*Klip B*:

$v_f = v_i + a\Delta t$

$= -2,96 + (9,8)(6,70 - 5)$ (✓)

$= 13,7$ m·s^{-1}

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \underline{\left(\frac{-2,96 + (13,7)}{2}\right)(6,70 - 5)}$ ✓

$= 9,13$ m

Distance travelled by stone **B:** 9,13 m
*Afstand afgelê deur klip **B:** 9,13 m*

Hot-air balloon/*Lugballon*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= \underline{-2,96(6,70 - 5) + 0}$ ✓

$= -5,03$ m

Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13+ 5,03 ✓

= 14,16 m ✓ (14,11 - 14,16)

OPTION 4/*OPSIE 4*

UPWARDS POSITIVE/
***OPWAARTS POSITIEF*:**
Stone B/*Klip B*:

$v_f = v_i + a\Delta t$
$= 2,96 + (-9,8)(6,70 \overset{\checkmark}{-} 5)$
$= - 13,7 \text{ m·s}^{-1}$
Balloon's height after 5 s: 214,8 m
Ballon se hoogte na 5 s: 214,8 m

$E_{mech/meg})_{214,8\ m} = (E_{mech/meg})_{1,7\ s}$
$(E_P + E_K)_{214,8\ m} = (E_P + E_K)_{1,7\ s}$ ✓
$(mgh + ½ mv^2) = (mgh + ½ mv^2)_{1,7s}$
$\underline{(9,8)(214,9) + ½(2,96)^2 =}$
$\underline{(9,8)h + ½(13,7)^2}$ ✓
$\therefore h = 205,67$ m

Distance travelled by stone **B**/
*Afstand afgelê deur klip **B**:*
214,8 – 205,67 = 9,13 m

Hot-air balloon/*Lugballon*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{2,96(6,70 - 5)}$ ✓ + 0
$= 5,03$ m
Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: $\underline{9,13 + 5,03}$ ✓ = 14,16 m ✓
(14,11 to/*tot* 14,16)

DOWNWARDS POSITIVE/
AFWAARTS POSITIEF:
Stone B/*Klip B*:

$v_f = v_i + a\Delta t$
$= -2,96 + (9,8)(6,70 \overset{\checkmark}{-} 5)$
$= 13,7 \text{ m·s}^{-13}$
Balloon's height after 5 s: 214,8 m
Ballon se hoogte na 5 s: 214,8 m

$(E_{mech/meg})_{214,8\ m} = (E_{mech/meg})_{1,7\ s}$
$(E_P + E_K)_{214,8\ m} = (E_P + E_K)_{1,7\ s}$ ✓
$(mgh + ½ mv^2) = (mgh + ½ mv^2)_{1,7s}$
$\underline{(9,8)(214,8) + ½(2,96)^2 =}$
$\underline{(9,8)h + ½(13,7)^2}$ ✓
$\therefore h = 205,67$ m

Distance travelled by stone **B**/
*Afstand afgelê deur klip **B**:*
214,8 – 205,67 = 9,13 m

Hot-air balloon/*Lugballon*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{-2,96(6,70 - 5)}$ ✓ + 0
$= -5,03$ m
Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: 9,13 + 5,03 ✓ = 14,16 m ✓
(14,11 to/*tot* 14,16)

OPTION 5/*OPSIE 5*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
Stone B/*Klip B*:

$v_f = v_i + a\Delta t$
$= 2,96 + (-9,8)(6,70 \overset{\checkmark}{-} 5)$
$= - 13,7 \text{ m·s}^{-1}$
$W_{net} = \Delta E_K$ ✓
$F_{net}\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$
$= ½m(v_f^2 - v_i^2)$
$(9,8)\Delta h\cos 0° = \underline{½(13,7^2 - 2,96^2)}$ ✓
$\Delta h = 9,13$ m

Distance travelled by stone **B**/
*Afstand afgelê deur klip **B**:* 9,13 m

Hot-air balloon/*Lugballon*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{2,96(6,70 - 5)}$ ✓ + 0
$= 5,03$ m
Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: $\underline{9,13 + 5,03}$ ✓ = 14,16 m ✓
(14,11 to/*tot* 14,16)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
Stone B/*Klip B*:

$v_f = v_i + a\Delta t$
$= -2,96 + (9,8)(6,70 \overset{\checkmark}{-} 5)$
$= 13,7 \text{ m·s}^{-1}$
$W_{net} = \Delta E_K$ ✓
$F_{net}\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$
$= ½m(v_f^2 - v_i^2)$
$(9,8)\Delta h\cos 0° = \underline{½(13,7^2 - 2,96^2)}$ ✓
$\Delta h = 9,13$ m

Distance travelled by stone **B**/
*Afstand afgelê deur klip **B**:* 9,13 m

Hot-air balloon/*Lugballon*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{-2,96(6,70 - 5)}$ ✓ + 0
$= -5,03$ m
Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: 9,13+ 5,03 ✓ = 14,16 m ✓
(14,11 to/*tot* 14,16)

OPTION 6/*OPSIE 6*
Using relative velocities/*Deur relatiewe snelhede te gebruik*:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (\overset{\checkmark}{2,96} - \overset{\checkmark}{2,96})(1,7) + \frac{1}{2}(-9,8)(\overset{\checkmark}{1,7})^2$
$= -14,16$ m
Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: 14,16 m ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (\overset{\checkmark}{2,96} - \overset{\checkmark}{2,96})(1,7) + \frac{1}{2}(9,8)(\overset{\checkmark}{1,7})^2$
$= 14,16$ m ✓

OPTION 7/*OPSIE 7*
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{(2,96)(1,7) + \frac{1}{2}(-9,8)(1,7)^2}$ ✓ ✓
$= -9,13$ m
Distance travelled by stone **B:** 9,13 m
*Afstand afgelê deur klip **B:** 9,13 m*

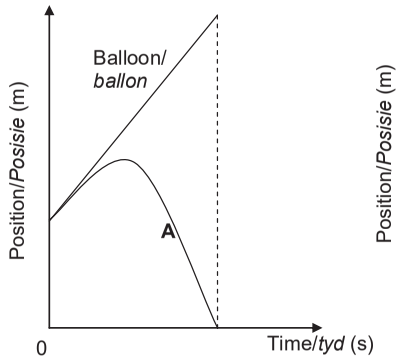
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{(-2,96)(1,7) + \frac{1}{2}(9,8)(1,7)^2}$ ✓ ✓
$= 9,13$ m

Height of stone B from the ground = 200 + 14,8 – 9,13 = 205,63 m
Hoogte van klip B vanaf die grond:
Height of balloon from the ground = 200 + (6,7)(2,96)✓ = 219,83 m
Hoogte van ballon vanaf die grond:
Distance between B and the balloon = 219,83 – 205,63 ✓ = 14,16 m✓
Afstand tussen B en die ballon:

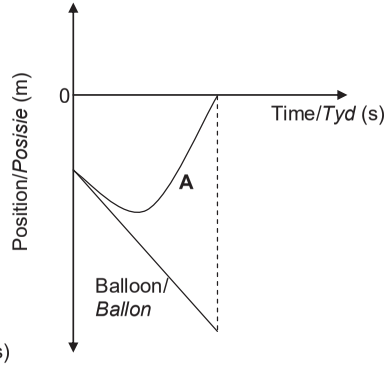
(6)

3.3

UPWARDS POSITIVE
OPWAARTS POSITIEF



DOWNWARDS POSITIVE
AFWAARTS POSITIEF



Criteria for graph/*Kriteria vir grafiek*	
Correct shape for stone **A** not starting from 0 m./*Korrekte vorm vir klip **A** wat nie by 0 m begin nie.*	✓
Correct shape and initial position for hot-air balloon. /*Korrekte vorm en aanvanklike posisie vir lugballon.*	✓
Gradient for hot-air balloon is higher than that of stone **A** until stone **A** reaches the maximum height./*Gradiënt vir lugballon is groter as dié vir klip **A** totdat klip **A** sy maksimum hoogte bereik.*	✓
Both graphs starting at the same position and ending at the same time. / *Beide grafieke begin by dieselfde posisie en eindig by dieselfde tyd.*	✓

(4)
[18]

QUESTION 4/*VRAAG 4*

4.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. */Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*
NOTE/*LET WEL*
If "total" is omitted: minus 1 mark / *Indien "totaal" uitgelaat is: minus 1 punt*

A collision in which both the total momentum and total kinetic energy are conserved.✓✓
'n Botsing waar die totale momentum en die totale kinetiese energie behoue bly.

(2)

4.2

OPTION 1/*OPSIE 1*
$\sum E_{Ki} = \sum E_{Kf}$
$\frac{1}{2}m_1v_{i1}^2 + \frac{1}{2}m_2v_{i2}^2 = \frac{1}{2}m_1v_{f1}^2 + \frac{1}{2}m_2v_{f2}^2$
$\frac{1}{2}m_xv_{ix}^2 + \frac{1}{2}m_yv_{iy}^2 = \frac{1}{2}m_xv_{fx}^2 + \frac{1}{2}m_yv_{fy}^2$ } ✓Any one/*Enige een*
$\underline{\frac{1}{2}(10)(2)^2 + \frac{1}{2}(2)v_{iy}^2}$ ✓ $= \underline{0 + 36}$ ✓
$v_y = \pm 4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes* ✓ **ACCEPT/*AANVAAR:*** left/*links*

OPTION 2/*OPSIE 2*
$E_{Ki} = \frac{1}{2} m_Y v_f^2$
$36 = \frac{1}{2}(2) v_f^2$
$v_f = 6\ m\cdot s^{-1}$

$\sum p_i = \sum p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_xv_{xi} + m_yv_{yi} = m_Xv_{xf} + m_yv_{yf}$ } ✓Any one/*Enige een*
$\underline{(10)(2) + (2)v_y}$ ✓ $= 0 + (2)(6)$ ✓
$v_y = -4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes*✓ **ACCEPT/*AANVAAR***: left/*links*

OPTION 3/*OPSIE 3*
$E_{Ki} = \frac{1}{2} m_Y v_f^2$
$36 = \frac{1}{2}(2) v_f^2$
$v_f = 6\ m\cdot s^{-1}$

$\Delta p_X = -\Delta p_Y$
$m_x(v_{xf} - v_{xi}) = -m_Y(v_{Yf} - v_{Yi})$ } ✓Any one/*Enige een*
$(10)(0 - 2)$✓ $= -(2)(6 - v_Y)$ ✓
$v_{Yf} = -4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes*✓ **ACCEPT/*AANVAAR:*** left/*links*

(5)

4.3 **POSITIVE MARKING FROM QUESTION 4.2 FOR Y; OPTIONS 1, 3 and 6**
POSITIEWE NASIEN VANAF VRAAG 4.2 VIR Y; OPSIES 1, 3 en 6

OPTION 1/*OPSIE 1*

EAST POSITIVE/*OOS POSITIEF*:
For **Y**/*Vir **Y***:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } *Enige een*
$F_{net}(0,1) = 2\{6 - (-4)\}$ ✓
$F_{net} = 200$ N ✓

WEST POSITIVE/*WES POSITIEF:*
For **Y**/*Vir **Y***:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } *Enige een*
$F_{net}(0,1) = 2(-6 - 4)$ ✓
$F_{net} = -200$ N
$F_{net} = 200$ N ✓

OPTION 2/*OPSIE 2*

EAST POSITIVE/*OOS POSITIEF*:
For **X**/*Vir **X***:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } *Enige een*
$F_{net}(0,1) = 10(0 - 2)$ ✓
$F_{net} = -200$ N
$F_{net} = 200$ N ✓

WEST POSITIVE/*WES POSITIEF*
For **X**/*Vir **X***:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } *Enige een*
$F_{net}(0,1) = 10\{0 - (-2)\}$ ✓
$F_{net} = 200$ N ✓

OPTION 3/*OPSIE 3*

EAST POSITIVE/*OOS POSITIEF*:
For **Y**/*Vir **Y***:
$v_f = v_i + a\Delta t$
$6 = -4 + a(0,1)$
$a = 100\ m{\cdot}s^{-2}$
$F_{net} = ma$ ✓
$= 2(100)$ ✓
$= 200$ N ✓

WEST POSITIVE/*WES POSITIEF*
For **Y**/*Vir **Y***:
$v_f = v_i + a\Delta t$
$-6 = 4 + a(0,1)$
$a = -100\ m{\cdot}s^{-2}$
$F_{net} = ma$ ✓
$= 2(-100)$ ✓
$= -200$ N
$F_{net} = 200$ N ✓

OPTION 4/*OPSIE 4*

EAST POSITIVE/*OOS POSITIEF*:
For **X**/*Vir **X***:
$v_f = v_i + a\Delta t$
$0 = 2 + a(0,1)$
$a = -20\ m{\cdot}s^{-2}$
$F_{net} = ma$ ✓
$= 10(-20)$ ✓
$= -200$ N
$F_{net} = 200$ N ✓

WEST POSITIVE/*WES POSITIEF*
For **X**/*Vir **X***:
$v_f = v_i + a\Delta t$
$0 = -2 + a(0,1)$
$a = 20\ m{\cdot}s^{-2}$
$F_{net} = ma$ ✓
$= 10(20)$ ✓
$F_{net} = 200$ N ✓

OPTION 5/*OPSIE 5*

EAST POSITIVE/*OOS POSITIEF*:
For **X**/*Vir **X***:

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$0 = 2 + a(0,1)$ $\quad 0 = (2)^2 + 2(-20)\Delta x$ $\quad = \left(\frac{0+2}{2}\right)(0,1)$

$a = -20\ m{\cdot}s^{-2}$ $\quad \Delta x = 0,10$ m $\quad = 0,10$ m

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos180° = ½\ (10)(0^2 - 2^2)$ ✓
$F_{net} = 200$ N ✓

OPTION 5/*OPSIE 5*
WEST POSITIVE/*WES POSITIEF*:
For **X**/*Vir **X***:

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$0 = -2 + a(0,1)$ $\quad 0 = (-2)^2 + 2(20)\Delta x$ $\quad = \left(\frac{0+(-2)}{2}\right)(0,1)$

$a = 20\ m{\cdot}s^{-2}$ $\quad \Delta x = -0,10$ m $\quad = -0,10$ m

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos180° = ½\ (10)(0^2 - 2^2)$ ✓
$F_{net} = 200$ N ✓

OPTION 6/*OPSIE 6*

EAST POSITIVE/*OOS POSITIEF*:
For **Y**/*Vir **Y***:

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$6 = -4 + a(0,1)$ $\quad (6)^2 = (-4)^2 + 2(100)\Delta x$ $\quad = \left(\frac{6-4}{2}\right)(0,1)$

$a = 100\ m{\cdot}s^{-2}$ $\quad \Delta x = 0,10$ m $\quad = 0,10$ m

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos0° = ½\ (2)(6^2 - (-4)^2)$ ✓
$F_{net} = 200$ N ✓

OPTION 6/*OPSIE 6*
WEST POSITIVE/*WES POSITIEF*:
For **Y**/*Vir **Y***:

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$-6 = 4 + a(0,1)$ $\quad (-6)^2 = (4)^2 + 2(-100)\Delta x$ $\quad = \left(\frac{-6+4}{2}\right)(0,1)$

$a = -100\ m{\cdot}s^{-2}$ $\quad \Delta x = -0,10$ m $\quad = -0,10$ m

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos0° = ½\ (2)((-6)^2 - (4)^2)$ ✓
$F_{net} = 200$ N ✓

(3)
[10]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. */Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

ACCEPT/*AANVAAR*
For isolated system:
- Closed system/*Geslote sisteem.*
- Only conservative forces act on the system/*Slegs konserwatiewe kragte werk in op die sisteem.*
- No external forces act on system/*Geen eksterne kragte werk in op die sisteem.*

The total mechanical energy in an isolated system remains constant / the same. ✓✓
Die totale meganiese energie in 'n geïsoleerde sisteem bly konstant / dieselfde.
OR/*OF*
The sum of the kinetic and gravitational potential energies in an isolated system remains constant/the same.
Die som van die kinetiese en gravitasie potensiële energie in 'n geïsoleerde/geslote sisteem bly konstant/dieselfde. (2)

5.2

NOTE/LET WEL
- Mass may be omitted during substitution. */Massa mag uitgelaat word tydens vervanging.*
- If equations of motion are used. Max 1/3 for correct answer. / *Indien bewegingsvergelykings gebruik word. Maks 1/3 vir korrekte antwoord.*

OPTION 1/*OPSIE1*
$E_{P/mech\ top/meg\ bo} = E_{Q/mech\ ground\ /meg\ grond}$
$(E_p + E_k)_{P/top/bo} = (E_p + E_k)_{Q/bottom/onder}$
$(mgh + ½mv^2)_{P/top/bo} = (mgh + ½mv^2)_{Q/bottom/onder}$ ✓Any one/*Enige een*
$(2)(9,8)(5) + 0 = 0 + ½(2)v_f^2$ ✓
$v_f = 9,90\ m{\cdot}s^{-1}$ ✓ (9,899)

OPTION 2/*OPSIE2*
$\Delta E_p + \Delta E_K = 0$
$(mgh_f - mgh_i) + ½m(v_f^2 - v_i^2) = 0$ ✓Any one/*Enige een*
$0 - (2)(9,8)(5) + ½(2)(v_f^2 - 0)$ ✓ $= 0$
$v_f = 9,90\ m{\cdot}s^{-1}$ ✓ (9,899) (3)

5.3 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VANAF VRAAG 5.2.

OPTION 1/*OPSIE 1*
$W_{net} = \Delta E_K$
$W_f = ½mv_f^2 - ½mv_i^2$
$W_N + W_f + W_w = ½mv_f^2 - ½mv_i^2$
$f\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$ ✓Any one/*Enige een*
$f(10)\cos 180°$ ✓$= ½(2)(4^2 - 9,90^2)$ ✓
$f = 8,2\ N$ ✓

OPTION 2/*OPSIE 2*
$W_{nc} = \Delta E_K + \Delta E_p$
$W_f = ½mv_f^2 - ½mv_i^2$
$W_N + W_f = ½mv_f^2 - ½mv_i^2$
$f\Delta x\cos\theta = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓Any one/*Enige een*
$f(10)\cos 180°$ ✓$= ½(2)(4^2 - 9,90^2) + 0$ ✓
$f = 8,2\ N$ ✓ (4)

5.4

LEFT NEGATIVE/*LINKS NEGATIEF*
$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$
$F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/*Enige een*
$-14 = 2(v_f - 4)$ ✓
$v_f = -3\ m{\cdot}s^{-1}$

ACCEPT/*AANVAAR*
Impulse/*Impuls* = mΔv

$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(-3)^2 - 4^2]$ ✓
$= -7\ J$ ✓

Do not penalise if +3 is substituted.
Moenie penaliseer indien +3 vervang is.

ACCEPT/AANVAAR
$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(0)^2 - (-3)^2]$ ✓
$= -9\ J$ ✓

Do not penalise if +3 is substituted.
Moenie penaliseer indien +3 vervang is.

RIGHT NEGATIVE/*REGS NEGATIEF*
$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$
$F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/*Enige een*
$14 = 2(v_f - (-4))$ ✓
$v_f = 3\ m{\cdot}s^{-1}$

ACCEPT/*AANVAAR*
Impulse/*Impuls* = mΔv

$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(3)^2 - (-4)^2]$ ✓
$= -7\ J$ ✓

Do not penalise if +4 is substituted.
Moenie penaliseer indien +4 vervang is.

ACCEPT/*AANVAAR*
$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(0)^2 - (-3)^2]$ ✓
$= -9\ J$ ✓

Do not penalise if +3 is substituted.
Moenie penaliseer indien +3 vervang is.

(5)
[14]

QUESTION 6/*VRAAG 6*

6.1 $v = f\lambda$ ✓
$340 = 680\lambda$ ✓
$\lambda = 0,5$ m ✓ (3)

6.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The change in frequency/pitch/wavelength of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓
Die verandering in frekwensie/toonhoogte/golflengte van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het.

OR/*OF*
An (apparent) change in observed/detected frequency/pitch/wavelength, as a result of the relative motion between a source and an observer (listener). ✓✓
'n (Skynbare) verandering in waargenome frekwensie/toonhoogte/golflengte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.3.1 Decreased/*Afgeneem* ✓ (1)

6.3.2 Increased/*Toegeneem* ✓ (1)

6.4 **POSITIVE MARKING FROM QUESTION 6.1 /**
POSITIEWE NASIEN VANAF VRAAG 6.1

OPTION 1/*OPSIE 1*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓

$f_L = \frac{v}{\lambda_L}$

$= \frac{340}{0,5 - 0,05}$ ✓

$= \frac{340}{0,45}$

$= 755,56$ Hz

$755,56 = \left(\frac{340 + 0}{340 - v_s}\right)$ ✓ 680 ✓

$v_s = 34\ m \cdot s^{-1}$ ✓ (33,67 - 34,04)

OPTION 2/*OPSIE 2*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓

$\frac{v}{\lambda_L} = \left(\frac{v + 0}{v - v_s}\right) f_s$

$\frac{340}{0,5 - 0,05}$ ✓ $= \left(\frac{340 + 0}{340 - v_s}\right)$ ✓ 680 ✓

$\frac{340}{0,45} = \left(\frac{340 + 0}{340 - v_s}\right) 680$

$v_s = 34\ m \cdot s^{-1}$ ✓ (33,67 - 34,04)

OPTION 3/*OPSIE 3*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓

$\frac{v}{\lambda_L} = \left(\frac{v + 0}{v - v_s}\right) \frac{v}{\lambda_s}$

$\therefore \frac{1}{\lambda_L} = \left(\frac{v + 0}{v - v_s}\right) \frac{1}{\lambda_s}$

$\frac{1}{0,5 - 0,05}$ ✓ $= \left(\frac{340 + 0}{340 - v_s}\right)$ ✓ $\frac{1}{0,5}$ ✓

$\frac{1}{0,45} = \left(\frac{340 + 0}{340 - v_s}\right) \frac{1}{0,5}$

$v_s = 34\ m \cdot s^{-1}$ ✓ (33,67 - 34,04)

OPTION 4/*OPSIE 4*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓

$v_1 = v_2$
$f_s\lambda_1 = f_L\lambda_2$
$(600)(0,5) = f_L(0,45)$ ✓
$f_L = 755,56$ Hz

$755,56 = \left(\frac{340 + 0}{340 - v_s}\right)$ ✓ 680 ✓

$v_s = 34\ m \cdot s^{-1}$ ✓ (33,67 - 34,04)

(5)
[12]

QUESTION 7/*VRAAG 7*

7.1.1 Added/*Toegevoeg* ✓ (1)

7.1.2

NOTE/*LET WEL*
Ignore signs of the charges./ *Ignoreer tekens van die ladings.*

$n = \frac{Q}{q_e}$ ✓

$= \frac{-1,95 \times 10^{-6}}{-1,6 \times 10^{-19}}$ ✓

$= 1,22 \times 10^{13}$ ✓ $(1,21875 \times 10^{13})$ (3)

7.1.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The (electrostatic) force experienced per unit positive charge placed at that point.
Die (elektrostatiese) krag per eenheid positiewe lading wat by die punt geplaas is.

NOTE/*LET WEL* (1 mark for:/*1 punt vir:*)
An electric field is a region of space in which an electric charge experiences a force.
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind. (2)

7.1.4 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9 \times 10^9)(1,95 \times 10^{-6})}{(0,5)^2}$ ✓

$= 7,02 \times 10^4\ N \cdot C^{-1}$ ✓ (3)

7.2

OPTION 1/*OPSIE 1*

Marking criteria/*Nasienkriteria:*

- Coulomb's Law formula/*Coulomb se formule* ✓
- Correct substitution for F_{q1} **OR** F_{q2} into $\frac{kQ_1Q_2}{r^2}$ ✓

  *Korrekte substitusie van F_{q1} **OF** F_{q2} in* $\frac{kQ_1Q_2}{r^2}$
- Correct substitution of 1,38 N for $F_{(net)}$/*Korrekte substitusie van 1,38 N vir $F_{(net)}$* ✓
- Subtracting (vector addition) electrostatic forces /*Aftrek (vektoraddisie) van elektrostatiese kragte* ✓
- Final answer/*Finale antwoord*: 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

$F_{E(net)} = F_{q2} + F_{q1}$

$1,38$ ✓$= \left(+\frac{kQ_1Q_2}{r^2}\right) + \left(-\frac{kQ_1Q_2}{r^2}\right)$ ✓

$1,38 = \left(+\frac{(9\times10^9)(1,95\times10^{-6})q_2}{(0,03)^2}\right) + \left(-\frac{(9\times10^9)(1,95\times10^{-6})q_2}{(0,05)^2}\right)$ ✓

q_2 = 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

OPTION 2/*OPSIE 2*

Marking criteria/*Nasienkriteria*:

- $E = \frac{kQ}{r^2}$ ✓
- Correct substitution of 7,08 x 10^5 N·C^{-1}/*Korrekte substitusie van 7,08 x10^5 N·C^{-1}* ✓
- Correct substitution for E_{q1} **OR** E_{q2} into $\frac{kQ_2}{r^2}$ ✓

  *Korrekte substitusie van E_{q1} **OF** E_{q2} in* $\frac{kQ_2}{r^2}$
- Subtracting electric fields/*Aftrek van elektriese velde* ✓
- Final answer/*Finale antwoord*: 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

$E = \frac{F}{q} = \frac{1,38}{1,95\times10^{-6}}$

= 7,08 x 10^5 N·C^{-1} (707692,30)

$E_{net} = E_{q2} + E_{q1}$

7,08 x 10^5 ✓$= \left(+\frac{kQ_2}{r^2}\right) + \left(-\frac{kQ_1}{r^2}\right)$ ✓

$= \left(+\frac{(9\times10^9)q_2}{(0,03)^2}\right) + \left(-\frac{(9\times10^9)q_1}{(0,05)^2}\right)$ ✓

q_2 = 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

(5)

[14]

QUESTION 8/*VRAAG 8*

8.1.1 12 V ✓ (1)

8.1.2 0 (V) ✓ (1)

8.2

Marking criteria/*Nasienkriteria*

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The rate at which work is done or energy is expended/transferred.

Die tempo waarteen arbeid verrig word of energie oorgedra word. (2)

8.3

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓

$5,76 = (1,2^2)R$ ✓

R = 4 Ω ✓

OPTION 2/*OPSIE 2*

P = VI

5,76 = V(1,2)

V = 4,8 V

$P = \frac{V^2}{R}$ ✓

$5,76 = \frac{(4,8)^2}{R}$ ✓

R = 4 Ω ✓

V = IR ✓

4,8 = (1,2)R ✓

R = 4 Ω ✓

(3)

8.4 **POSITIVE MARKING FROM QUESTION 8.3**

POSITIEWE NASIEN VANAF VRAAG 8.3

OPTION 1/*OPSIE 1*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{8,4}$ ✓

R_p = 3,5 Ω

R_T = 3,5 + 4 ✓

= 7,5 Ω ✓

OPTION 2/*OPSIE 2*

$R_p = \frac{R_1R_2}{R_1 + R_2}$

$R_p = \frac{(6)(8,4)}{6+8,4}$ ✓

R_p = 3,5 Ω

R_T = 3,5 + 4 ✓

= 7,5 Ω ✓

(3)

8.5 **POSITIVE MARKING FROM QUESTION 8.3**
POSITIEWE NASIEN VANAF VRAAG 8.3

CALCULATE V_P/*BEREKEN V_P*	**CALCULATE V_2/*BEREKEN V_2***
Marking criteria/*Nasienkriteria*	**Marking criteria/*Nasienkriteria***
• Formula/*Formule*: $V = IR$ ✓ • Substitution to calculate V_p / *Vervanging om V_p te bereken.*✓	• Substitution to calculate I_{branch} or ratio of R_{branch}/ *Vervanging om I_{tak} of verhouding van R_{tak} te bereken.* ✓ • Substitution to calculate V_2 / *Vervanging om V_2 te bereken.*✓ • Final Answer/*Finale antwoord:* 3 V✓
OPTION 1/*OPSIE 1* $V_p = IR$ $= (1,2)(3,5)$ ✓ $= 4,2$ V	$I = \frac{V}{R}$ $= \frac{4,2}{8,4}$ ✓ $= 0,5$ A $V_2 = IR$ ✓ $= (0,5)(6)$ ✓ $= 3$ V ✓
OPTION 2/*OPSIE 2* $P_x = VI$ $5,76 = V(1,2)$ $V_x = 4,8$ V $I_{6\Omega} = \frac{8,4}{14,4} \times 1,2$ $= 0,7$ A $V_{6\Omega} = IR$ $= (0,7)(6)$ ✓ $= 4,2$ V	**OR/*OF***
OPTION 3/*OPSIE 3* $\varepsilon = I(R + r)$ $12 = 1,2(7,5 + r)$ $r = 2,5\ \Omega$ $V_p = 12 - 1,2(2,5 + 4)$ ✓$= 4,2$ V	$R_{2,4} : R_6 = 2,4 : 6$ ✓ $= 2 : 5$ $V_{2,4} : V_6 = 1,2 : 3$ ✓✓ $V_2 = 3$ V ✓
CALCULATION OF $I_{8,4\Omega}$ AND V_2/*BEREKENING VAN $I_{8,4\Omega}$ EN V_2* **OPTION 4/*OPSIE 4*** $I_{8,4\Omega} = \left(\frac{6}{14,4}\right)(1,2)$ **OR/*OF*** $\left(\frac{3,5}{8,4}\right)(1,2)$ $= 0,5$ A ✓✓ $V_2 = IR$ ✓ $= (0,5)(6)$ ✓ $= 3$ V ✓	
OPTION 5/*OPSIE 5* $V_x = IR$ $= (1,2)(4)$ $= 4,8$ V $V_{ext} = IR_{ext}$ $= (1,2)(7,5)$ $= 9$ V $V_p = 9 - 4,8$✓ $= 4,2$ V $V_{8,4\Omega} = IR$ $4,2 = I(8,4)$✓ $I = 0,5$ A $V_2 = IR$ ✓ $= (0,5)(6)$ ✓ $= 3$ V ✓	

(5)

8.6 Decreases/*Neem af* ✓
Total resistance decreases. / *Totale weerstand neem af.* ✓
Current increases. /*Stroom neem toe.* ✓
$V_{internal}$ /Internal voltage ("lost volts") increases. /*Interne potensiaalverskil neem toe.* ✓
$V_{external}$ /external voltage decreases. /Eksterne potensiaalverskil neem af.

NOTE/*LET WEL*
Do not penalise if "total" is omitted. / *Moenie penaliseer indien "totaal" uitgelaat is nie.* (4)
[19]

QUESTION 9/*VRAAG 9*

9. 1 Slip rings/*Sleepringe* ✓

ACCEPT/*AANVAAR*
Split ring/slip ring commutator /*splitring/sleepring kommutator* (1)

9. 2 Y to/*na* X ✓✓ (2)

9.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The AC potential difference which dissipates the same amount of energy as an equivalent DC potential difference.
Die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke GS-potensiaalverskil.

ACCEPT/*AANVAAR*
The DC potential difference which dissipates the same amount of energy as an equivalent AC potential difference.
Die GS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke WS-potensiaalverskil. (2)

9.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ $= \frac{100}{\sqrt{2}}$ ✓ $= 70,71$ V $I_{rms/wgk} = \frac{V_{rms/wgk}}{R}$ ✓ $= \frac{70,71}{25}$ ✓ $= 2,83$ A ✓ **ACCEPT/*AANVAAR*** If subscipts omitted in $V = IR$ *Indien onderskrifte uitgelaat is in $V = IR$*	$I_{max/maks} = \frac{V_{max/maks}}{R}$ $= \frac{100}{25}$ ✓ $= 4$ A $I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓ $= \frac{4}{\sqrt{2}}$ ✓ $= 2,83$ A ✓	$P_{ave} = \frac{V_{rms}^2}{R}$ $= \frac{\frac{100^2}{\sqrt{2}}}{25}$ ✓ $= 200$ W $P_{ave} = V_{rms}I_{rms}$ ✓ $200 = \left(\frac{100}{\sqrt{2}}\right)I_{rms}$ ✓ $I_{rms} = 2,83$ A ✓

(4)

9.5 **POSITIVE MARKING FROM QUESTION 9.4 /**
POSITIEWE NASIEN VANAF VRAAG 9.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P_{ave/gem} = \frac{V^2_{rms/wgk}}{R}$ ✓ $= \frac{70{,}71^2}{25}$ ✓ = 200,00 W ✓ (200 W)	$P_{ave} = V_{rms}I_{rms}$ ✓ = (70,71)(2,83) ✓ = 200,11 W ✓	$P_{ave/gem} = I^2_{rms/wgk}R$ ✓ = $(2{,}83)^2(25)$ ✓ = 200,22 W ✓

OPTION 4/*OPSIE 4*

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$2{,}83 = \frac{I_{max}}{\sqrt{2}}$

$I_{max/maks} = 4$ A

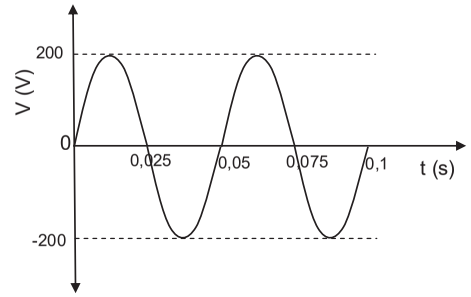
$P_{ave/gem} = \frac{V_{max/maks}I_{max/maks}}{2}$ ✓

$= \frac{(100)(4)}{2}$ ✓

= 200 W ✓

(3)

9.6



Marking criteria/*Nasienkriteria*
- 2 waves ✓
  2 golwe
- Period of wave is 0,05 s ✓
  Periode van golf is 0,05 s
- Amplitude = 200 V ✓

(3)
[15]

QUESTION 10/*VRAAG 10*

10.1 **Marking criteria/*Nasienkriteria***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The minimum frequency of light needed to eject electrons from a metal / surface. ✓✓
Minimum frekwensie van lig benodig om elektrone vanaf 'n metaal / oppervlak vry te stel.

(2)

10.2 Greater than/*Groter as* ✓✓ (2)

10.3

OPTION 1/*OPSIE 1*

$E = W_o + E_{k(max)}$ ✓

$f_x = (\frac{1}{6{,}63 \times 10^{-34}})$ ✓$(23{,}01 \times 10^{-19})$ ✓ + $10{,}40 \times 10^{14}$ ✓

$= 4{,}51 \times 10^{15}$ (Hz)✓ $(45{,}1 \times 10^{14}$ Hz)

OPTION 2/*OPSIE 2*

$m = \frac{1}{h}$ ✓

$\frac{f_x - 10{,}4 \times 10^{14}}{23{,}01 \times 10^{-19} - 0}$ ✓ $= \frac{1}{6{,}63 \times 10^{-34}}$ ✓

$f_x = 4{,}51 \times 10^{15}$ (Hz) ✓ $(45{,}1 \times 10^{14}$ Hz)

OPTION 3/*OPSIE 3*

$E = W_o + E_{k(max)}$ ✓

$hf = hf_0 + E_{k(max)}$

$6{,}63 \times 10^{-34} f_x$ ✓$= (6{,}63 \times 10^{-34})(10{,}40 \times 10^{14})$✓$+ 23{,}01 \times 10^{-19}$ ✓

$f_x = 4{,}51 \times 10^{15}$ (Hz)✓ $(45{,}1 \times 10^{14}$ Hz)

(5)

10.4

10.4.1 No effect/*Geen effek nie* ✓ (1)

10.4.2 Increases/*Verhoog* ✓ (1)

10.4.3 No effect/*Geen effek* nie ✓ (1)
[12]

TOTAL/*TOTAAL*: 150

Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2021

PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: **150**

This marking guideline consists of 17 pages./
Hierdie nasienriglyn bestaan uit 17 bladsye.

QUESTION/*VRAAG* 1: MULTIPLE-CHOICE QUESTIONS/ *MEERVOUDIGEKEUSE-VRAE*

1.1	C ✓✓	(2)
1.2	A ✓✓	(2)
1.3	B ✓✓	(2)
1.4	D ✓✓	(2)
1.5	D ✓✓	(2)
1.6	C ✓✓	(2)
1.7	A ✓✓	(2)
1.8	C ✓✓	(2)
1.9	D ✓✓	(2)
1.10	B ✓✓	(2)
		[20]

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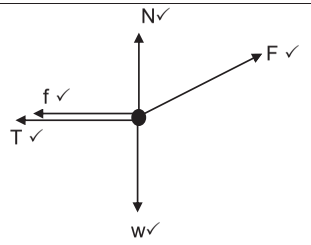
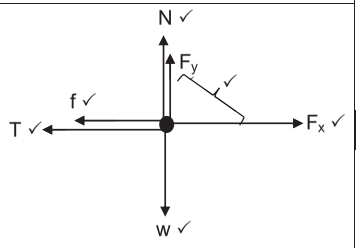
QUESTION/*VRAAG* 2

2.1.1 When a (non-zero) resultant/net force acts on an object, it accelerates in the direction of the force. The acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
Indien 'n (nie-nul) resultante/netto krag op 'n voorwerp inwerk, versnel dit in die rigting van die krag. Die versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp. ✓✓ (2)

2.1.2

OPTION/*OPSIE* 1	OPTION/*OPSIE* 2
	

(5)

Accept the following symbols./*Aanvaar die volgende simbole*:	
N ✓	F_N/Normal/*Normaal*/Normal force/*Normaalkrag*
f ✓	F_f/ f_k / f_r/ frictional force/*wrywingskrag*/kinetic frictional force / *kinetiese wrywingskrag*
w ✓	$F_{g,}$/mg/weight/$F_{Earth\ on\ block}$/49 N/gravitational force/g*ewig/*$F_{aarde\ op\ blok}$/ *gravitasiekrag*
T ✓	Tension / *Spanning* / F_T / F_s
$F_{applied/toegepas}$ ✓	F / F_A / Applied force / *Toegepaste krag*

Marks awarded for arrow and label/*Punte toegeken vir pyltjie en byskrif.*

Do not penalise for length of arrows since drawing is not drawn to scale.

Moenie penaliseer vir pyltjie-lengtes nie (diagram is nie volgens skaal nie).

Any other additional force(s)/*Enige addisionele krag(te)* $\frac{3}{4}$

If force(s) do not make contact with body. Max./*Maks.* $\frac{3}{4}$

Indien krag(te) nie kontak maak met voorwerp nie.

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2.1.3

OPTION/*OPSIE* 1 (To the right is positive) (*Na regs positief*)	OPTION/*OPSIE* 2 (To the right is negative) (*Na regs negatief*)
F_{net} = ma T – f = ma Fcosθ - T – f = ma Any one / *Enige een* ✓ T – 10 = 2 (2)✓ T = 14 N Fcosθ - T – f = ma Fcos20° – 14 – 15 ✓= 5(2) ✓ F = 41,50 N ✓	F_{net} = ma f – T = -ma T + f – Fcosθ = -ma Any one ✓ / *Enige 1* 10 – T = 2(-2) ✓ T = 14 N T + f – Fcosθ = -ma 14 + 15 -Fcos20° ✓= 5(-2) ✓ F = 41,50 N ✓

(5)

2.2

$$F = \frac{Gm_1m_2}{d^2} \checkmark$$

$$1\,842{,}50 \checkmark = \frac{(6{,}67\times10^{-11})(5{,}98\times10^{24})(200)}{d^2} \checkmark$$

d = 6 579 982,80 m

distance above earth surface/*afstand bo die aardoppervlak* =
6 579 982,80 – 6,38 x 10^6 ✓
= 199 982,80 m (1,9998280 x 10^5 m / 2,00 x 10^5 m) ✓ (5)
[17]

QUESTION/*VRAAG* 3

3.1.1 **OPTION/*OPSIE* 1**

UPWARDS POSITIVE *OPWAARTS POSITIEF*	UPWARDS NEGATIVE *OPWAARTS NEGATIEF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-25)^2 = (-20)^2 + 2(-9,8)\,\Delta y$ ✓ Δy = -11,48 Δy = 11,48 m ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(25)^2 = (20)^2 + 2(9,8)\,\Delta y$ ✓ Δy = 11,48 m ✓

OPTION/*OPSIE* 2

UPWARDS POSITIVE *OPWAARTS POSITIEF*	UPWARDS NEGATIVE *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ -25 = -20 + (-9,8)(Δt) Δt = 0,51 s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ Δy = (-20)(0,51) + ½(-9,8)(0,51)² ✓ Δy = -11,47 Δy = 11,47 m ✓	$v_f = v_i + a\Delta t$ 25 = 20 + (9,8)(Δt) Δt = 0,51 s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ Δy = (20)(0,51) + ½(9,8)(0,51)² ✓ Δy = 11,47 m ✓

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OPTION/*OPSIE* 3	
UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ $-25 = -20 + (-9,8)(\Delta t)$ $\Delta t = 0,51$ s $\Delta y = \frac{v_f + v_i}{2}\ \Delta t$ ✓ $\Delta y = \frac{-25+(-20)}{2}$ x 0,51✓ $\Delta y = -11,48$ m $\Delta y = 11,48$ m ✓	$v_f = v_i + a\Delta t$ $25 = 20 + (9,8)(\Delta t)$ $\Delta t = 0,51$ s $\Delta y = \frac{v_f + v_i}{2}\ \Delta t$ ✓ $\Delta y = \frac{25+20}{2}$ x 0,51✓ $\Delta y = 11,48$ m ✓

OPTION/*OPSIE* 4 (ACCEPT/*AANVAAR*)	
UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ $-25 = -20 + (-9,8)(\Delta t)$ $\Delta t = 0,51$ s $\Delta y = lb + ½bh$ ✓ $\Delta y = 20 \times 0,51 + ½(5)0,51$ ✓ $\Delta y = 11,48$ m ✓	$v_f = v_i + a\Delta t$ $25 = 20 + (-9,8)(\Delta t)$ $\Delta t = 0,51$ s $\Delta y = lb + ½bh$ ✓ $\Delta y = 20 \times 0,51 + ½(5)0,51$ ✓ $\Delta y = 11,48$ m ✓

(3)

3.1.2

UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ ✓ $-25 = -20 + (-9,8)(\Delta t)$ ✓ $\Delta t = 0,51$ s (time to reach to ground) *(tyd om die grond te bereik)* $v_f = v_i + a\Delta t$ $0 = 12 + (-9,8)(\Delta t)$ ✓ $\Delta t = 1,22$ s (time to reach maximum height) *(tyd om maks hoogte te bereik)* $t = 1,22 + 0,51$ ✓ $t = 1,73$ s ✓	$v_f = v_i + a\Delta t$ ✓ $25 = 20 + (-9,8)(\Delta t)$ ✓ $\Delta t = 0,51$ s (time to reach to ground) *(tyd om die grond te bereik)* $v_f = v_i + a\Delta t$ $0 = -12 + (9,8)(\Delta t)$ ✓ $\Delta t = 1,22$ s (time to reach maximum height) *(tyd om maks hoogte te bereik)* $t = 1,22 + 0,51$ ✓ $t = 1,73$ s ✓

(5)

3.1.3

OPTION/*OPSIE* 1	
Positive marking from 3.1.1/*Positiewe merk vanaf 3.1.1*	
UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = 12^2 + 2(-9,8)\ \Delta y$ ✓ $\Delta y = 7,35$ m Displacement = $\underline{-11,48}$ + 7,35 ✓ *Verplasing* = - 4,13 = 4,13 m (downwards/*afwaarts)* ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = -12^2 + 2(9,8)\ \Delta y$ ✓ $\Delta y = -7,35$ m Displacement = $\underline{11,48}$ + (- 7,35) ✓ *Verplasing* = 4,13 m (downwards/*afwaarts)* ✓

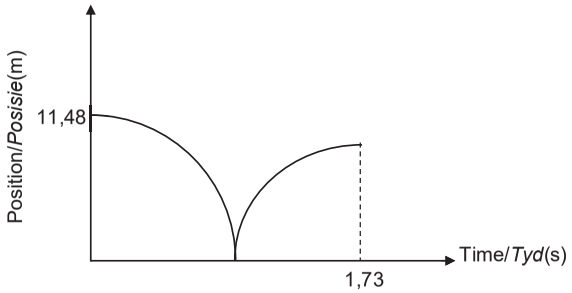
OPTION/*OPSIE* 2	
Positive marking from 3.1.1/*Positiewe merk vanaf 3.1.1*	
UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ $0 = 12 + (-9,8)(\Delta t)$ $\Delta t = 1,22$ s $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ $\Delta y = 12 \times 1,22 + ½(-9,8)(1,22)^2$ ✓ $\Delta y = 7,35$ m Displacement = $\underline{-11,48}$ + 7,35 ✓ *Verplasing* = - 4,13 = 4,13 m (downwards/*afwaarts)* ✓	$v_f = v_i + a\Delta t$ $0 = -12 + (9,8)(\Delta t)$ $\Delta t = 1,22$ s $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ $\Delta y = (-12)(1,22) + ½(9,8)(1,22)^2$ ✓ $\Delta y = -7,35$ Displacement = $\underline{11,48}$ + (- 7,35) ✓ *Verplasing* = 4,13 m (downwards/*afwaarts)* ✓

OPTION/*OPSIE* 3	
Positive marking from 3.1.1 / *Positiewe merk vanaf 3.1.1*	
UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ $0 = 12 + (-9,8)(\Delta t)$ $\Delta t = 1,22$ s $\Delta y = \frac{v_f + v_i}{2}\ \Delta t$ ✓ $\Delta y = \frac{0+(12)}{2} \times 1,22$ ✓ $\Delta y = 7,32$ m Displacement = $\underline{-11,48}$ + 7,32 ✓ *Verplasing* = - 4,16 = 4,16 m (downwards/*afwaarts)* ✓	$v_f = v_i + a\Delta t$ $0 = -12 + (9,8)(\Delta t)$ $\Delta t = 1,22$ s $\Delta y = \frac{v_f + v_i}{2}\ \Delta t$ ✓ $\Delta y = \frac{0+(-12)}{2} \times 1,22$ ✓ $\Delta y = -7,32$ m Displacement = $\underline{11,48}$ + (- 7,32) ✓ *Verplasing* = 4,16 m (downwards/*afwaarts)* ✓

OPTION/*OPSIE* 4	
Positive marking from 3.1.1 / *Positiewe merk vanaf 3.1.1*	
UPWARDS POSITIVE *OPWAARTS POSITIEF*	**UPWARDS NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ $0 = 12 + (-9,8)\Delta t$ $\Delta t = 1,22$ s Area/*oppervlakte* = ½bh ✓ = ½ (1,22)(12) ✓ = 7,32 m Displacement = $\underline{-11,48}$ + 7,32 ✓ *Verplasing* = - 4,16 = 4,16 m (downwards/*afwaarts)* ✓	$v_f = v_i + a\Delta t$ $0 = -12 + (9,8)\Delta t$ $\Delta t = 1,22$ s Area/*oppervlakte* = ½bh ✓ = ½ (1,22)(-12) ✓ = -7,32 m Displacement = $\underline{11,48}$ + (- 7,32) ✓ *Verplasing* = 4,16 m (downwards/*afwaarts)* ✓

(4)

3.2 **Positive marking from 3.1.1 and 3.1.2 / *Positiewe merk vanaf 3.1.1 en 3.1.2***



CRITERIA FOR MARKING/*MERK KRITERIA*	
Correct shape/*Korrekte vorm*	✓
Height indicated/*Hoogte aangedui* (11,48 m)	✓
Time t indicated/*Tyd t aangedui* (1,73 s)	✓

(3)
[15]

QUESTION/*VRAAG* 4

4.1 In an isolated system total linear momentum is conserved. ✓✓
Die totale lineêre momentum bly behoue in 'n geïsoleerde/geslote sisteem. (2)

4.2.1 $\sum p_i = \sum p_f$
$m_A v_{iA} + m_B v_{iB} = (m_A + m_B)v_f$ ✓ Any one/*Enige een* ✓

$(2 \times v_{iA}) + (4 \times -5)$ ✓$= (2+4)(-1,67)$ ✓
$v_{iA} = 4,99\ m.s^{-1}$ (East/*Ooswaarts*) ✓

(4)

4.2.2

POSITIVE MARKING FROM 4.2.1/*Positiewe merk vanaf 4.2.1*	**POSITIVE MARKING FROM 4.2.1/*Positiewe merk vanaf 4.2.1***
OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
$F_{net}.\Delta t = \Delta p$ $F_{net}.\Delta t = m(v_f - v_i)$ ✓ Any one /*Enige een* ✓	$F_{net}.\Delta t = \Delta p$ $F_{net}.\Delta t = m(v_f - v_i)$ ✓ Any one /*Enige een* ✓
$F_{net} \times 0,01$✓ $= 2\ (-1,67 - 4,99)$ ✓	$F_{net} \times 0,01$✓ $= 2\ [1,67 - (-4,99)]$ ✓
$F_{net} = -1\ 332$ N	$F_{net} = -1\ 332$ N
F_{net} = 1 332 N west/left/*Wes/links* ✓	F_{net} = 1 332 N west/left/*Wes/links* ✓

OPTION/*OPSIE* 3	**OPTION/*OPSIE* 4**
$F_{net} = ma$ $F_{net} = m\left(\frac{v_f - v_i}{\Delta t}\right)$ Any one /*Enige een* ✓	$F_{net} = ma$ $F_{net} = m\left(\frac{v_f - v_i}{\Delta t}\right)$ Any one /*Enige een* ✓
$F_{net} = 2 \times \left(\frac{-1,67 - 4,99}{0,01}\right)$ ✓✓	$F_{net} = 2 \times \left(\frac{1,67 - (-4,99)}{0,01}\right)$ ✓✓
$F_{net} = -1\ 332$	F_{net} = 1 332 N west/left/*Wes/links* ✓
F_{net} = 1 332 N west/left/*Wes/links* ✓	

OPTION 5/*OPSIE* 5	**OPTION 6/*OPSIE* 5**
$F_{net}.\Delta t = \Delta p$ $F_{net}.\Delta t = m(v_f - v_i)$ Any one ✓/Enige een	$F_{net}.\Delta t = \Delta p$ $F_{net}.\Delta t = m(v_f - v_i)$ Any one ✓/Enige een
$F_{net}(0,01)$ ✓ $= 4(-1,67 - -5)$ ✓	$F_{net}(0,01)$ ✓ $= 4(1,67 - 5)$ ✓
$F_{net} = 1\ 332$	$F_{net} = -1\ 332$
$F_{AB} = -F_{BA}$	$F_{AB} = -F_{BA}$
$F_{net(BA)}$ = 1 332 N west/left ✓	$F_{net(BA)}$ = 1 332 N west/left ✓

(4)
[10]

QUESTION/*VRAAG* 5

5.1 Gravitational force / *Gravitasiekrag* ✓ (1)

5.2 $\Delta x = \frac{12}{\sin 30^o}$ ✓ $= 24$ m
$W_f = f.\Delta x \cos\theta$ ✓
$W_f = 35,5 \times 24 \cos 180^o$ ✓
$W_f = -852$ J ✓ (4)

5.3 Zero/0 J ✓ (1)

5.4 **Positive marking from 5.2/*Positiewe merk vanaf 5.2***

OPTION/*OPSIE* 1

$W_{net} = \Delta E_k$
$W_f + W_F + W_{Fg} = \Delta E_k$ } Any one/*Enige een* ✓
$f \times \Delta x \cos\theta + F\Delta x \cos\theta + mg(h_2 - h_1) = \Delta E_k$

-852 ✓ + $(62,5 \times 24 \cos 180^o)$ ✓ + $m(9,8)(12-0)$ ✓ = 0
m = 20 kg ✓

OPTION/*OPSIE* 2

$W_{nc} = \Delta E_p + \Delta E_k$
$W_f + W_F = \Delta E_p + \Delta E_k$ } Any one/*Enige een* ✓
$f\Delta x \cos\theta + F\Delta x \cos = mg(h_2 - h_1) + \Delta E_k$

-852 ✓+ $(62,5)(24)\cos 180^o$ ✓= $m(9,8)(0 - 12)$ ✓+ 0
m = 20 kg ✓

OPTION 3/*OPSIE* 3

$W_{net} = \Delta E_k$
$W_f + W_F + W_w = \Delta E_k$ } Any one/*Enige een* ✓
$f\Delta x \cos\theta + F\Delta x \cos\theta + mg\Delta x \cos\theta = \Delta E_k$

-852 ✓ + $(62,5)(24)\cos 180^o$ ✓ + $m(9,8)(24)\cos 60^o$ ✓ = 0
m = 20 kg ✓ (5)

[11]

QUESTION/*VRAAG* 6

6.1.1 520 Hz / 520 waves per second (waves.s^{-1})/*golwe per sekondes (golwe.s^{-1})* ✓ (1)

6.1.2 The change in frequency ✓(or pitch) observed/detected by a listener because the listener and the sound source have different velocities relative to the medium of sound propagation. ✓
Die verandering in frekwensie ✓ (of toonhoogte) waargeneem deur 'n luisteraar want die luisteraar en die klankbron het verskillende snelhede relatief tot die medium wat klank voortplant. ✓

OR/*OF*

The (apparent) changed in observed/detected frequency (pitch) as a result of relative motion between the sound source and the listener. ✓ ✓
Die waarskynlike verandering in die waargenome frekwensie (toonhoogte) as gevolg van die relatiewe beweging tussen die klankbron en die luisteraar. ✓✓ (2)

6.1.3 TOWARDS ✓ Detected frequency is higher than the source frequency ✓
NA. ✓ *Waargenome frekwensie is hoër as die bron se frekwensie* ✓ (2)

6.1.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

520 ✓ $= \left(\frac{343}{343 - v_s}\right)$ ✓ (480) ✓

$v_s = 26,38\ m \cdot s^{-1}$ ✓ (5)

6.1.5 Decreases/*Neem af* ✓
For a constant velocity/speed of sound, if the frequency increases, λ decreases. ✓
Vir 'n konstante snelheid/spoed van klank, indien die frekwensie toeneem, neem λ af.

OR/*OF*

$\lambda \alpha \frac{1}{f}$ at constant velocity/speed/*by konstante snelheid/spoed* ✓

OR/*OF*

$f \alpha \frac{1}{\lambda}$ at constant velocity/speed/*by konstante snelheid/spoed* ✓ (2)

6.2 Light from the star is shifted towards longer wavelength (towards the red end of the spectrum) ✓which indicated that the star is moving away from the earth. ✓
Lig van die ster skuif na 'n langer golflengte (na die rooi kant van die spektrum) ✓ *wat aandui dat die ster wegbeweeg van die aarde af.* ✓ (2)

6.3 Used to measure the direction and speed of blood flow in arteries and veins. ✓
Word gebruik om die rigting en spoed waarteen bloed in are en slagare vloei, te meet.

OR/*OF*

Used to measure the heartbeat of a foetus in the womb.
Word gebruik om die hartklop van 'n fetus in die baarmoeder te meet. (1)

[15]

QUESTION/*VRAAG* 7

7.1.1 GAIN/*BYGEKRY* ✓ (1)

7.1.2 $n = \frac{Q}{q_e}$ ✓

$n = \frac{5 \times 10^{-6}}{1,6 \times 10^{-19}}$ ✓

$n = 3,125 \times 10^{13}$ (electrons/*elektrone*) ✓ (3)

7.1.3 $E = \frac{kQ}{r^2}$ ✓

$E = \frac{9 \times 10^9 \times 5 \times 10^{-5}}{0,1^2}$ ✓ ✓

$E = 4,5 \times 10^6\ N.C^{-1}$ ✓ left/*links* ✓ (5)

7.2.1 Negative/*Negatief* ✓
Like charges repel each other/*Gelyksoortige ladings stoot mekaar af.* ✓

OR/*OF*

The charges repel each other. If sphere **A** is negative, then sphere **B** must also be negative. ✓
*Die ladings stoot mekaar af. Indien sfeer **A** negatief is, dan moet sfeer **B** ook negatief wees.* (2)

7.2.2 $F_E = T\sin30^o$
$F_E = 25\sin30^o$ ✓
$F_E = 12,5$ N
$F_E = \frac{kQ_1Q_2}{r^2}$ ✓
$12,5 = \frac{(9\times10^9)(5\times10^{-6})Q}{0,05^2}$ ✓ ✓
$Q = 6,94 \times 10^{-7}$ C ✓ (6)
[17]

QUESTION/*VRAAG* 8

8.1.1 Temperature/*temperatuur* ✓
Length of the conductors/*Lengte van die geleiers* ✓ (Any two/*Enige twee*)
Thickness of the conductors/*Dikte van die geleiers* ✓
ACCEPT: Type of material
AANVAAR: Tipe materiaal (2)

8.1.2 Gradient is the inverse of the resistance. ✓/
Gradiënt is die inverse van die weerstand ✓
OR/*OF*
Gradient = $\frac{1}{R}$ ✓ (1)

8.1.3 Conductor C./*Geleier C.* ✓
It has the highest resistance. The higher the resistance of a conductor, the more heat is produced in the conductor if the current is constant. ✓
Dit het die hoogste weerstand. Hoe hoër die weerstand, hoe meer hitte geproduseer word in die geleier indien die stroom konstant is. (2)

8.2.1 $R = \frac{V}{I}$ ✓
$R = \frac{12}{1,5}$ ✓
$R = 8\ \Omega$ ✓ (3)

8.2.2 **OPTION/*OPSIE* 1**
$R_{total} = R + r$ ✓
$[8 = \underline{(4 + 3)}$ ✓$+ r]$ ✓
$r = 1\ \Omega$ ✓

OPTION/*OPSIE* 2
$\varepsilon = I(R+ r)$ ✓
$12 = 1,5\ [\underline{(4 + 3)}$ ✓$+ r]$ ✓
$r = 1\ \Omega$ ✓ (4)

8.2.3 $W = I^2R\Delta t$ ✓
$W = (1,5)^2(3)(180)$ ✓
$W = 1\ 215$ J ✓ (3)

8.3.1 Decrease/*Neem af.* ✓ (1)

8.3.2 Increase/*Neem toe.* ✓ (1)

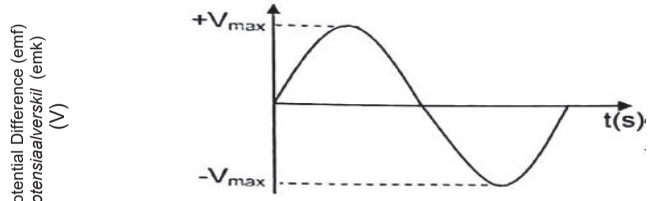
8.4 Increase/*Neem toe.* ✓
R_{ext} decreases. Current through battery increases. ✓
$W = I^2r\Delta t$ / Energy transfer to the battery/work done by battery increases. ✓
R_{eks} neem af. Stroom deur die battery neem toe. ✓
$W = I^2r\Delta t$ / Energie oorgedra aan die battery/arbeid verrig deur die battery neem toe. ✓ (3)
[20]

QUESTION/*VRAAG* 9

9.1 Mechanical energy to electrical energy.
Meganiese energie na elektriese energie ✓✓ (2)

9.2 AC generator has slip rings and DC generator has a split ring / commutator ✓
WS-generator het sleepringe en GS-generator het 'n splitring / kommutator (1)

9.3



CRITERIA FOR MARKING/*MERK KRITERIA*	
Correct shape/*Korrekte vorm*	✓
Axes labelled correct/*Asse korrek*	✓
V_{max} indicated on graph/ V_{maks} *aangedui op grafiek*	✓

(2)

9.4

$P_{ave} = V_{rms}I_{rms}$ ✓
$2000 = I_{rms} \times 230$ ✓
$I_{rms} = 8,70$ A
$I_{rms} = \frac{I_{max}}{\sqrt{2}}$
$8,70 = \frac{I_{max}}{\sqrt{2}}$ ✓
$I_{max} = 12,30$ A ✓

$P_{gem} = V_{wgk}I_{wgk}$ ✓
$2000 = I_{wgk} \times 230$ ✓
$\therefore I_{wgk} = 8,70$ A
$I_{wgk} = \frac{I_{max}}{\sqrt{2}}$
$8,70 = \frac{I_{max}}{\sqrt{2}}$ ✓
$\therefore I_{maks} = 12,30$ A ✓ (4)

9.5

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓
$230 = \frac{V_{max}}{\sqrt{2}}$ ✓
$V_{max}/V_{maks} = 325,27$ V ✓ (3)
[12]

QUESTION/*VRAAG* 10

10.1 Work function (of the metal) / *Werksfunksie (van die metaal)* ✓

$E_{k(max)} = \frac{hc}{\lambda} - W_0$ ✓

The intercept on the vertical axis = W_0.
Die afsnit op die vertikale-as = W_o ✓

OR/OF

$\frac{hc}{\lambda} = W_0 + E_{k(max)}$ ✓

The intercept on the vertical axis is equal to the W_o
Die afsnit op die vertikale-as is gelyk aan die W_o ✓ (3)

10.2 $E = W_0 + E_{k(max)}$
$hf = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$
Any one/*Enige een* ✓

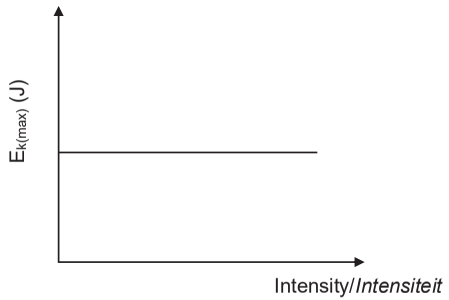
$6{,}63 \times 10^{-34} \times 6{,}16 \times 10^{14}$ ✓ = $6{,}63 \times 10^{-34} f_0$ ✓ + $5{,}6 \times 10^{-20}$ ✓
$f_0 = 5{,}32 \times 10^{14}$ Hz ✓ (5)

10.3.1 Remain the same/*Bly dieselfde* ✓
The gradient is equal to the product of Planck's constant and the speed of light in vacuum which are constants. ✓
Die gradient is gelyk aan die produk van Planck se konstante en die spoed van lig in 'n vakuum wat konstantes is.

OR/*OF*

Gradient = hc, which are constants/*Gradiënt = hc, wat konstantes is.* (2)

10.3.2 Remains the same/*Bly dieselfde* ✓



CRITERIA FOR MARKING/*MERK KRITERIA*	
Axes labelled/*Asse benoem*	✓
Correct shape/*Korrekte vorm*	✓

(3)
[13]

TOTAL/*TOTAAL*: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/*SENIOR SERTIFIKAAT*
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2020

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages./
Hierdie nasienriglyne bestaan uit 19 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	C ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	A ✓✓	(2)
1.7	A ✓✓	(2)
1.8	D ✓✓	(2)
1.9	A ✓✓	(2)
1.10	B ✓✓	(2)

[20]

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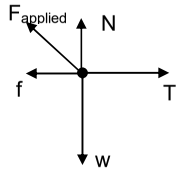
QUESTION 2/*VRAAG 2*

2.1

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase*

The perpendicular force exerted by a surface on an object in contact with the surface. ✓✓
Die loodregte krag deur 'n oppervlak uitgeoefen op 'n voorwerp wat daarmee in kontak is. (2)

2.2



	Accepted symbols/*Aanvaarde simbole*
N ✓	F_N/Normal/Normal force/173,5N /*Normaal/Normaalkrag*
f ✓	F_f /f_k /frictional force/*wrywingskag*/kinetic frictional force/*kinetiese wrywingskrag/5 N*
w ✓	F_g /mg/Weight/$F_{Earth\ on\ block}$/Fw/G*ewig*/Gravitational force/ *Gravitasiekrag/*196 N
T ✓	Tension/*Spanning*/F_T
$F_{applied}$ ✓ $F_{toegepas}$	F/Applied force/35 N/Toegepaste krag/ F_A

Notes/*Aantekeninge*
• Mark is awarded for label and arrow./*Punt word toegeken vir byskrif en pyltjie.*
• Do not penalise for length of arrows./*Moenie vir die lengte van die pyltjies penaliseer nie.*
• Deduct 1 mark for any additional force./*Trek 1 punt af vir enige addisionele krag.*
• If all forces are correctly drawn and labelled, but no arrows, deduct 1 mark. / *Indien all kragte korrek geteken en benoem is, maar geen lyne nie, trek 1punt af.*

(5)

2.3

For the/*Vir die* 20 kg: $F_{net} = ma$ $T - f - F_{Ax} = ma$ ✓ $T - 5 - 35\cos 40° \checkmark = 0$ ✓ T = 31,81 N For/*vir* m: $F_{net} = ma$ $mg - T = ma$ $m(9,8) - 31,81 \checkmark = 0$ m = 3,25 kg ✓	**Marking criteria/*Nasienriglyne*** • Formula for 20 kg or m kg/*Formule vir 20 kg of m kg* / F_{net} = ma ✓ • Substitution of zero into either formula ✓ *Vervanging van nul in een van die formules* • All substitutions into F_{net} for 20 kg as shown ✓ *Alle vervanging in F_{net} for 20 kg soos getoon* • Substitution of value of T in eqn for m /*Substitusie van waarde vir T in vgl vir m* ✓ • Final answer/*finale antwoord*: 3,25 kg ✓

(5)

2.4.1 Decreases/*Neem af* ✓ (1)

2.4.2 **POSITIVE MARKING FROM QUESTION 2.3**
POSITIEWE NASIEN VANAF VRAAG 2.3
Moving to the right/*Beweeg na regs*
Velocity decreases/*snelheid neem af* ✓

Accelerates/Net force to left /*Versnelling/netto krag na links*✓✓

OR/*OF*
As the tension force decreases, the net force/acceleration acts in the opposite direction of motion /to the left. ✓✓
Soos die spanning afneem, is daar 'n netto krag/versnelling in die teenoorgestelde rigting / na links

Moving to the left/Beweeg na links
Velocity increases/*snelheid neem toe* ✓
Accelerates/Net force to left /*Versnelling/netto krag na links*✓✓ (3)
[16]

QUESTION 3/*VRAAG 3*

3.1 (Motion of an object) under the influence of gravity (weight) only. ✓✓ (2 or 0)
(Beweging van 'n voorwerp) slegs onder die invloed van gravitasie (gewig).

OR/*OF*
(Motion in which) the only force acting on the object is gravity (weight).
(Beweging waar) die enigste krag wat op die voorwerp inwerk, gravitasie (gewig) is. (2)

3.2.1 $\Delta t = 0,67 - 0,64 = 0,03$ s ✓✓ (2)

3.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\Delta t = \frac{(1,90 - 0,67)}{2}$ ✓ = 0,62 s ✓ (0,615 s)	$\Delta x = v_i\Delta t + ½\ a\Delta t^2$ $(-1,85) = 0 + ½\ (-9,8)\Delta t^2$ ✓ Δt = 0,61 s ✓ (0,6145 s)
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$\Delta t = \frac{(1,90 + 0,67)}{2}$ = 1,285 s $\Delta t = 1,285 - 0,67$ ✓ = 0,62 s ✓ (0,615 s)	$v_f^2 = v_i^2 + 2a\Delta x$ $0 = v_i^2 + 2(-9,8)(1,85)$ $v_i = 6,02\ m{\cdot}s^{-1}$ $v_f = v_i + a\Delta t$ $0 = 6,02 + (-9,8)\Delta t$ ✓ Δt = 0,61 s ✓

(2)

3.2.3

POSITIVE MARKING FROM QUESTION 3.2.2
POSITIEWE NASIEN VANAF VRAAG 3.2.2

Marking Criteria/*Nasienriglyne*
- Any appropriate formula/*Enige geskikte formule* ✓
- Correct substitution/*Korrekte vervanging* ✓
- Final answer/*Finale antwoord*: 5,94 to 6,08 $m\cdot s^{-1}$ ✓

OPTION 1/*OPSIE 1*

Upwards positive/*Opwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(0,62)$ ✓
$v_i = 6,08\ m\cdot s^{-1}\ (6,076\ m\cdot s^{-1})$ ✓

Downwards positive/*Afwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (9,8)(0,62)$ ✓
$v_i = -6,08$
$\therefore 6,08\ m\cdot s^{-1}\ (6,076\ m\cdot s^{-1})$ ✓

OPTION 2/*OPSIE 2*

Upwards positive/*Opwaarts positief*
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
$1,85 = v_i\ (0,62) + ½\ (-9,8)\ (0,62)^2$ ✓
$v_i = 6,02\ m\cdot s^{-1}\ (6,022\ m\cdot s^{-1})$ ✓

Downwards positive/*Afwaarts positief*
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
$1,85 = v_i\ (0,62) + ½\ (9,8)\ (0,62)^2$ ✓
$v_i = -6,02$
$\therefore\ v_i = 6,02\ m\cdot s^{-1}\ (6,022\ m\cdot s^{-1})$ ✓

OPTION 3/*OPSIE 3*

Motion from top to bottom /
Beweging vanaf bo na onder

Downwards positive/*Afwaarts positief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = 0 + 2(9,8)(1,85)$ ✓
$v_f = 6,02\ m\cdot s^{-1}$ ✓
initial velocity/*beginsnelheid*=6,02 $m\cdot s^{-1}$

Upwards positive/*Opwaarts positief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = 0 + 2(-9,8)(-1,85)$ ✓
$v_f = 6,02\ m\cdot s^{-1}$ ✓
initial velocity/*beginsnelheid*=6,02 $m\cdot s^{-1}$

Motion from bottom to top
Beweging vanaf onder na bo

Downwards positive/*Afwaarts positief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0^2 = v_i^2 + 2(9,8)(-1,85)$ ✓
$v_i = 6,02\ m\cdot s^{-1}$ ✓

Upwards positive/*Opwaarts positief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = v_i^2 + 2(-9,8)(1,85)$ ✓
$v_i = 6,02\ m\cdot s^{-1}$ ✓

OPTION 4/*OPSIE 4*

Upwards positive/*Opwaarts positief*
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
$0 = v_i(1,23) + ½\ (-9,8)(1,23)^2$ ✓
$v_i = 6,03\ m\cdot s^{-1}$ ✓

Downwards positive/*Afwaarts positief* $\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
$0 = v_i(1,23) + ½\ (9,8)(1,23)^2$ ✓
$v_i = -6,03\ m\cdot s^{-1}$
speed/*spoed* = 6,03 $m\cdot s^{-1}$ ✓

OPTION 5/*OPSIE 5*

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$1,85 = \left(\frac{0 + v_i}{2}\right)(0,62)$ ✓
$v_i = 5,97\ m\cdot s^{-1}$ ✓

OPTION 6/*OPSIE 6*

$F_{net}\Delta t = m\Delta v$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓
$m(9,8)(0,62) = m(0 - v_i)$ ✓
$v_i = 6,08\ m\cdot s^{-1}$ ✓

OPTION 7/*OPSIE 7*

$(E_p + E_k)_{floor/vloer} = (E_p + E_k)_{top/bo}$ ✓
$(mgh + ½\ mv^2)_{floor/vloer} = (mgh + ½\ mv^2)_{top/bo}$
$0 + ½\ v^2 = (9,8)(1,85) + 0$ ✓
$v = 6,02\ m\cdot s^{-1}$ ✓

(3)

3.2.4

OPTION/*OPSIE* 1, 2, 3, 4: Marking criteria/*Nasienriglyne*

Calculate initial velocity:
Bereken aanvanklike snelheid:
- Appropriate formula/*Geskikte formule* ✓
- Substitution/*Vervanging* ✓

Calculate/*Bereken* Δt:
- Appropriate formula/*Geskikte formule* ✓
- Substitution/*Vervanging* ✓
- 1,97 s + Δt ✓
- Fin answer/*Fin antwoord*: 2,95 – 2,97 s ✓

Calculate initial velocity:
Bereken beginsnelheid

OPTION 1/*OPSIE 1*

Downwards positive/*Afwaarts positief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = v_i^2 + 2(9,8)(-1,2)$ ✓
$v_i = -4,85\ m\cdot s^{-1}$

Upwards positive/*Opwaarts positief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = v_i^2 + 2(-9,8)(1,2)$ ✓
$v_i = 4,85\ m\cdot s^{-1}$

OPTION 2/*OPSIE 2*

$(E_{mech})_{top} = (E_{mech})_{bot/ond}$
$(E_p + E_k)_{top} = (E_p + E_k)_{Bot/Ond}$ } ✓Any one/ *Enige een*
$(mgh + ½mv^2)_{top} = (mgh + ½mv^2)_{Bot/Ond}$
$(9,8)(1,2) + 0 = 0 + (½)v^2$ ✓
$v_i = 4,85\ m\cdot s^{-1}$ upwards /*opwaarts*

OPTION 3/*OPSIE 3*

$W_{nc} = \Delta E_p + \Delta E_k$
$0 = (0 - mgh) + ½m(v_f^2 - v_i^2)$ } ✓Any one/ *Enige een*
$0 = -(9,8)(1,2) + ½v_i^2$ ✓
$v_i = 4,85\ m\cdot s^{-1}$ upwards /*opwaarts*

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_k$
$w\Delta x\cos 180° = ½m(v_f^2 - v_i^2)$ } ✓Any one/ *Enige een*
$(9,8)(1,2)\cos 180° = ½v_i^2$ ✓
$v_i = -4,85\ m\cdot s^{-1}$

Calculate time Δt
Bereken tyd Δt

Upwards positive
Opwaarts positief
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
$1,2 = (4,85)\Delta t + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 0,4898\ s / 0,5\ s$
$t = 1,97 + 2(0,4898)$ ✓
$= 2,95\ s / 2,97\ s$ ✓
OR/*OF*
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓
$0 = (4,85)\Delta t + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 0,9898\ s$ (or $\Delta t = 0$)
$t = 1,97 + 0,9898$ ✓ $= 2,96\ s$ ✓

Downwards positive
Afwaarts positief
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
$1,2 = (-4,85)\Delta t + ½(9,8)\Delta t^2$ ✓
$\Delta t = 0,4898\ s / 0,5\ s$
$t = 1,97 + 2(0,4898)$ ✓
$= 2,95\ s / 2,97\ s$ ✓
OR/*OF*
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
$0 = (4,85)\Delta t + ½(9,8)\Delta t^2$ ✓
$\Delta t = 0,9898\ s$ (or $\Delta t = 0$)
$t = 1,97 + 0,9898$ ✓ $= 2,96\ s$ ✓
OR/*OF*
$v_f = v_i + a\Delta t$ ✓
$-4,85 = 4,85 + (-9,8)\Delta t$ ✓
$\Delta t = 0,9898\ s$
$\Delta t = 1,97 + 0,9898$ ✓$= 2,96\ s$✓
OR/*OF*
Upwards positive
Opwaarts positief
$v_f = v_i + a\Delta t$ ✓
$0 = 4,85 + (-9,8)\Delta t$ ✓
$\Delta t = 0,4949\ s$
$\Delta t = 1,97 + (2)(0,4949)$ ✓
$= 2,96\ s$ ✓
OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$1,2 = \left(\frac{0 + 4,85}{2}\right)\Delta t$✓$\Delta t = 0,4948s$
$\Delta t_{total} = 2(0,4948) = 0,99\ s$
$\Delta t = 1,97 + 0,99$ ✓$= 2,96\ s$ ✓

OPTION 5/*OPSIE 5*	**OPTION 5: Marking criteria/ *OPSIE 5: Nasienriglyne***
Downwards positive/*Afwaarts positief* $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ 1,2 ✓= 0 + ½(9,8) Δt^2✓ Δt = 0,49 s t = 1,97 + ✓ 2(0,49) ✓ = 2,96 s ✓ Upwards positive/*Opwaarts positief* $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ -1,2 ✓= 0 + ½(-9,8)Δt^2✓ Δt = 0,49 s t = 1,97 + ✓ 2(0,49) ✓ = 2,96 s ✓	• Formula ✓/*Formule* • Substitution/*Vervanging* Δy = 1,2 ✓ • Substitution/*Vervanging* 0 + ½(9,8) Δt^2 • 1,97 s + ✓ • 2 Δt ✓ • Final answer/*Finale antwoord*: 2,95 - 2,97 s ✓

(6)
[15]

QUESTION 4/*VRAAG 4*

4.1 (Linear) momentum (of an object) is the product of mass and velocity. ✓✓
(Liniêre) momentum (van 'n voorwerp) is die produk van massa en snelheid.
(2 or/*of* 0) (2)

4.2.1

OPTION 1/*OPSIE 1*
East as positive/*Oos as positief*
$\sum p_i = \sum p_f$
$m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$ } ✓Any one/*Enige een*

(0,16)(10) + (0,2)(-15) ✓= (0,16)(-5) +(0,2)v_{Qf} ✓
v_{Qf} = -3 m·s^{-1}
v_{Qf} = 3 m·s^{-1} ✓ west/*wes* ✓

OPTION 2/*OPSIE 2*
West as positive/*Wes as positief*
$\sum p_i = \sum p_f$
$m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$ } ✓Any one/*Enige een*

(0,16)(-10) + (0,2)(15) ✓= (0,16)(5) +(0,2)Q_{Nf} ✓
v_{Qf} = 3 m·s^{-1} ✓ west/*wes* ✓

OPTION 3/*OPSIE 3*
$\Delta p_p = -\Delta p_Q$ ✓
(0,16)(-5 – 10) ✓= -(0,2)(v – (-15))✓
v = -3 m·s^{-1}
= 3 m·s^{-1} ✓west/*wes* ✓

(5)

4.2.1

For ball/*Vir bal* P:
West as negative/*Wes as negatief*
Impulse = Δp
$F_{net}\Delta t = \Delta p$
$\Delta p = m(v_{Pf} - v_{Pi})$ } ✓Any one/*Enige een*
= 0,16(-5 – 10) ✓
= - 2,4
∴ 2,4 N·s ✓ (2,4 kg·m·s^{-1})

OR/*OF*
West as positive /*Wes as positief*
Impulse = Δp
$F_{net}\Delta t = \Delta p$
$= m(v_{Pf} - v_{Pi})$ } ✓Any one/*Enige een*
= 0,16(5 – (-10)) ✓
= 2,4 N·s ✓

POSITIVE MARKING FROM QUESTION 4.2.1 /*POSITIEWE NASIEN VANAF VRAAG 4.2.1*

For ball/*Vir bal* Q:
West as negative/*Wes as negatief*
Impulse = Δp
$F_{net}\Delta t = \Delta p$
$= m(v_{Qf} - v_{Qi})$ } ✓ Any one/*Enige een*
= 0,2[-3 – (-15)] ✓
= 2,4 N·s ✓ (2,4 kg·m·s^{-1})

OR/*OF*
West as positive /*Wes as positief*
Impulse = Δp
$F_{net}\Delta t = \Delta p$
$= m(v_{Qf} - v_{Qi})$ } ✓Any one/*Enige een*
= 0,16(3 – (15)) ✓
= - 2,4 N·s
∴ 2,4 N·s ✓ (2,4 kg·m·s^{-1})

(3)
[10]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase. However, **IF**: The word "work" is omitted 0 marks
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
*- 1 punt per woord/frase. Maar, **INDIEN**: Die woord "arbeid" uitgelaat is, 0 punte*

A force is non-conservative if the work it does on an object (which is moving between two points) depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig (op 'n voorwerp wat tussen twee punte beweeg*) afhanklik is van die pad.*

OR/*OF*
A force is non-conservative if the work it does on an object depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhanklik is van die pad.

OR/*OF*
A force is non-conservative if the work it does in moving an object around a closed path is non-zero. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg, nie-nul is nie. (2)

5.2

$K = \frac{1}{2} mv^2 / E_k = \frac{1}{2} mv^2$
$\Delta K = K_f - K_i$
$\Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$= \frac{1}{2}m(v_f^2 - v_i^2)$
$= \frac{1}{2}(200)(2^2 - 4^2)$✓ } ✓Any one /*Enige een*
ΔK = - 1 200 J ✓

(3)

5.3

POSITIVE MARKING FROM QUESTION 5.2.
POSITIEWE NASIEN VANAF VRAAG 5.2.

Marking criteria/*Nasienriglyne*
- Appropriate formula/*Geskikte formule* ✓
- Substitution into appropriate formula together with/*Vervanging in geskikte formule saam met* $-3,40 \times 10^3$ ✓✓
- Final answer/*Finale antwoord*: 8,88 m ✓

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$ } ✓Any one/*Enige een*
$= ½ m (v_f^2 - v_i^2) + mg(h_f - h_i)$
$-3,40 \times 10^3$ ✓ $= -1\,200 + 200(9,8)(h_f - 10)$ ✓
h = 8,88 m ✓ (8,87765 m)

OPTION 2/*OPSIE 2*

$E_{(mech/meg)A} + W_f = E_{(mech)B}$
$(E_p + E_k)_A + W_f = (E_p + E_k)_B$ } ✓Any one/*Enige een*
$(mgh + ½mv^2)_A + W_f = (mgh + ½mv^2)_B$
$200(9,8)(10) + ½(200)(4^2) - 3,40 \times 10^3$ ✓ $= 200(9,8)(h) + ½(200)(2)^2$ ✓
h = 8,88 m ✓ (8,87755)

OPTION 3/*OPSIE 3*

$W_{net} = \Delta K$
$W_f + W_w = ½mv_f^2 - ½mv_i^2$
$W_f - \Delta E_p = ½mv_f^2 - ½mv_i^2$ } ✓Any one/*Enige een*
$W_f - mg(h_f - h_i) = ½m(v_f^2 - v_i^2)$
$-3,40 \times 10^3 - 200(9,8)(h-10)$ ✓$= -1\,200$ ✓
h = 8,88 m ✓ (8,87755 m)

(4)

5.4

OPTION 1 AND 2/*OPSIE 1 EN 2:* Marking criteria /*Nasienriglyne*
- Appropriate formula/*Geskikte formule* ✓✓
- Work done by friction/*Arbeid verrig deur wrywing*✓✓
- Substitution of/*Vervanging* van (200)(9,8)(13,12)✓
- Appropriate formula/*Geskikte formule*
- Substitution into power formula/*Vervanging in drywingformule*
- Final answer /*Finale antwoord*: 1 814,35 W

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta K + \Delta U$
$W_{engine} + W_f = ½mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$ } ✓✓Any one/*Enige een*
$= ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$
$W_{engine} + (50)(15)(2)\cos 180°$ ✓✓ $= 0 + 200(9,8)$✓(22 – 8,88)
$W_{engine} = 27\,215,20$ J

$P_{engine} = \dfrac{W_{engine}}{\Delta t}$ ↓
$= \dfrac{27\,215,20}{15}$
$= 1\,814,35$ W

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$
$W_N + W_{engine} + W_w + W_f = 0$ } ✓✓Any one/*Enige een*
$W_N + W_{engine} - \Delta Ep + W_f = 0$
$0 + W_{engine} - (200)(9,8)$✓$(13,12) + (50)(2)(15)\cos 180°$ ✓✓ $= 0$
$W_{engine} = 27\,215,20$ J

OR/*OF*

$W_{net} = \Delta K$ ✓✓
$W_N + W_{engine} + W_{w||} + W_f = 0$
$W_N + W_{engine} + mg\sin\theta \Delta x \cos 180° + W_f = 0$
$0 + W_{engine} - (200)(9,8)$✓$\left(\dfrac{13,12}{\Delta x}\right)\Delta x(-1) + (50)(2)(15)\cos 180°$ ✓✓ $= 0$

$W_{engine} = 27\,215,20$ J
$P_{engine} = \dfrac{W_{engine}}{\Delta t}$ ↓
$= \dfrac{25\,215,20}{15}$
$= 1\,814,35$ W

OPTION/OPSIE 3: Marking criteria/*Nasienriglyne Opsie 3*
- Appropriate formula/*Geskikte formule* ✓✓
- Substitution of/*Vervanging van* **- 50** ✓✓
- Substitution of/*Vervanging van* (-200)(9,8)(0,4373) or/*of* (-200)(9,8)(0,44)✓
- Appropriate formula/*Geskikte formule*
- Substitution into/*Vervanging in* $P_{ave} = Fv_{ave}$
- Final answer/*Finale antwoord*: 1 814,35 W - 1 824,8 W

OPTION 3/*OPSIE 3*

$F_{net} = ma$ } ✓✓Any one/*Enige een*
$F_{engine} + F_{friction} + F_{g//} = 0$
$F_{engine} + (-50)$ ✓✓ $+ (-200)(9,8)$✓$(0,4373) = 0$
$F_{engine} = 906,52$ N (906,52 – 912,4)

$P_{ave} = Fv_{ave}$
$P_{ave} = (908,52)(2)$
$= 1\,813,04$ W (1 824,8 W)

$\sin\theta = \dfrac{h}{\Delta x}$
$= \dfrac{13,12}{2(15)}$
$= 0,4373$

OR/*OF*

$W = F_{engine}\Delta x \cos\theta$
$= (906,52)(30)\cos 0°$
$= 27\,195,6$ J (27 372 W)

$P = \dfrac{W}{\Delta t} = \dfrac{27195,6}{15} = 1\,813,04$ W ✓ (1 824,8 W)

(5)
[14]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
- 1 punt per woord/frase

The change in frequency✓ (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓
Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/*OF*
An (apparent) change in (observed/detected) frequency (pitch), as a result of the relative motion between a source and an observer (listener).
'n (Skynbare) verandering in (waargenome) frekwensie (toonhoogte), as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/ luisteraar. (2)

6.2 Towards/*Nader* ✓ (1)

6.3

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$

$3148 \checkmark = \left(\frac{340+0}{340-v_s}\right) f_s$ ✓ $2073 \checkmark = \left(\frac{340-0}{340+v_s}\right) f_s$ ✓

$\frac{3148(340-v_s)}{340+0} = \frac{2073(340+v_s)}{340-0}$

v_s = 70 m·s^{-1}✓ (69,95 - 70,16 m·s^{-1}) (6)

6.4

POSITIVE MARKING FROM QUESTION 6.3
POSITIEWE NASIEN VANAF VRAAG 6.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$\Delta t = \frac{\Delta x}{v}$ $\Delta t = \frac{350}{70}$ ✓ Δt = 5 s ✓	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $350 = 70\Delta t + 0$ ✓ Δt = 5 s ✓	$\Delta x = \left(\frac{v_i + v_f}{2}\right) \Delta t$ $350 = \left(\frac{70+70}{2}\right) \Delta t$ ✓ Δt = 5 s ✓

(2)
[11]

QUESTION 7/*VRAAG 7*

7.1

$n = \frac{Q}{e}$ ✓
$= \frac{(-)4 \times 10^{-6}}{(-)1,6 \times 10^{-19}}$ ✓
$= 2,5 \times 10^{13}$ ✓ (3)

7.2 **Electrostatic force on B due to A:/*Elektrostatiese krag op B a.g.v. A:***

$F_{AB} = \frac{kQ_1Q_2}{r^2}$ ✓
$= \left[\frac{9 \times 10^9 (4 \times 10^{-6})(3 \times 10^{-6})}{0,2^2}\right]$ ✓
= 2,7 N ✓ (3)

Ignore negative signs
Ignoreer negatiewe tekens

7.3

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
- 1 punt per woord/frase

Electric field is a region (in space) where (in which) an (electric) charge experiences a (electric) force. ✓✓
Elektriese veld is 'n gebied (in die ruimte) waarin 'n (elektriese) lading 'n (elektriese) krag ondervind. (2)

7.4

Marking criteria/*Nasienriglyne*
- Appropriate formula/*Geskikte formule* ✓
- Correct substitution for A and B/*Korrekte vervanging van A en B* ✓✓
- Subtraction of electric fields/*Aftrek van elektriesevelde*✓
- Final answer/*Finale antwoord*: 2,3 x10^6 N·C^{-1}✓

OPTION 1/*OPSIE* 1

Electric field at M due to / *Elektriese veld by M as gevolg van*: -4 x10^{-6} C

$E_{AM} = k\frac{Q}{r^2}$ ✓

$= 9\times10^9\frac{(4x10^{-6})}{(0,3)^2}$ ✓

= 4,0 x 10^5 N·C^{-1} (to left /*links*)

Electric field at M due to / *Elektriese veld by M as gevolg van*: +3 x10^{-6} C,

$E_{BM} = k\frac{Q}{r^2}$

$= 9x10^9\frac{(3x10^{-6})}{(0,1)^2}$ ✓

= 2,7 x10^6 N·C^{-1} (to right /*regs*)

Net electric field at M /*Netto elektrieseveld by M*

$E_{net} = E_{BM} + E_{AM}$

= 4,0 x10^5 – 2,7 x10^6 ✓

= 2,3 x10^6 N·C^{-1} ✓(right/*regs*)

OR/*OF*

Net electric field at M /*Netto elektrieseveld by M*

$E_{net} = E_{BM} + E_{AM}$

= -4,0 x10^5 + 2,7 x10^6 ✓

= - 2,3 x10^6 N·C^{-1}

= 2,3 x10^6 N·C^{-1} ✓(right)

OPTION 2/*OPSIE* 2

$F_{AM} = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^9)(4\times10^{-6})Q}{(0,3)^2}$ ✓ = 4 x 10^5Q N

$F_{BM} = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^9)(3\times10^{-6})Q}{(0,1)^2}$ ✓ = 2,7 x 10^6Q N

F_{net} = 2,7 x 10^6Q + (-4 x 10^5Q)✓ = 2,3 x 10^6Q

$E = \frac{F}{q}$ ✓= $\frac{2,3\times10^6Q}{Q}$ = 2,3 x 10^6 N·C^{-1} ✓(right/*regs*)

(5)

7.5 Positive/*Positief* ✓ (1)

7.6

POSITIVE MARKING FROM 7.2/*POSITIEWE NASIEN VANAF 7.2*

Marking criteria/*Nasienriglyne*
- Correct substitution into Pythagoras's equation/*Korrekte vervanging in Pythagoras se vergelyking* ✓
- Correct substitution into Coulomb's Law/*Korrekte vervanging in Coulomb se wet* ✓
- Correct answer/*Korrekte antwoord* ✓

$(F_{net})^2 = (F_{AD})^2 + (F_{AB})^2$

$(7,69)^2 = (F_{AD})^2 + (2,7)^2$ ✓

F_{AD} = 7,2 N

$F_{AD} = \frac{kQ_1Q_2}{r^2}$

$7,2 = \frac{(9\times10^9)(4x10^{-6})Q}{(0,15)^2}$ ✓

Q_D = 4,5 x 10^{-6} C ✓

OR/*OF*

$F_{AD} = k\frac{Q_1Q_2}{r^2}$

$= 9x10^9\frac{(4x10^{-6})Q}{0,15^2}$ ✓

= 1,6 x 10^6 Q

$F_{net} = \sqrt{F_{AB}^2 + F_{AD}^2}$ **OR/*OF*** $F_{net}^2 = F_{AB}^2 + F_{AD}^2$

$7,69 = \sqrt{2,7^2 + (1,6x10^6Q)^2}$ ✓

Q = 4,50 x 10^{-6} C ✓

(3)

[17]

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase*

(Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it. ✓✓
(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/ eenheidslading wat daardeur beweeg.

Work done by the battery to move a unit coulomb of charge across the circuit./*Arbeid verrig deur die battery om 'n eenheidslading oor die stroombaan te beweeg.* (2)

8.2 Energy (per coulomb of charge) is converted to heat in the battery due to the internal resistance. ✓✓
Energie (per coulomb lading) word na hitte omskep binne-in die battery a.g.v. interne weerstand. (2)

8.3.1
$I = \frac{V}{R}$ ✓
$I = \frac{1,5}{0,5}$ ✓
= 3 A ✓ (3)

8.3.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓	$R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓
$\frac{1}{R_P} = \frac{1}{25} + \frac{1}{15}$ ✓	$R_p = \frac{(25)(15)}{25+15}$ ✓
R_p = 9,375 Ω	R_p = 9,375 Ω
R_{ext} = 9,375 + 4 ✓ = 13,38 Ω ✓ (13,375 Ω)	R_{ext} = 9,375 + 4 ✓ = 13,38 Ω ✓ (13,375 Ω)

(4)

8.3.3

POSITIVE MARKING FROM QUESTIONS 8.3.1 AND 8.3.2. ***POSITIEWE NASIEN VANAF VRAAG 8.3.1 EN 8.3.2.***
OPTION 1/*OPSIE 1*
$\mathcal{E} = I(R + r)$ ✓ = 3(13,38 + 0,5) ✓ = 41,64 V ✓ (Range/*Gebied:* 41,625 – 41,64)
OPTION 2/*OPSIE 2*
$\mathcal{E} = V_{ext/eks} + V_{int}$ ✓ = (3)(13,38) + 1,5 ✓ = 41,64 V ✓ (Range/*Gebied:* 41,625 – 41,64)

(3)

8.4 Yes. ✓/*Ja*

For the same voltage/potential difference, ✓
a larger current will flow through a smaller resistor ($I = \frac{V}{R}$) ✓
Vir dieselfde spanning/ potensiaalverskil
sal 'n groter stroom deur die kleiner weerstand vloei ($I = \frac{V}{R}$).

OR/*OF*
$I \alpha \frac{1}{R}$ ✓, V = constant /*konstant*✓
I is inversely proportional to R and V is constant.
I is omgekeerd eweredig aan R en V is konstant.

OR/*OF*
$V_{||} = IR$
= (3)(9,38)
= 28,14 V

$I_{R2} = \frac{V}{R} = \frac{28,14}{25}$ = 1,13 A ✓
$I_{R3} = \frac{V}{R} = \frac{28,14}{15}$ = 1,88 A ✓

OR/*OF*
V is the same / *V is dieselfde* ✓
$I_{15\Omega} = \frac{25}{40} I$
$I_{25\Omega} = \frac{15}{40} I$ ✓
(3)

8.5 Remains the same/*Bly dieselfde*✓ (1)
[18]

QUESTION 9/*VRAAG 9*

9.1.1 (DC) motor/*(GS-)motor* ✓ (1)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1**
POSITIEWE NASIEN VANAF VRAAG 9.1.1
Electrical to mechanical /kinetic (energy) ✓✓ **(2 or 0)**
Elektriese na meganiese/kinetiese (energie) ***(2 of 0)*** (2)

9.1.3 Split ring/commutator/*Splitring/kommutator* ✓ (1)

9.1.4 Anticlockwise/*antikloksgewys* ✓✓ (2)

9.2.1 (The rms voltage/value of AC is) the AC voltage/potential difference which dissipates the same amount of energy/heat/power as an equivalent DC voltage/potential difference. ✓✓ **(2 or 0)**
(Die wgk-waarde van WS is) die WS-potensiaalverskil/spanning wat dieselfde hoeveelheid energie/hitte/drywing verbruik as 'n ekwivalente GS-spanning/ potensiaalverskil. **(*2 of 0*)**

ACCEPT/*AANVAAR*
The rms voltage/value of AC is the DC potential difference which dissipates the same amount of energy/heat/power as AC.
Die wgk-waarde van WS is die GS-potensiaalverskil wat dieselfde hoeveelheid energie/hitte/drywing verbruik as die WS. (2)

9.2.2

Marking criteria/*Nasienriglyne*
- Appropriate formula for P_{ave}/*Geskikte formule* vir P_{ave} ✓
- Substitution to calculate/*Vervanging vir berekening van* R ✓
- Final answer/*Finale antwoord*: 242 Ω ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $200 = \frac{220^2}{R}$ ✓ R = 242 Ω ✓	$P_{ave} = V_{rms}I_{rms}$ ✓ $200 = I_{rms}(220)$ I_{rms} = 0,909 A (0,91) $R = \frac{V_{rms}}{I_{rms}}$ or/*of* $R = \frac{V}{I}$ $R = \frac{220}{0,909}$ ✓ R = 242 Ω ✓ (241,76 Ω)	$P_{ave} = V_{rms}I_{rms}$ ✓ $200 = I_{rms}(220)$ I_{rms} = 0,909 A(0,91) $P_{ave} = I_{rms}^2R$ $200 = (0,909)^2R$ ✓ R = 242 Ω ✓ (241,52 Ω)

(3)

9.2.3

Marking criteria for options 1,2 and 3 /*Nasienriglyne vir opsies 1,2 en 3*
- Appropriate formula to calculate P or I_{rms} /*Geskikte formule om* P *of* I_{rms} te bereken ✓
- Substitution/*Vervanging* ✓
- Formula for P or W containing Δt/*Formule vir P of W wat Δt bevat* ✓
- Substitution/*Vervanging* ✓
- Final answer/Finale antwoord: 55 785,12 J ✓

POSITIVE MARKING FROM QUESTION 9.2.2.
POSITIEWE NASIEN VANAF VRAAG 9.2.2.

OPTION 1/*OPSIE 1*
Marking criteria / *Nasienriglyne*
- Appropriate formula for W containing V/*Geskikte formule vir W wat V bevat* ✓✓
- Substitution/*Vervanging* ✓✓
- Final answer/*Finale antwoord*: 55 785,12 J ✓

$W = \frac{V^2\Delta t}{R}$ ✓✓
$= \frac{(150^2)(10 \times 60)}{242}$ ✓ ✓
= 55 785,12 J ✓

OPTION 2/*OPSIE 2*	**OPTION 3/*OPSIE 3***	**OPTION 4/*OPSIE 4***
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{150^2}{242}$ ✓ P_{av} = 92,975 W $P = \frac{W}{\Delta t}$ ✓ $92,975 = \frac{W}{(10)(60)}$ ✓ W = 55 785,12 J ✓ (55785,12 – 55896 J)	$R = \frac{V_{rms}}{I_{rms}}$ ✓/ $R = \frac{V}{I}$ $242 = \frac{150}{I_{rms}}$ ✓ I_{rms} = 0,620 A $P_{ave} = I_{rms}V_{rms}$ = (0,62)(150) = 92,97 W (93 W) $P = \frac{W}{\Delta t}$ ✓ $92,975 = \frac{W}{(10)(60)}$ ✓ W = 55 785,12 J ✓ (55785,12 – 55896 J)	$R = \frac{V_{rms}}{I_{rms}}$ ✓/ $R = \frac{V}{I}$ $242 = \frac{150}{I_{rms}}$ ✓ I_{rms} = 0,620 A $W = I^2R\Delta t$ ✓ = $(0,62)^2(242)(10)(60)$ ✓ = 55 814,88 J ✓ (55785,12 – 55896 J) **OR/*OF*** $W = VI\Delta t$ = (150)(0,62)(600) = 55 800 J

OPTION 5/*OPSIE 5*
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{150^2}{242}$ ✓ = 92,975 W
$P_{ave} = I_{rms}^2R$
$92,975 = I_{rms}^2(242)$
I_{rms} = 0,6198 A
$W = I^2R\Delta t$ ✓
$= (0,6198)^2(242)(10)(60)$ ✓
= 55 778,88 J ✓

(5)
[16]

QUESTION 10/*VRAAG 10*

10.1 Photoelectric effect/*Fotoëlektriese effek* ✓ (1)

10.2 Work function (of potassium)/*Werksfunksie/Arbeidsfunksie (van kalium)* ✓ (1)

10.3 Potassium/*Kalium* ✓
It has the lowest work function / threshold frequency / highest threshold wavelength. ✓
Dit het die laagste arbeidsfunksie / drumpelfrekwensie / hoogste drumpel golflengte. (2)

10.4

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase*

The work function of a metal is the minimum energy that an electron (in the metal) needs✓ to be emitted/ejected from the metal / surface. ✓
Die werkfunksie/arbeidsfunskie van 'n metaal is die minimum energie benodig om 'n elektron vanaf 'n oppervlak / metaal vry te stel. (2)

10.5.1 $W_o = hf_o$ ✓
$= (6,63 \times 10^{-34})(1,75 \times 10^{15})$ ✓
$= 1,160 \times 10^{-18}$ J ✓

OR/*OF*
$E = W_o + E_{k(max)}$
$hf = W_o + E_{k(max)}$
✓ Any one / *Enigeen*
$(6,63 \times 10^{-34})(1,75 \times 10^{15}) = W_o + 0$ ✓
$W_o = 1,160 \times 10^{-18}$ J ✓ (3)

10.5.2 **POSITIVE MARKING FROM QUESTION 10.5.1.**
POSITIEWE NASIEN VANAF VRAAG 10.5.1.
$E = W_o + E_{k(max)}$
$hf = hf_o + \frac{1}{2}mv_{max}^2$
✓Any one/*Enige een*

$(6,63 \times 10^{-34})f$ ✓ $= 1,160 \times 10^{-18} + \frac{1}{2}(9,11 \times 10^{-31})(5,60 \times 10^5)^2$ ✓
$\therefore f = 1,97 \times 10^{15}$ Hz ✓ (4)
[13]

TOTAL/*TOTAAL*: 150

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Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2020

PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: 150

This marking guideline consists of 18 pages./
Hierdie nasienriglyn bestaan uit 18 bladsye.

QUESTION/*VRAAG* 1: MULTIPLE-CHOICE QUESTIONS/ *MEERVOUDIGEKEUSE-VRAE*

1.1	C ✓✓	(2)
1.2	C ✓✓	(2)
1.3	A ✓✓	(2)
1.4	D ✓✓	(2)
1.5	A ✓✓	(2)
1.6	B ✓✓	(2)
1.7	D ✓✓	(2)
1.8	B ✓✓	(2)
1.9	D ✓✓	(2)
1.10	C ✓✓	(2)

[20]

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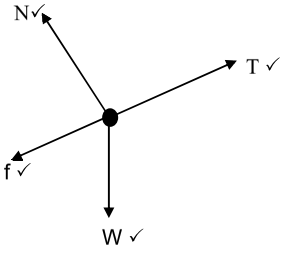
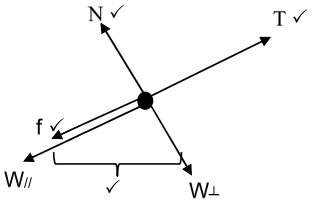
QUESTION/*VRAAG* 2

2.1 When a resultant/net force acts on an object, it accelerates in the direction of the force. The acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
Indien 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag. Die versnelling is direk eweredig aan die krag en omgekeerde eweredig aan die massa van die voorwerp. ✓✓ (2)

2.2

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
	

(4)

Mark awarded for arrow and label. / *Punt toegeken vir byskrif en pyltjie.*
Do not penalise for length of arrows since drawing is not drawn to scale./ *Moenie vir die lengte van die pyltjies penaliseer nie, aangesien die skets nie volgens skaal geteken is nie.*

Any other additional force(s) / *Enige addisionele kragte* $\frac{3}{4}$

If force(s) do not make contact with body. / *Indien die kragte nie kontak maak met die voorwerp nie.* Max./Maks. $\frac{3}{4}$

2.3

OPTION 1 (To the right is positive) *OPSIE 1 (Na regs is positief)*	**OPTION 2 (To the right is negative)** *OPSIE 2 (Na regs is negatief)*
$F_{net} = ma$ $F_{net} = 0$ N $F_g - T = ma$ } Any one / *Enige een* ✓ $15 \times 9,8 - T = 0$ ✓ $T = 147$ N $T - W\sin\theta - f = ma$ $T - mg\sin\theta - f = ma$ $147 - 22 \times 9,8\sin\theta - 43,86 = 0$ ✓ $\theta = 28,58^\circ$ ✓	$F_{net} = ma$ $F_{net} = 0$ N $T - F_g = ma$ } Any one / *Enige een* ✓ $T - 15 \times 9,8 = 0$ ✓ $T = 147$ N $W\sin\theta + f - T = ma$ $mg\sin\theta + f - T = ma$ $22 \times 9,8\sin\theta + 43,86 - 147$ ✓ $= 0$ $\theta = 28,58^\circ$ ✓

(4)

2.4 2.4.1 The kinetic friction force depends on the angle of the inclined to the horizontal and nature of the surface. ✓✓
Die kinetiese wrywingskrag is afhanklik van die hoek van die skuinsvlak met die horisontaal en die aard van die oppervlakte. ✓✓ (2)

2.4.2

Positive marking from Question 2.3 / *Merk positief vanaf Vraag 2.3*	**Marking criteria / *Merk kriteria***
For 15 kg block / *Vir 15 kg-blok* $F_{net} = ma$ ✓ $F - F_g - T = ma$ $172 - 147 - T$ ✓ $= 15a$ …(1) For 22 kg block / *Vir 22 kg-blok* $T + W\sin\theta - f = ma$ $T + mg\sin\theta - f = ma$ $[T + 22 \times 9,8 \sin 28,58^\circ$ ✓ $- 43,86]$ ✓ $=$ $22a$ ✓ $[T + 101,14 - 43,86] = 22a$ (2) $\therefore a = 2,278$ m.s^{-2} ✓	$F_{net} = ma$ $F - F_g - T = ma$ $T + W\sin\theta - f = ma$ $T + mg\sin\theta - f = ma$ } Any one / *Enige een* ✓ Calculating $F_{g//}$ *Berekening van* $F_{g//}$ ✓ Substitution for the 15 kg block *Instelling vir die 15 kg-blok* ✓ Substitution for the 22 kg block *Instelling vir die 22 kg-blok* ✓ Substitution for either 15a or 22a *Instelling vir 15a of 22a* ✓ Answer/*Antwoord* ✓

(6)
[18]

QUESTION/*VRAAG* 3

3.1

UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$v_f = v_i + a\Delta t$ ✓ $v_f = -3,28 + (-9,8) \times 1,2$ ✓ $v_f = -15,04$ $v_f = 15,04$ m.s^{-1} downwards/*afwaarts* ✓	$v_f = v_i + a\Delta t$ ✓ $v_f = 3,28 + (9,8) \times 1,2$ ✓ $v_f = 15,04$ m.s^{-1} downwards/*afwaarts* ✓

(3)

3.2

OPTION/*OPSIE* 1	
UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$\Delta y = v_i \Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\Delta y = \underline{-3,28 \times 1,2}$ ✓$+ \frac{1}{2}(-9,8)1,2^2$ ✓ $\Delta y = -10,99$ $\Delta y = 10,99$ m downwards/*afwaarts* ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = \underline{3,28 \times 1,2}$ ✓$+ \frac{1}{2}(9,8)1,2^2$ ✓ $\Delta y = 10,99$ m downwards/*afwaarts* ✓
OPTION /*OPSIE* 2	
Positive marking from Question 3.1/*Positiewe merk vanaf Vraag 3.1*	
UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $-15,04^2$ ✓ $= -3,28^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 10,99$ m downwards/*afwaarts* ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $15,04^2$ ✓$= 3,28^2 + 2(9,8)\Delta y$ ✓ $\Delta y = 10,99$ m downwards/*afwaarts* ✓

OPTION/*OPSIE* 3	
Positive marking from Question 3.1/*Positiewe merk vanaf Vraag 3.1*	
UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓ $\Delta y = \frac{-15,04 + (-3,28)}{2}$ ✓$\times 1,2$ ✓ $\Delta y = -10,99$ m $\Delta y = 10,99$ m downwards/*afwaarts* ✓	$\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓ $\Delta y = \frac{15,04 + 3,28}{2}$ ✓$\times 1,2$ ✓ $\Delta y = 10,99$ m downwards/*afwaarts* ✓

(4)

3.3

OPTION 1/*OPSIE* 1	
UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = -3,28^2 + 2(-9,8)(30)$ ✓ $v_f^2 = -24,47$ m.s^{-1} $v_f^2 = 24,47$ m.s^{-1} downwards/*afwaarts* ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 3,28^2 + 2(9,8)(30)$ ✓ $v_f^2 = 24,47$ m.s^{-1} downwards/*afwaarts* ✓

OPTION 2/*OPSIE* 2	
UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $-30 = -3,28\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $\Delta t = 2,16$ s $v_f = v_i + a\Delta t$ ✓ $v_f = -3,28 + (-9,8)(2,16)$ ✓ $v_f = -24,45$ m.s^{-1} $v_f = 24,45$ m.s^{-1} downwards/*afwaarts* ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $30 = 3,28\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $\Delta t = 2,16$ s $v_f = v_i + a\Delta t$ ✓ $v_f = 3,28 + (9,8)(2,16)$ ✓ $v_f = 24,45$ m.s^{-1} downwards/*afwaarts* ✓

(3)

3.4

Positive marking from Question 3.2/*Positiewe merk vanaf Vraag 3.2*	
UPWARD POSITIVE *OPWAARTS POSITIEF*	**UPWARD NEGATIVE** *OPWAARTS NEGATIEF*
$F_{net}.\Delta t = m(v_f - v_i)$ ✓ $205 \times 0,1$ ✓$= \underline{0,5\,[v_f - (-24,47)]}$ ✓ $v_f = 16,53$ m.s^{-1} upwards/*opwaarts* ✓	$F_{net}.\Delta t = m(v_f - v_i)$ ✓ $-205 \times 0,1$ ✓ $= \underline{0,5\,(v_f - 24,47)]}$ ✓ $v_f = -16,53$ m.s^{-1} $v_f = 16,53$ m.s^{-1} upwards/*opwaarts* ✓

(4)

3.5

OPTION 1/*OPSIE* 1	
Positive marking from Question 3.1 and 3.3 ***Positiewe merk vanaf Vraag 3.1en 3.3***	
UPWARD POSITIVE ***OPWAARTS POSITIEF***	**UPWARD NEGATIVE** ***OPWAARTS NEGATIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ 0^2 ✓ $= 16,53^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 13,94$ m width of window / *wydte van venster* = 30 – (10,99+13,94) ✓ = 5,07 m ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ 0^2 ✓ $= -16,53^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -13,94$ m width of window / *wydte van venster* = 30 – (10,99 +13,94) ✓ = 5,07 m ✓

OPTION 2/*OPSIE* 2
$W_{net} = \Delta E_k$ $F_{net}\Delta y\cos\theta = \Delta E_k$ } Any one/*Enige een* ✓ $F_g\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $4,9\,\Delta y\cos 180^o$ ✓ $= 0 - \frac{1}{2} \times 0,5 \times 16,53^2$ ✓ $\Delta y = 13,94$ m width of window / *wydte van venster* = 30 – (10,99 + 13,94) ✓ = 5,07 m ✓

(5)
[19]

QUESTION/*VRAAG* 4

4.1 In an isolated system total linear momentum is conserved. ✓✓
In 'n geïsoleerde sisteem bly die totale lineêre momentum behoue. ✓✓ (2)

4.2 4.2.1 $ME_i = ME_f$
$mgh_1 + \frac{1}{2}mv_i^2 = mgh_2 + \frac{1}{2}mv_f^2$
$0 + \frac{1}{2} \times 2,005 \times v_i^2$ ✓ $= 2,005 \times 9,8 \times 0,06 + 0$ ✓
$v_i = 1,08$ m.s^{-1}
$\sum p_i = \sum p_f$
$m_{block}v_{iblock} + m_{bullet}v_{ibullet} = (m_{block} + m_{bullet})v_f$ } Any one/*Enige een* ✓
$0 + 0,005 \times v_{ibullet} = 2,005 \times 1,08$ ✓
$v_{bullet} = 433,08$ m.s^{-1} right/*regs* ✓ (5)

4.2.2 **Positive marking from Question 4.2.1/*Positiewe merk vanaf Vraag 4.2.1***
$\sum p_i = \sum p_f$
$(m_{gun} + m_{bullet})v_i = m_{gun}v_{fgun} + m_{bullet}v_{fbullet} =$ } Any one/*Enige een* ✓
$0 = 5 \times v_{f(gun)} + 0,005 \times 433,08$ ✓
$v_{f(gun)} = -0,43$ m.s^{-1}
$v_{f(gun)} = 0,43$ m.s^{-1} left/*links* ✓ (3)
[10]

QUESTION/*VRAAG* 5

5.1 In an isolated system the total mechanical energy is conserved. ✓✓
In 'n geïsoleerde sisteem bly die totale meganiese energie behoue. ✓✓ (2)

5.2 $ME_i = ME_f$
$(E_p + E_k)_A = (E_p + E_k)_B$ } Any one/*Enige een* ✓
$mgh_1 + E_{k(A)} = mgh_2 + E_{k(B)}$
$55 \times 9,8 \times 15 + 0 = 0 + E_{k(B)}$ ✓
$E_{k(B)} = 8085$ J ✓ (3)

5.3 The net work done on an object is equal to the object's change in kinetic energy. ✓✓

OR

The work done by a net force is equal to the object's change in kinetic energy. ✓✓
Die netto arbeid verrig op 'n voorwerp is gelyk aan die voorwerp se verandering in kinetiese energie. ✓✓

OF

Die arbeid verrig deur 'n netto krag is gelyk aan die voorwerp se verandering in kinetiese energie. ✓✓ (2)

5.4 5.4.1 **Positive marking from Question 5.2/*Positiewe merk vanaf Vraag 5.2***

OPTION 1/*OPSIE* 1

$W_{ner} = \Delta E_k$
$W_f + W_{Fg//} = \Delta E_k$ } Any one/*Enige een* ✓
$f \times \Delta x \cos\theta + mg\sin\theta\ \Delta x \cos\theta = \Delta E_k$
$\underline{15 \times 10 \cos 180^o}$ ✓ + $\underline{55 \times 9,8 \sin 15^o \times 10 \cos 180^o}$ ✓ = 0 – E_{ki}
$E_{ki} = 1545,035$ J ✓

OPTION 2/*OPSIE* 2

$W_{nc} = \Delta E_k + \Delta E_p$
$W_f = \Delta E_k + \Delta E_p$ } Any one/*Enige een* ✓
$f \times \Delta x \cos\theta = \Delta E_p + \Delta E_k$
$\underline{15 \times 10 \cos 180^o}$ ✓ = $\underline{[55 \times 9,8 \times (10 \sin 15^o)]}$ - 0 ✓ + $\underline{0 - E_{ki}}$
$-150 = 1395,035 - E_{ki}$
$E_{ki} = 1545,035$ J ✓

OPTION 3/*OPSIE* 3

$W_{ner} = \Delta E_k$
$W_f + W_{Fg} = \Delta E_k$ } Any one/*Enige een* ✓
$f \times \Delta x \cos\theta + mg\ \Delta x \cos\theta = \Delta E_k$
$\underline{15 \times 10 \cos 180^o}$ ✓ + $\underline{55 \times 9,8 \times 10 \cos(90 + 15)}$ ✓ = 0 – E_{ki}
$E_{ki} = 1545,035$ J ✓ (4)

5.4.2

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
$W_{net} = \Delta E_k$ $W_f = \Delta E_k$ $f \times \Delta x \cos\theta = \Delta E_k$ } Any one/*Enige een* ✓ $\underline{f \times 10 \cos 180^o}$ ✓ = $\underline{1545,035}$ ✓ - 8085 ✓ 654,00 N ✓	$W_{nc} = \Delta E_k + \Delta E_p$ $W_f = \Delta E_k + \Delta E_p$ $f \times \Delta x \cos\theta = \Delta E_k + \Delta E_p$ } Any one/*Enige een* ✓ $\underline{f \times 10 \cos 180^o}$ ✓ = $\underline{1545,035}$ ✓ $\underline{- 8085}$ ✓ f = 654,00 N ✓

(5)
[16]

QUESTION/*VRAAG* 6

6.1 Doppler effect/*Doppler effek* ✓ (1)

6.2 AWAY. ✓ The observed frequency is less than the source frequency. ✓
WEG VAN. ✓ *Die waargenome frekwensie is minder as die bron se frekwensie.* ✓ (2)

6.3 As the listener's velocity increases, the observed frequency decreases. ✓✓
As die luisteraar se snelheid toeneem, verminder die waargenome frewensie. ✓✓ (2)

6.4 The intercept on the vertical axis represents the frequency of the source, f_s. ✓✓
Die afsnit op die vertikale as verteenwoordig die frekwensie van die bron, f_s. ✓✓ (2)

6.5

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
Gradient/*Helling* $= \frac{492-470}{5-20}$ ✓ $= -\frac{22}{15}$ $= -\frac{f_s}{v}$ ✓ $-\frac{22}{15}$ ✓ $= -\frac{f_s}{340}$ ✓ $f_s = 498,67$ Hz ✓	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ 492 ✓ $= \frac{340-15}{340}$ ✓✓ x f_s $f_s = 499,34$ Hz ✓

OPTION 3/*OPSIE* 3
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ 470 ✓ $= \frac{340-15}{340}$ ✓✓ x f_s $f_s = 499,38$ Hz ✓ Range (498,67 Hz – 499,38 Hz)

(5)

6.6

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**	**OPTION 3/*OPSIE* 3**
$v = f\lambda$ $340 = 498,67\ \lambda$ ✓ $\lambda = 0,68$ m ✓ The wavelength produced by the tuning fork is less than the required wavelength. ∴ It is not suitable. ✓ *Die golflengte wat voortgeplant word deur die stemvurk is minder as die benodigde golflengte.* *∴ Dit is nie geskik nie.* ✓	$v = f\lambda$ $340 = 499,34\ \lambda$ ✓ $\lambda = 0,68$ m ✓ The wavelength produced by the tuning fork is less than the required wavelength. ∴ It is not suitable. ✓ *Die golflengte wat voortgeplant word deur die stemvurk is minder as die benodigde golflengte.* *∴ Dit is nie geskik nie.* ✓	$v = f\lambda$ $340 = 499,38\ \lambda$ ✓ $\lambda = 0,68$ m ✓ The wavelength produced by the tuning fork is less than the required wavelength. ∴ It is not suitable. ✓ *Die golflengte wat voortgeplant word deur die stemvurk is minder as die benodigde golflengte.* *∴ Dit is nie geskik nie.* ✓

(3)
[15]

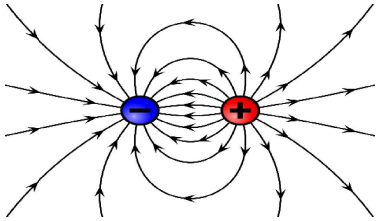
QUESTION/*VRAAG* 7

7.1 $n = \frac{Q}{q_e}$ ✓

$n = \frac{2x10^{-6}}{1,6x10^{-19}}$ ✓

$n = 1,25 \times 10^{13}$ ✓ (3)

7.2



Criteria for marking/*Kriteria vir merk*	
Correct shape / *Korrekte vorm*	✓
Direction of electric field / *Rigting van elektriese veld*	✓
Lines not crossing each other / *Lyne sny nie mekaar nie.*	✓

(3)

7.3 7.3.1 $v_f = v_i + a\Delta t$ ✓

$6,25 \times 10^3 = 0 + 2 \times 10^{-3}\ a$ ✓

$a = 3,125 \times 10^6\ m.s^{-2}$

$F_{net} = ma$

$F_{net} = 5 \times 10^{-6} \times 3,125 \times 10^6$ ✓

$F_{net} = 15,625\ N$

Any one /*Enige een* ✓

$E_{net} = \frac{F_{net}}{q}$ ✓

$E_{net} = \frac{15,625}{2x10^{-6}}$ ✓

$E_{net} = 7,81 \times 10^6\ N.C^{-1}$ ✓ (6)

7.3.2

Positive marking from Question 7.3.1/*Positiewe merk vanaf Vraag 7.3.1*	
OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
$E = \frac{kQ}{r^2}$ ✓ $7,81 \times 10^6 = \frac{9x10^9\ x\ 2x10^{-6}}{r^2}$ ✓ $\therefore r = 4,80 \times 10^{-2}\ m$ ✓	$v_f^{\ 2} = v_i^2 + 2a\ \Delta x$ ✓ $(6,25 \times 10^3)^2 = 0^2 + 2(3,125 \times 10^6)\Delta x$ ✓ $\Delta x = 6,25\ m$ ✓

Using equations of motion / *Gebruik van bewegingsvergelykings*	
OPTION 3/*OPSIE* 3	**OPTION/*OPSIE* 4**
$\Delta x = ½(v_f + v_i)\ \Delta t$ ✓ $= ½(6,25 \times 10^3 + 0)(2 \times 10^{-3})$ ✓ $\Delta x = 6,25\ m$ ✓	$\Delta x = v_i\ \Delta t + ½\ a\ \Delta t^2$ ✓ $= 0 + ½(3,125 \times 10^6)(2 \times 10^{-3})^2$ ✓ $\Delta x = 6,25\ m$ ✓

(3)

7.3.3

Positive marking from Question 7.3.1 and 7.3.2 ***Positiewe merk vanaf Vraag 7.3.1en 7.3.2***	
OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
$F_E = \frac{kQ_1Q_2}{r^2}$ ✓ $15,625$ ✓$= \frac{9x10^9\ x\ Q\ x\ 2x10^{-6}}{\left(4,80x10^{-2}\right)^2}$ ✓ $\therefore Q = 2,00 \times 10^{-6}\ C$ ✓	$F_E = \frac{kQ_1Q_2}{r^2}$ ✓ $15,625$ ✓$= \frac{(9 \times 10^9)(Q1)(2 \times 10^{-6})}{6,25^2}$ ✓ $\therefore Q = 3,39 \times 10^{-2}\ C$ ✓

(4)
[19]

QUESTION/*VRAAG* 8

8.1 Resistance/*Weerstand* ✓ (1)

8.2 8.2.1 Gradient/*Helling* = $\frac{4,2 - 0,2}{24 - 0}$ ✓

$= \frac{1}{6}$

$= \frac{1}{\text{emf}}$

$\frac{1}{\text{emf}} = \frac{1}{6}$ ✓

∴ emf = 6 V ✓ (4)

8.2.2

Positive marking from Question 8.2.1/*Positiewe merk vanaf Vraag 8.2.1*	
OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
Intercept on vertical axis = $\frac{r}{\text{emf}}$ $0,2 = \frac{r}{\text{emf}}$ ✓ $0,2 = \frac{r}{6}$ ✓ r = 1,2 Ω ✓	$\varepsilon = I(R + r)$ ✓ $6 = \frac{1}{4,2}(24 + r)$ ✓ r = 1,2 Ω ✓

(3)

8.3 8.3.1

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
P = VI ✓ 3 = I x 1,5 ✓ I = 2 A ✓	$P = \frac{V^2}{R}$ $3 = \frac{1,5^2}{R}$ R = 0,75 Ω P = I^2 R ✓ 3 = I^2 x 0,75 ✓ I = 2 A ✓

(3)

8.3.2

Positive marking from Question 8.2.1en 8.2.2 ***Positiewe merk vanaf Vraag 8.2.1en 8.2.2***	
OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
$P = \frac{V^2}{R_{\text{toy car}}}$ $3 = \frac{1,5^2}{R_{\text{toy car}}}$ ✓ $R_{\text{toy car}}$ = 0,75 Ω emf = I (R_{ext} + r) ✓ 6 = 2 (R_{ext} + 1,2) ✓ R_{ext} = 1,8 Ω $R_{\text{ext}} = R_{\text{toy car}} + R_p$ $1,8 = 0,75 + R_p$ ✓ R_p = 1,05 Ω $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{1,05} = \frac{1}{3} + \frac{1}{R}$ ✓ R = 1,62 Ω ✓	$P = \frac{V^2}{R_{\text{toy car}}}$ $3 = \frac{1,5^2}{R_{\text{toy car}}}$ ✓ $R_{\text{toy car}}$ = 0,75 Ω emf = I (R_{ext} + r) ✓ 6 = 2 (R_{ext} + 1,2) ✓ R_{ext} = 1,8 Ω $R_{\text{ext}} = R_{\text{toy car}} + R_p$ $1,8 = 0,75 + R_p$ ✓ R_p = 1,05 Ω $R_p = \frac{R_1 R_2}{R_1 + R_2}$ $1,05 = \frac{3 \times R}{3 + R}$ ✓ R = 1,62 Ω ✓

(6)

8.4 No, ✓ the external resistance will increase. Current will decrease. ✓
$P = I^2R$, P α I^2 since resistance remain constant, power will decrease. ✓
Nee, ✓ die eksterne weerstand sal toeneem. Stroom sal afneem. ✓
$P = I^2R$, P α I^2 *aangesien die weerstand constant bly sal die drywing afneem.* ✓ (3)
[20]

QUESTION/*VRAAG* 9

9.1 (Electric) motor/ (*Elektriese) motor* ✓ (1)

9.2 Electrical energy ✓to mechanical energy ✓
Elektriese energie ✓*na meganiese energie* ✓ (2)

9.3 CLOCKWISE / *KLOKSGEWYS* ✓ (1)

9.4 Replace the split ring with slip rings. ✓
Replace the cell with a resistor / ammeter / voltmeter. ✓
Vervang die split ring met sleepringe ✓
Vervang die sel met 'n resistor / ammeter / voltmeter. ✓ (2)

9.5 9.5.1

$$P_{average} = \frac{V_{rms}^2}{R} \checkmark$$

$$1500 = \frac{230^2}{R} \checkmark$$

$R = 35{,}27\ \Omega$ ✓ (3)

9.5.2

OPTION 1/*OPSIE* 1	**OPTION 2/*OPSIE* 2**
$R = \frac{V_{rms}}{I_{rms}}$ $35{,}27 = \frac{230^2}{I_{rms}}$ ✓ $I_{rms} = 6{,}52$ A $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $6{,}52 = \frac{I_{max}}{\sqrt{2}}$ ✓ $I_{max} = 9{,}22$ A ✓	$P_{average} = V_{rms}I_{rms}$ $1\,500 = I_{rms} \times 230$ ✓ $I_{rms} = 6{,}52$ A $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $6{,}52 = \frac{I_{max}}{\sqrt{2}}$ ✓ $I_{max} = 9{,}22$ A ✓

(4)
[13]

TOTAL/*TOTAAL*: 150

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CHEMISTRY PAPER 2 MEMORANDA

basic education

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PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

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QUESTION/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	D ✓✓	(2)
1.3	B ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	B ✓✓	(2)
1.7	C ✓✓	(2)
1.8	D ✓✓	(2)
1.9	A ✓✓	(2)
1.10	D ✓✓	(2)
		[20]

QUESTION/*VRAAG 2*

2.1 Compounds with one or more multiple bonds between C atoms in the hydrocarbon chain. ✓✓ (2 or 0)
V rbindings m t n of m r m rvo dig bindings t ss n C-atom in die koolwat rstofk ttings. (of 0)
OR/*OF*
A hydrocarbon with two or more bonds between the C-atoms.
'n Koolwaterstof met tw of m r bindings t ss n di C-atom .
OR/*OF*
Hydrocarbons containing not only single bonds between C atoms.
Koolwat rstoww wat ni sl gs nk lbindings t ss n di C-atom b vat ni .
ACCEPT/*AANVAAR:*
Compounds with one or more double/triple bonds between C atoms in the hydrocarbon chain.
V rbindings m t n of m r d bb l tripp lbindings t ss n C-atom in di koolwat rstofk ttings. (2)

2.2.1 D ✓ (1)

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2.2.2 2,4-dimethylhexane ✓✓✓
2,4-dimetielheksaan

Marking criteria:
- Correct stem i.e. hexane. ✓
- Substituents (dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Substituente (dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

2.2.3 Propan-2-ol /2-propanol ✓✓

Marking criteria:
- Correct stem i.e. propanol. ✓
- IUPAC name completely correct including numbering and hyphens. ✓

Nasienkriteria:
- *Korrekte stam d.i. propanol.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering en koppeltekens.* ✓

(2)

2.2.4 hept-1-ene/1-heptene ✓✓
hept-1-een/1-hepteen

Marking criteria:
- Correct stem i.e. heptene. ✓
- IUPAC name completely correct including numbering and hyphens. ✓

Nasienkriteria:
- *Korrekte stam d.i. hepteen.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering en koppeltekens.* ✓

(2)

2.2.5 **Marking criteria/*Nasienkriteria***
- Correct molecular formula: C_8H_{18} ✓
  Korrekte molekulêre formula: C_8H_{18}
- Correct molecular formula of inorganic reactant and products. ✓
  Korrekte molekulêre formule vir die anorganiese reaktant en produkte.
- Balancing/*Balansering* ✓

$2C_8H_{18}$ ✓ + $25O_2 \rightarrow 16CO_2 + 18H_2O$ ✓ Bal ✓

Notes/*Aantekeninge:*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- If condensed structural formulae used:/*Indien gekondenseerde struktuurformules gebruik:* Max/*Maks.* $\frac{2}{3}$

(3)

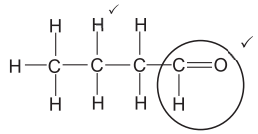
2.3.1 **Marking criteria/*Nasienkriteria***
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

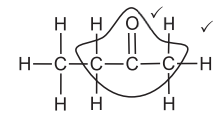
Compounds with the same molecular formula but different functional groups/homologous series. ✓✓
Verbindings met dieselfde molekulêre formule maar verskillende funksionele groepe/homoloë reekse.

(2)

2.3.2 **Marking criteria/*Nasienkriteria*:**

• Functional group for aldehyde correct ✓ *Funksionele groep van aldehied korrek* • Whole structure of aldehyde correct ✓ *Hele struktuur van aldehied korrek*	• Functional group for ketone correct ✓ *Funksionele groep van ketoon korrek* • Whole structure of ketone correct ✓ *Hele struktuur van ketoon korrek*





(4)

2.4 **Marking criteria**
- Calculate the mass/percentage of oxygen. ✓
- Substitute correct mass and molar mass for both C and H into $n = \frac{m}{M}$. ✓
- Substitute correct mass and molar mass for O into $n = \frac{m}{M}$. ✓
- Simplify ratio. (Accept correct empirical formula if no ratio is given.) ✓
- Correct molecular formula. ✓✓

Nasienkriteria:
- *Bereken die massa/persentasie suurstof.* ✓
- *Vervang korrekte massa en molêre massa vir beide C en H in $n = \frac{m}{M}$.* ✓
- *Vervang korrekte massa en molêre massa vir O in $n = \frac{m}{M}$.* ✓
- *Vereenvoudig verhouding.* (Aanvaar korrekte empiriese formule indien geen verhouding nie) ✓
- *Korrekte molekulêre formule.* ✓✓

OPTION 1/*OPSIE 1*

	C	H	O
Mass / *Massa*	1,09	0,18	2 – (1,09 + 0,18) ✓ = 0,73
Moles /*mol*	$n = \frac{m}{M}$ $= \frac{1,09}{12}$ = 0,0908	$n = \frac{m}{M}$ $= \frac{0,18}{1}$ ✓ = 0,18	$n = \frac{m}{M}$ $= \frac{0,73}{16}$ ✓ = 0,046
Simplest ratio *Eenvoudigste verhouding*	2	4	1 ✓
Empirical formula *Empiriese formule*	C_2H_4O		

$M(C_2H_4O) \times n = 88\ (g \cdot mol^{-1})$
$44n = 88$
$n = 2$

Molecular formula of compound **X**/
Molekulêre formule van verbinding **X**: $C_4H_8O_2$ ✓✓

OPTION 2/*OPTION 2*

	C	H	O
Percentage/Persentasie	54,5	9	36,5 ✓
Moles /*mol*	$n = \frac{m}{M}$ $= \frac{54,5}{12}$ $= 4,5417$	$n = \frac{m}{M}$ $= \frac{9}{1}$ $= 9$ ✓	$n = \frac{m}{M}$ $= \frac{36,5}{16}$ ✓ $= 2,28$
Simplest ratio *Eenvoudigste verhouding*	2	4	1 ✓
Empirical formula *Empiriese formule*	C_2H_4O		

$M(C_2H_4O) \times n = 88\ (g \cdot mol^{-1})$
$44n = 88$
$n = 2$

Molecular formula of compound **X**/
Molekulêre formule van verbinding **X**: $C_4H_8O_2$ ✓✓ (6)

[25]

QUESTION/*VRAAG 3*

3.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The temperature at which the vapour pressure (of a compound) equals atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk (van 'n verbinding) gelyk is aan die atmosferiese druk. (2)

3.2

Marking criteria/*Nasienkriteria*
- Compare compounds in terms of branches/chain lengths/surface area. ✓ *Vergelyk verbindings in terme van vertakkings/kettinglengte/oppervlakarea.*
- Compare strengths of IMF's/*Vergelyk sterkte van IMK'e.*✓
- Compare energy/*Vergelyk energie* ✓

Butan-1-ol ✓
- Has a longer chain length./is less branched./has a larger surface area/ contact area. ✓
- Strength of the intermolecular forces is greater./There are more sites for London forces. ✓
- More energy is needed to overcome/break intermolecular forces. ✓

- *Het 'n langer kettinglengte./is minder vertak./het 'n groter kontakoppervlak/reaksieoppervlak.* ✓
- *Sterkte van die intermolekulêre kragte verhoog./Daar is meer plekke vir Londonkragte.* ✓
- *Meer energie word benodig om die intermolekulêre kragte te oorkom/breek.* ✓

OR/*OF*
- 2-methylpropan-1-ol has a shorter chain length./is more branched./ has a smaller surface area/contact area.
- Strength of the intermolecular forces is weaker./There are fewer sites for London forces.
- Lesser energy is needed to overcome/break intermolecular forces.

- *2-metielpropan-1-ol het 'n korter kettinglengte./is meer vertak./het 'n kleiner kontakoppervlak/reaksieoppervlak.*
- *Sterkte van die intermolekulêre kragte is swakker./Daar is minder plekke vir Londonkragte.*
- *Minder energie word benodig om intermolekulêre kragte te oorkom/breek.* (4)

3.3 Boiling point/*Kookpunt* ✓ (1)

3.4

3.4.1 S ✓ (1)

3.4.2 P ✓ (1)

3.4.3 R ✓ (1)

3.5 Propanoic acid/P has the strongest intermolecular forces. ✓
OR
Two sites for hydrogen bonding (which is stronger than other intermolecular forces).
OR
Most energy needed to separate the chains.

Propanoësuur/P het die sterkste intermolekulêre kragte.
OF
Twee plekke vir waterstofbindings (wat sterker is as die ander intermolekulêre kragte).
OF
Meeste energie benodig om kettings te skei. (1)
[11]

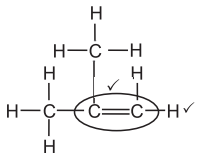
QUESTION/*VRAAG 4*

4.1
4.1.1 Halogenation/Bromination ✓
Halogenering/Brominering (1)

4.1.2 The bromine water/Br_2/solution decolourises./Brown colour disappears. ✓
Die broomwater/Br_2/oplossing ontkleur./Bruin kleur verdwyn.

OR/*OF*
Bromine water/Br_2/solution changes from brown/reddish to colourless.
Broomwater/Br_2/oplossing verander van bruin/rooierig na kleurloos. (1)

4.1.3



Marking criteria/*Nasienkriteria*
• Functional group correct ✓ *Funksionele groep korrek*
• Whole structure correct ✓ *Hele struktuur korrek*

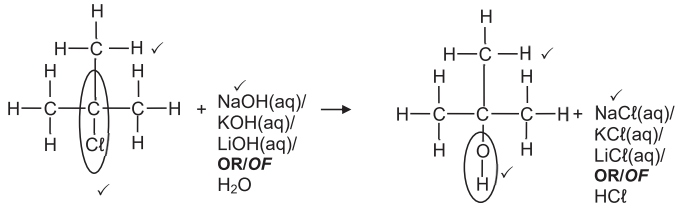
(2)

4.1.4 2-chloro-2-methyl✓propane✓ /*2-chloro-2-metielpropaan*

ACCEPT/*AANVAAR*:
2-chloromethylpropane / 2-*chlorometielpropaan* (2)

4.1.5

Marking criteria:
• C*ℓ* atom on second C atom on compound R ✓
• Whole structure of compound R correct ✓
• React compound R with NaOH(aq)/ KOH(aq)/LiOH(aq) **OR** H_2O ✓
• OH-group replaces C*ℓ* atom at the same position. ✓
• Whole structure of alcohol correct. ✓
• NaC*ℓ*(aq)/KC*ℓ*(aq)/LiC*ℓ*(aq) **OR** HC*ℓ*(aq) ✓ (must correspond to the inorganic reactant used)
Nasienkriteria:
• *C*ℓ*-atoom op tweede C-atoom van verbinding R* ✓
• *Hele struktuur van verbinding R korrek* ✓
• *Reageer verbinding R met NaOH*(aq)*/ KOH*(aq)*/LiOH*(aq) ***OF*** *H_2O* ✓
• *OH-groep vervang C*ℓ*-atoom by dieselfde posisie.* ✓
• *Hele struktuur van alkohol korrek.* ✓
• *NaC*ℓ*(aq)/KC*ℓ*(aq)/LiC*ℓ*(aq)* ***OF*** *HC*ℓ*(aq)* ✓ *(moet ooreenstem met die anorganiese reaktans gebruik)*



Notes/*Aantekeninge*:
• Ignore/*Ignoreer* ⇌
• Accept all inorganic reagents as condensed./*Aanvaar alle anorganiese reagense as gekondenseerd.*
• Accept coefficients that are multiples. *Aanvaar koëffisiënte wat veelvoude is.*
• Any additional reactants and/or products *Enige addisionele reaktanse en/of produkte:* Max./*Maks.* $^5/_6$
• Incorrect balancing/*Verkeerde balansering*: Max./*Maks.* $^5/_6$
• Molecular formulae/*Molekulêre formule*: Max./*Maks.* $^3/_6$
• Condensed formulae/*Gekondenseerde formule:* Max./*Maks.* $^4/_6$
Accept/*Aanvaar*: -OH as condensed / *-OH as gekondenseerd*

Condensed formulae/*Gekondenseerde formule:*

$CH_3C(CH_3)C\ell CH_3$ ✓ + NaOH(aq)/ KOH(aq)/ LiOH(aq)/ **OR/*OF*** H_2O ✓ → $CH_3C(CH_3)OHCH_3$ ✓ + NaC*ℓ*(aq)/ KC*ℓ*(aq)/ LiC*ℓ*(aq)/ **OR/*OF*** HC*ℓ* ✓

(6)

4.1.6 2-methyl✓propan-2-ol✓/2-methyl-2-propanol
2-metielpropan-2-ol/2-metiel-2-propanol
ACCEPT/AANVAAR:
Methylpropan-2-ol/ *Metielpropan-2-ol* (2)

4.1.7 Dehydration/*Dehidrasie/Dehidratering* ✓ (1)

4.2.1 Esterfication/Condensation ✓
Verestering/Esterfikasie/Kondensasie (1)

4.2.2 Butyl✓propanoate ✓
Butielpropanoaat (2)
[18]

QUESTION/*VRAAG 5*

5.1 Initial concentration is 0 (of NO_2)./Concentration increases./
Curve starts at 0. ✓
Beginkonsentrasie is 0 (van NO_2)./Konsentrasie verhoog./Kurwe begin by 0.

OR/*OF*
Curve B has an initial concentration and is the reactant as its concentration decreases.
Kurwe B het 'n beginkonsentrasie en is die reaktant aangesien sy konsentrasie afneem. (1)

5.2 True/*Waar* ✓
n mol of N_2O_5 forms 2n mol of NO_2 per unit time. ✓
n mol N_2O_5 vorm 2n mol NO_2 per eenheidstyd.

OR/*OF*
Gradient of graph for NO_2 is twice the gradient of graph for N_2O_5.
Gradiënt van grafiek vir NO_2 is twee keer die gradiënt van grafiek vir N_2O_5.
NOTE/*LET WEL*:
If gradients calculated correctly award mark.
Indien gradiënte korrek bereken word punt toegeken. (2)

5.3.1

Marking criteria/*Nasienkriteria:*
- Formula: $c = \frac{m}{MV}$ / $n(NO_2) = cV$ / $n(NO_2) = \frac{m}{M}$ ✓
- Substitute change in concentration. ✓
  Vervang verandering in konsentrasie .
- Substitute M (46) and V (2)./*Vervang M (46) en V (2).* ✓
- Final correct answer/ *Finale korrekte antwoord:* 1,84 g ✓

OPTION 1/*OPSIE 1*

$c(NO_2) = \frac{m}{MV}$ ✓

200×10^{-4} ✓ $= \frac{m}{(46)(2)}$ ✓

m = 1,84 g ✓

OPTION 2/*OPSIE 2*

$n(NO_2) = cV$ ✓

✓ either/ *enige een*: $= (200 \times 10^{-4})$ ✓ x 2 $= 4 \times 10^{-2}$ mol

$n(NO_2) = \frac{m}{M}$

$4 \times 10^{-2} = \frac{m}{46}$

✓ both/ *beide*

m = 1,84 g ✓ (4)

5.3.2

Marking criteria/*Nasienkriteria:*
- Substitute the change in concentration into rate formula. ✓
  Vervang verandering in konsentrasie in tempo formule.
- Substitute time into the rate formula./ *Vervang tyd in tempo formule.* ✓
- Use mol ratio/*Gebruik molverhouding:* rate/*tempo*(O_2) = ½ rate/*tempo*(N_2O_5)/ rate/*tempo*(O_2) = ¼ rate/*tempo*(NO_2) ✓
- Final correct answer/*Finale korrekte antwoord:* 1×10^{-5} (mol·dm^{-3}·s^{-1}) ✓

NOTE/LET WEL
If concentration is converted to moles, final moles per s (mol·s^{-1}) must be converted back to concentration (mol·dm^{-3}·s^{-1}). i.e. there must be multiplication and division by 2. If one of these is omitted: Max. $^2/_4$
Indien konsentrasie omgeskakel is na mol, moet die finale mol per s (mol·s^{-1}) omgeskakel word na konsentrasie (mol·dm^{-3}·s^{-1}) d.w.s daar moet vermenigvuldig en gedeel word deur 2. Indien een van hierdie uitgelaat word: Maks. $^2/_4$

OPTION 1/*OPSIE 1*

Ave rate/*gem tempo* $= -\frac{\Delta c(N_2O_5)}{\Delta t}$

$= -\frac{(60 \times 10^{-4} - 200 \times 10^{-4})}{700 (- 0)}$ ✓✓

$= 2 \times 10^{-5}$ (mol·dm^{-3}·s^{-1})

rate(O_2) = ½ rate(N_2O_5) = ½(2×10^{-5}) ✓

$= 1 \times 10^{-5}$ (mol·dm^{-3}·s^{-1}) ✓

OPTION 2/*OPSIE 2*

Ave rate/*gem tempo* $= \frac{\Delta c(NO_2)}{\Delta t}$

$= \frac{(280 \times 10^{-4} (- 0))}{700 (- 0)}$ ✓✓

$= 4 \times 10^{-5}$ (mol·dm^{-3}·s^{-1})

rate(O_2) = ¼ rate(NO_2) = ¼(4×10^{-5}) ✓

$= 1 \times 10^{-5}$ (mol·dm^{-3}·s^{-1}) ✓

OPTION 3/*OPSIE 3*

$\Delta c(O_2) = ½\ \Delta c(N_2O_5)$ **OR/*OF*** $\Delta c(O_2) = ¼\Delta c(NO_2)$

$= ½\ (60 \times 10^{-4} - 200 \times 10^{-4})$ ✓ $= ¼(280 \times 10^{-4}$ ✓$(-0))$

$= ½\ (140 \times 10^{-4})$ $= 7 \times 10^{-3}\ mol{\cdot}dm^{-3}$

$= 7 \times 10^{-3}\ mol{\cdot}dm^{-3}$ $= 7 \times 10^{-3}\ mol{\cdot}dm^{-3}$

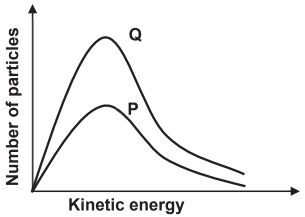
Ave rate/*gem tempo* $= \frac{\Delta c(O_2)}{\Delta t}$

$= \frac{(7 \times 10^{-3})}{700\ (-0)}$ ✓

$= 1 \times 10^{-5}\ (mol{\cdot}dm^{-3}{\cdot}s^{-1})$ ✓ (4)

5.4

5.4.1



Marking criteria/*Nasienkriteria*

- Curve Q must be above the given curve P and have the same shape as the given curve P and the peaks have to correspond. ✓
  Kurwe Q moet bo die gegewe kurwe P wees en moet dieselfde vorm hê as die gegewe kurwe P en die maksimums moet ooreenstem
- Starts at origin and not crossing curve P. ✓
  Begin by oorsprong en nie kruis met kurwe P nie.

(2)

5.4.2 Higher than/*Hoër as* ✓

- When the concentration of N_2O_5 is higher there are <u>more N_2O_5 particles per unit volume</u>. ✓
- <u>More effective collisions per unit time</u>/second. ✓
  OR
  Higher frequency of effective collisions.

- *'n Hoër konsentrasie van N_2O_5 bevat <u>meer N_2O_5-deeltjies per eenheidsvolume</u>.* ✓
- *<u>Meer effektiewe botsings per eenheidstyd/</u>sekonde.* ✓
  OF
  Hoër frekwensie van effektiewe botsings. (3)

[16]

QUESTION/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria:*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

<u>When the equilibrium in a closed system is disturbed</u>, the system will <u>re-instate a (new) equilibrium</u> by <u>favouring the reaction</u> that will <u>cancel/oppose the disturbance.</u> ✓✓
<u>Wanneer die ewewig in 'n geslote sisteem versteur word</u>, sal die sisteem 'n (nuwe) <u>ewewig instel</u> deur <u>die reaksie te bevoordeel</u> wat die <u>versteuring kanselleer/teenwerk</u>. (2)

6.2

6.2.1 $n[H_2(g)] = 0,11$ (mol) ✓ (1)

6.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(HI)_{used/gebruik} = 2n(I_2)$	$K_c = \frac{[H_2][I_2]}{[HI]^2}$
$= 2(0,11)$	$0,02 = \frac{(0,11)(0,11)}{[HI]^2}$
$n(HI)_{eq} = 1 - 0,22$	$[HI] = 0,78\ mol{\cdot}dm^{-3}$
$= 0,78$ (mol) ✓	$n(HI) = 0,78$ (mol) ✓

(1)

6.3

6.3.1 Endothermic/*Endotermies* ✓ (1)

6.3.2 K_c increased:

- The concentration of the product/$H_2(g)$ and $I_2(g)$ is increased. ✓
  OR: The concentration of the reactant/HI decreases.
- The increase in temperature favoures the forward reaction. ✓
- (According to Le Chatelier's principle) an increase in temperature favours the endothermic reaction. ✓

K_c het verhoog:

- *Die konsentrasie van die produkte/$H_2(g)$ en $I_2(g)$* verhoog. ✓
  OF: Die *konsentrasie van die reaktanse/HI verlaag.*
- *'n Toename in temperatuur bevoordeel die voorwaartse reaksie.* ✓
- *(Volgens Le Chatelier se beginsel) sal 'n toename in temperatuur die endotermiese reaksie bevoordeel.* ✓ (3)

6.3.3

POSITIVE MARKING FROM Q6.2/*POSITIEWE NASIEN VANAF V6.2*

Marking criteria:	***Nasienkriteria:***
(a) Correct K_c expression (formulae in square brackets). ✓	*(a) Korrekte K_c uitdrukking (formules in vierkantige hakies).* ✓
(b) Substitution of 0,09 in Kc expression. ✓	*(b) Vervang 0,09 in Kc uitdrukking.* ✓
(c) Correct initial moles from 6.2.1 and 6.2.2. ✓	*(c) Aanvanklike mol korrek vanaf 6.2.1 en 6.2.2.* ✓
(d) USING ratio: $nHI(g) : 2nI_2(g) = 1:2$ ✓	*(d) GEBRUIK verhouding: $nHI(g) : 2nI_2(g) = 1:2$* ✓
(e) Substitution of concentrations into correct K_c expression. ✓	*(e) Vervang konsentrasies in korrekte K_c uitdrukking.* ✓
(f) Subtraction $[HI]_{ini} - \Delta[HI]$ ✓	*(f) Verskil: $[HI]_{aanv} - \Delta[HI]$* ✓
(g) Substitution of 128 in m = nM. ✓	*(g) Vervang 128 in m = nM.* ✓
(h) Final answer: 80,64 g ✓ (range: 79,36 - 80,64 g)	*(h) Finale antwoord*: 80,64 g ✓ *(gebied*: 79,36 - 80,64 g)

OPTION 1/*OPSIE 1*

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓ **(a)**

✓ **(c)** (0,11 and/*en* 0,78 from 6.2.1 and/*en* 6.2.2)

(b) ✓ $0,09 = \frac{(0,11 + x)(0,11 + x)}{(0,78 - 2x)^2}$ ✓**(e)** ✓**(d)**

$x = 0,0775$

$[HI]_{equilibrium/ewewig} = [HI]_{ini/aanv} - \Delta[HI]$

$= \underline{0,78 - 2(0,0775)}$ ✓**(f)**

$= 0,63\ mol{\cdot}dm^{-3}$ (0,625)

$n(HI) = cV$

$= (0,63)(1)$

$= 0,63$ mol (0,625)

$m(HI) = nM$

$= (0,63)(128)$ ✓ **(g)**

$= 80,64$ g ✓ **(h)**

OR/*OF*

$m(HI) = cVM$

$= (0,63)(1)(128)$ ✓ **(g)**

$= 80,64$ g ✓ **(h)**

OPTION 2/*OPSIE 2*

	HI	I_2	H_2
Initial quantity (mol) *Aanvanklike hoeveelheid (mol)*	0,78	0,11	0,11
Change (mol) *Verandering (mol)*	2x	x	x
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	0,78 - 2x	0,11 + x	0,11 + x
Equilibrium concentration *Ewewigskonsentrasie* ($mol{\cdot}dm^{-3}$)	$\frac{0,78 - 2x}{1}$	$\frac{0,11+ x}{1}$	$\frac{0,11+ x}{1}$

Ratio 1:2 ✓

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓**(a)**

(b) ✓ $0,09 = \frac{(0,11 + x)(0,11 + x)}{(0,78 - 2x)^2}$ ✓**(e)**

$x = 0,0775$

$[HI]_{equilibrium/ewewig} = \underline{0,78 - 2(0,0775)}$ ✓ **(f)**

$= 0,63\ mol{\cdot}dm^{-3}$ (0,625)

$n(HI) = cV$

$= (0,63)(1)$

$= 0,63$ mol (0,625 mol)

$m(HI) = nM$

$= (0,63)(128)$ ✓**(g)**

$= 80,64$ g ✓**(h)**

OR/*OF*

$m(HI) = cVM$

$= (0,63)(1)(128)$ ✓ **(g)**

$= 80,64$ g ✓ **(h)**

(8)
[16]

QUESTION/*VRAAG 7*

7.1

7.1.1 **ANY ONE**:

- A substance whose aqueous solution contains ions. ✓✓ **(2 or 0)**
- Substance that dissolves in water to give a solution that conducts electricity.
- A substance that forms ions in water/forms ions when molten.

ENIGE EEN:

- *'n Stof waarvan die oplossing ione bevat.* ✓✓ ***(2 of 0)***
- *'n Stof wat in water oplos om 'n oplossing te vorm wat elektrisiteit gelei.*
- *'n Stof wat ione vorm in water/ione vorm wanneer gesmelt.* (2)

7.1.2 A ✓
H_2SO_4 is diprotic./Donates more than one mole of H^+ ions per mole of acid ✓ (and both acids are of the same concentration)./H_2SO_4 has a higher K_a value.
H_2SO_4 is diproties./Skenk meer as een mol H^+ ione per mol suur (en beide sure het dieselfde konsentrasie)/ H_2SO_4 het 'n hoër K_a-waarde.

OR/*OF*
It ionises to produce more than one mole of protons/H^+ ions for each mole of H_2SO_4./H_2SO_4 has a higher K_a value.
Dit ioniseer om meer as een mol protone/ H^+-ione vir elke mol H_2SO_4 te vorm./H_2SO_4 het 'n hoër K_a-waarde. (2)

7.1.3 B ✓
Stronger acid/ionises completely ✓(and both acids are of the same concentration)./HNO_3 has a higher K_a value.
Sterker suur/ioniseer volledig (en beide sure het dieselfde konsentrasie)./ HNO_3 het 'n hoër K_a-waarde.

OR/*OF*
C/CH_3COOH is a weaker acid/ionises incompletely.
C/CH_3COOH is 'n swak suur/ioniseer onvolledig. (2)

7.2
7.2.1

Marking criteria/*Nasienkriteria:*
- Substitute/*Vervang* 0,04 mol·dm^{-3} and 25 x 10^{-3} dm^3 (25 cm^3) and 19,5 x 10^{-3} dm^3 (19,5 cm^3). ✓
- USE mol ratio:/*GEBRUIK molverhouding:* $n(Na_2CO_3) : n(HC\ell) = 1 : 2$ ✓
- Final answer/*Finale antwoord:* 0,10 to/*tot* 0,103 mol·dm^{-3} ✓

OPTION 1/*OPSIE 1*

$$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$$

$$\frac{c_a(19,5)}{(0,04)(25)} \overset{\checkmark}{=} \frac{2}{1} \checkmark$$

c_a = 0,10 mol·dm^{-3} ✓ (0,103)

OPTION 2/*OPSIE 2*

$n(Na_2CO_3) = cV$
$= 0,04 \times 0,025$
$= 0,001$ mol
$n(HC\ell) = 2n(Na_2CO_3)$
$= 0,002$ mol ✓

$[HC\ell] = \frac{n}{V}$
$= \frac{0,002}{0,0195}$
= 0,10 mol·dm^{-3} ✓ (0,103) ✓

(3)

7.2.2 Greater than/*Groter as* ✓
(-) The few drops of water will dilute the HCℓ, ✓therefore greater volume of acid will be needed to neutralise the base.
'n Paar druppels water sal die HCℓ verdun, daarom sal 'n groter volume suur benodig word om die basis te neutraliseer. (2)

7.2.3

POSITIVE MARKING FROM Q7.2.1/*POSITIEWE NASIEN VANAF V7.2.1*

Marking criteria:
(a) Substitute 0,1 mol·dm^{-3} & 18,7 x 10^{-3} dm^3 (18,7 cm^3). ✓
(b) Use mole ratio: 1:1 ✓
(c) Calculate $n(NH_3)$ / $m(NH_3)$ in 250 cm^3; Substitute 0,25 dm^3 (250 cm^3) ✓
(d) Substitute 0,022 dm^3 (22 cm^3). ✓
(e) Substitute 0,02 dm^3 (20 cm^3) to calculate mole/mass in initial solution. ✓
(f) Use 17 g·mol^{-1} in $n = \frac{m}{M}$. ✓
(g) Final answer: 18,06 g ✓
Range: 17 to 19,13 g

Nasienkriteria:
(a) *Vervang 0,1 mol·dm^{-3} & 18,7 x 10^{-3} dm^3 (18,7 cm^3).* ✓
(b) *Gebruik molverhouding: 1:1* ✓
(c) *Bereken $n(NH_3)$ / $m(NH_3)$ in 250 cm^3: Vervang 0,25 dm^3 (250 cm^3).* ✓
(d) *Vervang 0,022 dm^3 (22 cm^3).* ✓
(e) *Vervang 0,02 dm^3 (20 cm^3) om mol/massa van oorspronklike oplossing te bereken.* ✓
(f) *Gebruik 17 g·mol^{-1} in* $n = \frac{m}{M}$. ✓
(g) *Finale antwoord:* 18,06 g ✓
Gebied: 17 *tot* 19,13 g

OPTION 1/*OPSIE 1*

$n(HC\ell) = cV$
$= (0,1)(18,7 \times 10^{-3})$ ✓ **(a)**
$= 1,87 \times 10^{-3}$ mol

$n(NH_3)_{reacted/reageer} = n(HC\ell)_{reacted/reageer}$
$= 1,87 \times 10^{-3}$ mol ✓**(b)**

$n(NH_3)$ in 22 cm^3 = $1,87 \times 10^{-3}$ mol

$n(NH_3)$ in 250 cm^3 = $\frac{(1,87 \times 10^{-3})(250)}{22}$ ✓ **(c)** ✓ **(d)**
$= 0,021$ mol
$(2,13 \times 10^{-2})$

$n(NH_3)$ in initial 20 cm^3 = 0,021 mol

$n = \frac{m}{M}$
$0,021 = \frac{m}{17}$ ✓ **(f)**
$m(NH_3) = 0,357$ g in 20 cm^3

$m(NH_3) = \frac{(0,357)(1000)}{20}$ ✓ **(e)**
= 17,85 g✓**(g)** (18,06)

OPTION 2/*OPSIE 2*

$n(HC\ell) = cV$
$= (0,1)(18,7 \times 10^{-3})$ ✓**(a)**
$= 1,87 \times 10^{-3}$ mol

$(NH_3)_{reacted/reageer} = n(HC\ell)_{reacted/reageer}$
$= 1,87 \times 10^{-3}$ mol ✓ **(b)**

$n(NH_3)$ in 22 cm^3 = $1,87 \times 10^{-3}$ mol

$n = \frac{m}{M}$
$1,87 \times 10^{-3} = \frac{m}{17}$ ✓ **(f)**
$m(NH_3) = 3,72 \times 10^{-3}$ g in 22 cm^3

$m(NH_3)$ in 250 cm^3 = $\frac{(3,72 \times 10^{-3})(250)}{22}$ ✓ **(c)** ✓ **(d)**
= 0,361 g

$m(NH_3)$ in initial 20 cm^3 = 0,361 g

$m(NH_3)$ in 1 000 cm^3 = $\frac{(0,361)(1000)}{20}$ ✓**(e)**
= 18,06 g✓**(g)**

(7)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$\frac{c_bV_b}{c_aV_a} = \frac{n_b}{n_a}$ $\frac{c_b(22)}{(0,1)(18,7)} = \frac{1}{1}$ ✓(d) ✓ (a) ✓ (b) $c_1 = 0,085\ mol{\cdot}dm^{-3}$ $[NH_3]$ in 22 cm^3 = 0,085 $mol{\cdot}dm^{-3}$ $[NH_3]$ in 250 cm^3 = 0,085 $mol{\cdot}dm^{-3}$ $c_1V_1 = c_2V_2$ $c_1(0,02) = \frac{(0,085)(0,25)}{(e)}$ ✓ ✓ (c) $c_1 = 1,06\ mol{\cdot}dm^{-3}$ m = cVM (f) = (1,06)(1)(17✓) = 18,06 g ✓ (g)	n(HCℓ)= cV = (0,1)(18,7 x 10^{-3}) ✓ (a) = 1,87 x 10^{-3} mol $(NH_3)_{reacted/reageer} = n(HC\ell)_{reacted/reageer}$ = 1,87 x 10^{-3} mol ✓(b) n(NH_3) in 22 cm^3 = 1,87 x 10^{-3} mol ✓ (c) n(NH_3) in 250 cm^3 = $\frac{(1,87 \times 10^{-3})(250)}{22}$ ✓(d) = 0,021 mol c(20 cm^3)=c(1 dm^3) $\frac{n_1}{V_1} = \frac{n_2}{V_2}$ n(NH_3) in 1 000 cm^3 = $\frac{0,021 \times 1000}{20}$ ✓ (e) = 1,06 mol $n = \frac{m}{M}$ $1,06 = \frac{m}{17}$ ✓(f) m(NH_3) = 18,06 g ✓(g)

7.2.4 Less than 7/*Minder as 7* ✓

$NH_4^+(aq) + H_2O(\ell)$ ✓ ⇌ $NH_3(aq) + H_3O^+(aq)$ ✓

Notes/*Aantekeninge*:
• Ignore single arrow/*Ignoreer* enkelpyl: →

(3)
[21]

QUESTION/*VRAAG 8*

8.1
- Pressure: 1 atmosphere /101,3 kPa /1,01 x 10^5 Pa ✓
  Druk: 1 atmosfeer /101,3 kPa /1,01 x 10^5 Pa
- Temperature/*Temperatuur*: 25 °C /298 K ✓
- Concentration of electrolytes: 1 $mol{\cdot}dm^{-3}$ ✓
  Konsentrasie van elektroliete: 1 $mol{\cdot}dm^{-3}$

(3)

8.2 To maintain electrical neutrality/To complete the circuit/To allow movement of ions between electrolytes ✓
Om elektriese neutraliteit te verseker/Om die stroombaan te voltooi/Laat ione toe om tussen elektroliete te beweeg

(1)

8.3

OPTION 1/*OPTION 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓ 1,20✓ = $E^\theta_{cathode} - 0$ ✓ $E^\theta_{cathode}$ = 1,20 (V) ✓ X is Pt/platinum ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv. $E°_{sel} = E°_{OM} - E°_{RM}$ gevolg deur korrekte vervangings:* Max./*Maks.* 4/5

OPTION 2/*OPSIE 2*

✓ $X^{2+} + 2e^- \rightarrow X$ E^θ = 1,20 V ✓
✓ $H_2 \rightarrow 2H^+ + 2e^-$ E^θ = 0,00 V ✓
$H_2 + X^{2+} \rightarrow X + 2H^+$ E^θ = 1,20 V ✓
X is Pt/Platinum ✓

(5)

8.4 $H_2(g) \rightarrow 2H^+(aq) + 2e^-$ ✓✓

Marking criteria/*Nasienkriteria:*
• $2H^+(aq) + 2e^- \leftarrow H_2(g)$ (2/2) $H_2(g) \rightleftharpoons 2H^+(aq) + 2e^-$ (1/2) $H_2(g) \leftarrow 2H^+(aq) + 2e^-$ (0/2) $2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$ (0/2)
• Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
• If charge (+) omitted on H^+/*Indien lading (+) weggelaat op H^+*: Example/*Voorbeeld:* $H_2(g) \rightarrow 2H(aq) + 2e^-$ Max./*Maks.* 1/2

(2)

8.5 H^+, X^{2+} (Pt^{2+}), Au^{3+} ✓

- H_2 loses/donates electrons to both Au and X/Pt. ✓
  OR
  H_2 is the anode/is oxidised in both cells.
  Therefore H^+ is the weakest oxidising agent.
- The reduction potential of $X\,|\,X^{2+}$ is 1,2 V and that of $Au\,|\,Au^{3+}$ is 1,5 V. ✓
  OR
  The reduction potential of $X\,|\,X^{2+}$ is smaller than that of $Au\,|\,Au^{3+}$.
  OR
  According to the Table of Standard Reduction Potentials Au^{3+} is stronger oxidation agent than Pt^{2+}.
  OR
  The cell containing Au produces a higher emf than cell containing X.
- *H_2 verloor/skenk elektrone aan beide Au en X/Pt.* ✓
  OF
  H_2 is die anode/word geoksideer in beide selle.
  Daarom is H^+ die swakste oksideermiddel
- *Die reduksiepotensiaal van $X\,|\,X^{2+}$ is 1,2 V en die van $Au\,|\,Au^{3+}$ is 1,5 V.* ✓
  OF
  Die reduksiepotensiaal van $X\,|\,X^{2+}$ is kleiner as dié van $Au\,|\,Au^{3+}$.
  OF
  Volgens *die Tabel van Standaardreduksiepotensiale is Au^{3+} 'n sterker oksideermiddel as* Pt^{2+}
  OF
  Die sel wat Au bevat het 'n hoër emk as die sel wat X bevat. (3)

[14]

QUESTION/*VRAAG 9*

9.1 A cell in which electrical energy is converted into chemical energy. ✓✓ (2 or 0)
'n Sel waar elektriese energie na chemiese energie omgeskakel word. (2 of 0) (2)

9.2 R ✓
Oxidation takes place./R loses electrons./R decreases in mass. ✓
Oksidasie vind plaas./R verloor elektrone./R se massa sal afneem. (2)

9.3
9.3.1 $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ ✓✓
Ignore phases/*Ignoreer fases*

Marking criteria/*Nasienkriteria:*
- $Zn(s) \leftarrow Zn^{2+}(aq) + 2e^-$ ($\frac{2}{2}$) $Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$ ($\frac{1}{2}$)
  $Zn^{2+}(aq) + 2e^- \leftarrow Zn(s)$ ($\frac{0}{2}$) $Zn(s) \rightleftharpoons Zn^{2+}(aq) + 2e^-$ ($\frac{0}{2}$)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Zn^{2+}/*Indien lading (+) weggelaat op* Zn^{2+}:
  Example/*Voorbeeld:* $Zn^2(aq) + 2e^- \rightarrow Zn(s)$ Max./*Maks:* $\frac{1}{2}$

(2)

9.3.2 Zinc/Zn/*Sink* ✓ (1)

9.4 Zn^{2+} ions are reduced/[Zn^{2+}] decreases. ✓
Zn^{2+} ions must be replaced by oxidation of the Zn electrode. ✓
Zn^{2+} ione word gereduseer/[Zn^{2+}] neem af.
Zn^{2+} ione moet vervang word deur oksidasie van Zn-elektrode. (2)

[9]

TOTAL/*TOTAAL:* 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2022

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages.
Hierdie nasienriglyne bestaan uit 19 bladsye.

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QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 D ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 A ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 D ✓✓ (2)

1.9 A ✓✓ (2)

1.10 A ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1
2.1.1 C & D ✓ (1)

2.1.2 Functional/*Funksionele* ✓ (1)

2.1.3 C_nH_{2n-2} ✓ (1)

2.1.4 Hydroxyl (group)/*Hidroksiel(groep)* ✓ (1)

2.2
2.2.1 4-bromo-3,3-dimethylhexane/*4-bromo-3,3-dimetielheksaan* ✓✓✓

Marking criteria:
- Correct stem i.e. hexane. ✓
- All substituents (bromo and dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Alle substituente (bromo en dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

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Please turn over/*Blaai om asseblief*

2.2.2 4,4-dimethylpent-2-yne/4,4-dimethyl-2-pentyne ✓✓
4,4-dimetielpent-2-yn/4,4-dimetiel-2-pentyn

Marking criteria/*Nasienkriteria:*
- Correct stem and substituents: dimethyl and pentyne ✓
  Korrekte stam en substituente: dimetiel en pentyn
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓
  IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.

(2)

2.2.3 Butanal/*Butanaal* ✓✓

Marking criteria/*Nasienkriteria*:
- Correct functional group: -al /
  Korrekte funksionele groep: –aal ✓
- IUPAC name correct/*IUPAC-naam korrek* ✓

(2)

2.3
2.3.1 Esterification/condensation ✓
Esterfikasie/verestering/kondensasie (1)

2.3.2 $M(C_3H_6O) = 58\ g\cdot mol^{-1}$

Marking criteria/*Nasienkriteria*:
- $C_6H_{12}O_2$ ✓
- $C_2H_4O_2$ ✓✓
- If only correct answer given ✓✓✓
  Indien slegs korrekte antwoord gegee

$$\frac{\text{molecular mass of molecular formula}}{\text{molecular mass empirical formula}} = \frac{116}{58} = 2$$

Compound S = $C_6H_{12}O_2$ ✓
$C_2H_4O_2$ ✓✓

NOTE/*LET WEL*
- Condensed or structural formula/*Gekondenseerde of struktuurformule*: Max./*Maks.* $^2/_3$

(3)
[15]

QUESTION 3/*VRAAG 3*

3.1.1 Ketone/*Ketoon* ✓ (1)

3.1.2 Functional group/homologous series ✓
Funksionele groep/homoloë reeks (1)

3.1.3

Marking criteria:
- Compare structures. ✓
- Compare the strength of intermolecular forces. ✓
- Compare the energy required to overcome intermolecular forces. ✓
- State the difference in melting point. ✓

Nasienkriteria:
- *Vergelyk strukture.* ✓
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓
- *Noem die verskil in smeltpunte.* ✓

Pentan-2-one/C
- **Structure:**
  Longer chain length/less branched/less compact/less spherical/larger surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Stronger/more intermolecular forces/Van der Waals forces/*London forces/* dipole-dipole forces. ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces/Van der Waals forces/dipole-dipole forces. ✓
- Higher melting point. ✓

NOTE
IF higher boiling point - Max. $^3/_4$
OR
3-methylbutanone/D
- **Structure:**
  Shorter chain length/more branched/more compact more spherical/smaller surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Weaker/less intermolecular forces/Van der Waals forces/*London forces/* dipole-dipole forces. ✓
- **Energy:**
  Less energy needed to overcome or break intermolecular forces/Van der Waals force/dipole-dipole forces. ✓
- Lower melting point.✓

NOTE
IF lower boiling point - Max. $^3/_4$

Pentan-2-oon/C

- ***Struktuur*:**
  Langer kettinglengte/minder vertak/minder kompak/minder sferies/groter oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte*:**
  Sterker/meer intermolekulêre kragte/Van der Waalskragte/Londonkragte/ dipool-dipoolkragte. ✓
- *Meer energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte te oorkom/breek.* ✓
- *Hoër smeltpunt.* ✓

LET WEL
***INDIEN** hoër kookpunt - Maks.* $^3/_4$

OF

3-metielbutanoon/D

- ***Struktuur*:**
  Korter kettinglengte/meer vertak/meer kompak/meer sferies/kleiner oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte*:**
  Swakker/minder intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte. ✓
- ***Energie*:**
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte te oorkom/breek. ✓
- *Laer smeltpunt.* ✓

LET WEL
***INDIEN** laer kookpunt - Maks.* $^3/_4$ (4)

3.2.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key words phrases in the **correct context** (vapour pressure) is omitted, deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde of frases in die **korrekte konteks** (dampdruk) uitgelaat is, trek 1 punt af.*

The pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓
Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem. (2)

3.2.2

Marking criteria/*Nasienkriteria:*
- Dependent and independent variables correctly identified. ✓
  Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.
- Correct relationship between dependent and independent variables stated. ✓
  Korrekte verwantskap tussen die afhanklike en onafhanklike veranderlikes gestel.

Vapour pressure decreases with increase in number of C atoms/chain length. ✓✓
Dampdruk neem af met toename in aantal C-atome/kettinglengte.
OR/*OF*
Vapour pressure increases with decrease in number of C atoms/chain length.
Dampdruk neem toe met afname in aantal C-atome/kettinglengte. (2)

3.2.3 Hexan-1-ol/1-Hexanol ✓✓✓
Heksan-1-ol/1-Heksanol

Marking criteria/*Nasienkriteria*
- Correct chain length i.e. hex ✓
  Korrekte kettinglengte d.i. heks
- **IF** hexanol/***INDIEN** heksanol*
  Max/*Maks*: $^2/_3$
- Whole name correct./*Volledige naam korrek.* $^3/_3$

(3)

3.2.4 Increases/*Toeneem* ✓ (1)
[14]

QUESTION 4/*VRAAG 4*

4.1 Tertiary/*Tersiêre* ✓

The halogen/bromine/functional group (-X) is bonded to a C atom that is bonded to three other C atoms/ a tertiary C atom. ✓
Die halogeen/broom/funksionele groep (-X) is gebind aan 'n C-atoom wat aan drie ander C-atome gebind is/ 'n tersiêre C-atoom.

OR/*OF*
The functional group (— C(X/Br)—) is bonded to three other C atoms.
Die funksionele groep (— C(X/Br)—) is gebind aan drie ander C-atome. (2)

4.2.1 Concentrated strong base ✓
OR
Concentrated NaOH/KOH/LiOH/sodium hydroxide/ potassium hydroxide/ lithium hydroxide
OR
Strong base/NaOH/KOH/LiOH/sodium hydroxide/ potassium hydroxide/lithium hydroxide in ethanol.

Gekonsentreerde sterk basis
OF
Gekonsentreerde NaOH /KOH/ LiOH /natriumhidroksied/ kaliumhidroksied/ litiumhidroksied
OF
Sterk basis/NaOH /KOH/ LiOH / natriumhidroksied/kaliumhidroksied/litium-hidroksied in etanol (1)

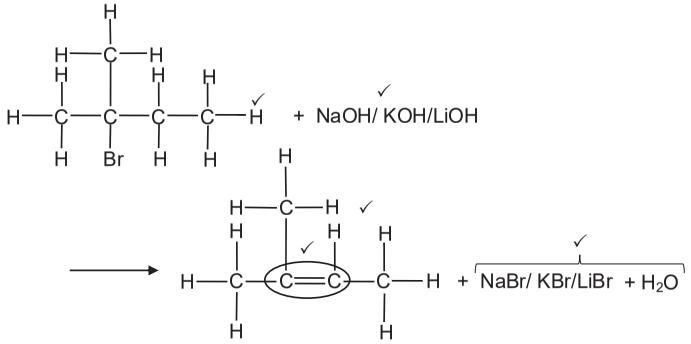
4.2.2 Elimination/dehydrohalogenation/dehydrobromination ✓
Eliminasie/dehidrohalogenering/dehidrohalogenasie/dehidrobrominasie/ dehidrobromonering (1)

4.2.3

Marking criteria:
- Whole structural formula correct for compound A. ✓
- React (2-bromo-2-methylbutane) with NaOH/KOH/LiOH. ✓
- Functional group of alkene correct. ✓
- Whole structural formula of alkene correct. ✓
- NaBr/KBr/LiBr + H_2O ✓

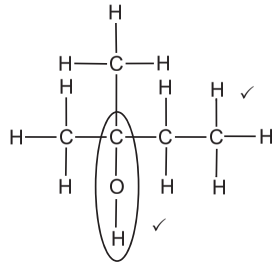
Nasienkriteria:
- *Hele struktuurformule vir verbinding A korrek.* ✓
- *Reageer (2-bromo-2-metielbutaan) met NaOH/KOH/LiOH.* ✓
- *Funksionele groep van alkeen korrek.* ✓
- *Hele struktuurformule van alkeen korrek.* ✓
- *NaBr/KBr/LiBr + H_2O* ✓

IF/*INDIEN*
- Any error e.g. omission of H atoms, condensed or semi structural formula/*Enige fout bv. weglating van H-atome, gekondenseerde of semi-struktuurformule:* Max/*Maks.* $^3/_5$
- Any additional reactants or products /*Enige addisionele reaktanse of produkte:* Max./*Maks.* $^4/_5$
- Molecular formulae used:/M*olekulêre formule gebruik:* Max./*Maks.* $^2/_5$
- No or incorrect inorganic reactants or products:/ *Geen of verkeerde anorganiese reaktanse of produkte:* Max./*Maks.* $^3/_5$
- Marking rule 6.3.10/*Nasienreël 6.3.10*



(5)

4.3.1



Marking criteria/*Nasienkriteria*:
- Functional group correct ✓
  Funksionele groep korrek
- Whole structure correct ✓
  Hele struktuur korrek

(2)

4.3.2 Water/H_2O ✓ (1)

4.3.3 Hydration/*Hidrasie* ✓ (1)

4.4.1 Substitution/Hydrolysis/*Substitusie/Hidrolise* ✓ (1)

4.4.2 Dilute strong base ✓
OR: Dilute NaOH/KOH/LiOH/sodium hydroxide/potassium hydroxide/lithium hydroxide
OR: NaOH(aq)/KOH(aq)/LiOH(aq)
OR: (Add) water/H_2O
Verdunde sterk basis
OF: *Verdunde NaOH/KOH/LiOH/natriumhidroksied/ kaliumhidroksied/ litiumhidroksied*
OF: *NaOH(aq)/KOH(aq)/LiOH(aq)*
OF: *(Voeg) water/H_2O (by)* (1)
[15]

QUESTION 5/*VRAAG 5*

5.1 B ✓
- The catalyst provides an alternative route of lower activation energy. ✓
- More molecules have enough/sufficient (kinetic) energy./More molecules have (kinetic) energy equal to or higher than the activation energy. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- *Die katalisator verskaf 'n alternatiewe roete van laer aktiveringsenergie.*
- *Meer molekule het genoeg/voldoende (kinetiese) energie./Meer molekule het (kinetiese) energie gelyk aan of groter hoër as die aktiveringsenergie.*
- *Meer effektiewe botsings per eenheidtyd./Hoër frekwensie van effektiewe botsings.*

(4)

5.2 Y ✓✓ (2)

5.3
5.3.1 560 (cm^3) / 0,56 dm^3 ✓✓ (2)

5.3.2 **POSITIVE MARKING FROM QUESTION 5.3.1.**
POSITIEWE NASIEN VANAF VRAAG 5.3.1.

Marking criteria:	***Nasienkriteria:***
(a) Substitute 24 000 and 560/24 and 0,56 in $n = \frac{V}{V_m}$ ✓ (b) USE mol ratio: $n(H_2O) : n(O_2) = 2 : 1$ ✓ (c) Substitute 18 and $n(H_2O)$ in $m = nM$ ✓ (d) Final answer: 0,83 g ✓ Range: 0,72 to 0,9 g	*(a) Vervang 24 000 en 560/24 en 0,56 in* $n = \frac{V}{V_m}$ ✓ *(b) GEBRUIK molverhouding:* $n(H_2O) : n(O_2) = 2 : 1$ ✓ *(c) Vervang 18 en* $n(H_2O)$ *in* $m = nM$ ✓ *(d) Finale antwoord: 0,83 g* ✓ *Gebied:* 0,72 *tot 0,9 g*
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(O_2) = \frac{V}{V_m}$ $= \frac{560}{24\,000}$ ✓**(a)** $= 0,023$ mol (0,0233) $n(H_2O) = 2n(O_2)$ $n(H_2O) = 2(0,023)$ ✓**(b)** $= 0,046$ mol (0,0467) $m = nM$ ✓**(c)** $= 0,046 \times 18$ $= 0,83$ g ✓**(d)**	1 mol …….24 000 cm^3 x mol …….560 cm^3 ✓**(a)** x = 0,023 mol (0,0233) $n(H_2O) = 2n(O_2)$ $n(H_2O) = 2(0,023)$ ✓**(b)** $= 0,046$ mol (0,0467) $m = nM$ ✓**(c)** $= 0,0466 \times 18$ $= 0,83$ g ✓**(d)**

(4)

5.4

5.4.1 0 ($g \cdot s^{-1}$) / zero / *nul* ✓ (1)

5.4.2 Greater than/*Groter as* ✓ (1)

5.4.3

Marking criteria	***Nasienkriteria:***
a) Substitute 0,9 g in $\frac{m}{M}$ ✓ b) Substitute 32 in $\frac{m}{M}$ ✓ c) USE mol /rate ratio: $n(H_2O_2) : n(O_2) = 2 : 1$ ✓ d) Substitute $2,1 \times 10^{-3}$ and $n(H_2O_2)$ in rate formula ✓ **OR:** Substitute rate O_2 (1,05 x 10^{-3}) and $n(O_2)$ in rate formula **OR:** Substitute rate O_2 (0,0336 $g \cdot s^{-1}$) in rate formula e) Final correct answer: 26,67 (s) ✓ Range: 26,67 to 28,57 (s)	*a) Vervang 0,9 g in* $\frac{m}{M}$ ✓ *b) Vervang 32 in* $\frac{m}{M}$ ✓ *c) GEBRUIK mol-/tempoverhouding:* $n(H_2O_2) : n(O_2) = 2 : 1$ ✓ *d) Vervang* $2,1 \times 10^{-3}$ *en* $n(H_2O_2)$ *in tempoformule* ✓ ***OF:*** *Vervang tempo* O_2 (1,05 x 10^{-3}) *en* $n(O_2)$ *in tempoformule* ***OF:*** *Vervang tempo* O_2 (*0,0336* $g \cdot s^{-1}$) *in tempoformule* *e) Finale korrekte antwoord: 26,67 (s)* ✓ *Gebied: 26,67* tot 28,57 *(s)*
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(O_2) = \frac{m}{M}$ $= \frac{0,9}{32}$ ✓**(a)** ✓**(b)** $= 0,028$ mol (0,0281) $n(H_2O_2) = 2n(O_2)$ $= 2(0,028)$ ✓**(c)** $= 0,056$ rate/*tempo* $= \frac{\Delta n}{\Delta t}$ ✓**(d)** $2,1 \times 10^{-3} = \frac{0,056 - 0}{\Delta t}$ $\Delta t = 26,67$ (s) ✓**(e)**	1 mol ……32 g ✓**(b)** x mol ……0,9 g ✓**(a)** x = 0,0275 mol $n(H_2O_2) = 2n(O_2)$ $= 2(0,0275)$ ✓**(c)** $= 0,056$ mol rate/*tempo* $= \frac{\Delta n}{\Delta t}$ = ✓**(d)** $2,1 \times 10^{-3} = \frac{0,056 - 0}{\Delta t}$ $\Delta t = 26,67$ (s) ✓**(e)**
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$n(O_2) = \frac{m}{M}$ $= \frac{0,9}{32}$ ✓**(a)** ✓**(b)** $= 0,028$ mol (0,0281) $Rate(O_2) = ½\ rate(H_2O_2)$ $= ½ (2,1 \times 10^{-3})$ ✓**(c)** $= 1,05 \times 10^{-3}$ rate/*tempo* $= \frac{\Delta n}{\Delta t}$ ✓**(d)** $1,05 \times 10^{-3} = \frac{0,028}{\Delta t}$ $\Delta t = 26,67$ (s) ✓**(e)**	rate $H_2O_2 = 2,1 \times 10^{-3}$ $mol \cdot s^{-1}$ $Rate(O_2) = ½\ rate(H_2O_2)$ $= ½ (2,1 \times 10^{-3})$ ✓**(c)** $= 1,05 \times 10^{-3}$ In one second: $n(O_2) = \frac{m}{M}$ $1,05 \times 10^{-3} = \frac{m}{32}$ ✓**(b)** $m(O_2) = 0,0336$ g rate = 0,0336 $g \cdot s^{-1}$ rate = $\frac{\Delta m}{\Delta t}$ ✓**(a)** ✓**(d)** $0,0336 = \frac{0,9 - 0}{\Delta t}$ $\Delta t = 26,79$ (s) ✓**(e)**

(5)
[19]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk. (2)

6.2

$$K_c = \frac{[CS_2]}{[S]^2} \checkmark$$

$$9,4 \overset{\checkmark}{=} \frac{0,5}{[S]^2} \checkmark$$

$[S] = 0,23 \text{ mol·dm}^{-3}$ ✓ (4)

NOTE/*LET WEL*
- Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $^2/_4$
- No K_c expression but correct substitution/*Geen K_c-uitdrukking but korrekte vervanging: Max/Maks.* $^3/_4$

6.3 Increases/*Neem toe* ✓ (1)

6.4
- Increasing/doubling the volume will decrease the pressure. ✓
- The reaction that produces a greater number of moles/amount of gas (1 mole gas to 2 moles gas) is favoured. ✓
- Reverse reaction is favoured. ✓

- *Verhoging/verdubbeling van volume sal die druk verlaag.*
- *Die reaksie wat 'n groter aantal mol/hoeveelheid gas (1 mol gas na 2 mol gas) lewer word bevoordeel.*
- *Terugwaartse reaksie word bevoordeel.* (3)

6.5 **POSITIVE MARKING FROM 6.2./*POSITIEWE NASIEN VAN VRAAG 6.2.***

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK
Marking criteria*:*
(a) Initial concentration is halved. ✓
(b) Change in $[CS_2]$ and [S] **USING** ratio: $S : CS_2 = 2 : 1$ ✓
(c) Equilibrium [S] = initial [S] + change in [S] ✓
(d) Equilibrium $[CS_2]$ = initial $[CS_2]$ - change in $[CS_2]$ ✓
(e) ***CORRECT*** final answer. ✓
***Nasienkriteria*:**
(a) Aanvanklike konsentrasie is gehalveer.✓
*(b) Verandering in $[CS_2]$ en [S] deur **GEBRUIK** van verhouding $S : CS_2 = 2 : 1$* ✓
(c) Ewewig [S] = aanvanklike [S] + verandering in [S] ✓
(d) Ewewig $[CS_2]$ = aanvanklike $[CS_2]$ - verandering in $[CS_2]$ ✓
(e) ***KORREKTE** finale antwoord.* ✓

OPTION 1/*OPSIE 1*

	S	CS_2	
Initial concentration ($mol·dm^{-3}$) *Aanvangskonsentrasie ($mol·dm^{-3}$)*	0,23 x ½ = 0,115	0,5 x ½ = 0,25	✓(a)
Change in concentration ($mol·dm^{-3}$) *Verandering in konsentrasie ($mol·dm^{-3}$)*	2x	x	✓(b)
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie ($mol·dm^{-3}$)*	0,115 + 2x	0,25 - x	
	✓(c)	✓(d)	

$$K_c = \frac{[CS_2]}{[S]^2}$$

$$9,4 = \frac{0,25 - x}{(0,115 + 2x)^2} \checkmark \text{(e)}$$

Wrong K_c expression
Verkeerde K_c- uitdrukking: Max./*Maks.* $^4/_5$

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK
Marking criteria*:*
(a) n(initial) = c(initial) x 2. ✓
(b) Change in n(S) and n(CS_2) **USING** ratio*: S* : CS_2 = 2 : 1 ✓
(c) Equilibrium n(S) = initial n(S) + change in n(S) ✓
(d) Equilibrium n(CS_2) = initial n(CS_2) - change in n(CS_2) ✓
(e) **CORRECT** final answer. ✓

***Nasienkriteria*:**
(a) n(aanvanklik) = c(aanvanklik) x 2 ✓
*(b) Verandering in n(S) en n(CS_2) deur **GEBRUIK** van verhouding: S : CS_2 = 2 : 1* ✓
(c) Ewewig n(S) = aanvanklike n(S) + verandering in n(S) ✓
(d) Ewewig n(CS_2) = aanvanklike n(CS_2) - verandering in n(CS_2) ✓
*(e) **KORREKTE** finale antwoord.* ✓

OPTION 2/*OPSIE 2*

	S	CS_2	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,46	1	✓(a)
Change (mol) *Verandering (mol)*	8x	4x	✓(b)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)* ✓(c)	0,46 + 8x	1 – 4x	✓(d)
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{0,46 + 8x}{4}$	$\frac{1 - 4x}{4}$	

$$K_c = \frac{[CS_2]}{[S]^2}$$

$$9,4 = \frac{\frac{1 - 4x}{4}}{\left(\frac{0,46 + 8x}{4}\right)^2}$$ ✓(e)

Wrong K_c expression
Verkeerde K_c-uitdrukking: Max./*Maks.* $^4/_5$

(5)

6.6
6.6.1 (Chemical) equilibrium / Rate of the forward and reverse reactions are equal. / Concentrations of reactants and products are constant. ✓
(*Chemiese) ewewig / Tempo van voorwaartse en terugwaartse reaksie dieselfde./Konsentrasies van reaktante en produkte is konstant.* (1)

6.6.2 Increase in the amount/concentration of S/reactant **OR** S was added. ✓
*Toename in die hoeveelheid/konsentrasie S/reaktans **OF** S is bygevoeg.* (1)

6.6.3 Decrease in temperature/*Verlaging in temperatuur* ✓ (1)

6.6.4
- The rates of the forward and reverse reactions decrease. ✓
- The reverse reaction is favoured / faster than the forward reaction.
  OR
  The forward reaction decreases more. ✓
- A decrease in temperature favours the exothermic reaction. ✓
- *Die voorwaartse en terugwaartse reaksietempo neem af.*
- *Die terugwaartse reaksie word bevoordeel/is vinniger as die voorwaartse reaksie.*
  OF
  Die voorwaartse reaksie neem meer af.
- *'n Verlaging in die temperatuur bevoordeel die eksotermiese reaksie.* (3)

[21]

QUESTION 7/*VRAAG 7*

7.1
7.1.1 (An acid is a) proton donor/H^+ (ion) donor. ✓✓ (**2 or 0**)
('n Suur is 'n) protonskenker/H^+(-ioon) skenker. (***2 of 0***) (2)

7.1.2 (Weak acids) ionise/dissociate incompletely/partially (in water)/have a low K_a value. ✓
(Swak sure) ioniseer/dissosieer onvolledig/gedeeltlik (in water)/het 'n lae K_a-waarde. (1)

7.1.3 H_2O ✓ and CH_3COO^- ✓ (2)

7.2
7.2.1 n(NaOH) = cV ✓
n = (0,167)(0,300) ✓
∴ n(NaOH) = 0,05 mol ✓ (5 x 10^{-2} mol) (3)

7.2.2

Marking criteria:	***Nasienkriteria:***
a) Any formula: pH = -log[H_3O^+] / pH = -log[H^+] / pOH = -log[OH^-] / [H_3O^+][OH^-] = 10^{-14} / pH + pOH = 14 ✓ b) Substitute 11,4 in pH = -log[H_3O^+]/ pH + pOH = 14 ✓ c) Substitute calculated [H_3O^+] in [H_3O^+][OH^-] / 2,6 in pOH = -log[OH^-] ✓ d) Final answer: 2,51 x 10^{-3} mol·dm^{-3} ✓ (0,003 mol·dm^{-3})	*a)* Enige formule: pH = - log[H_3O^+] / pH = - log[H^+] / pOH = - log[OH^-] / [H_3O^+][OH^-] = 10^{-14} / pH + pOH = 14 ✓ *b) Vervang* 11,4 in pH = - log[H_3O^+]/ pH + pOH = 14 ✓ *c) Vervang berekende* [H_3O^+] in [H_3O^+][OH^-] / 2,6 in pOH = -log[OH^-] ✓ *d) Finale antwoord:* 2,51x 10^{-3} mol·dm^{-3} ✓ (0,003 mol·dm^{-3})

OPTION 1/*OPSIE 1*

pH = - log[H_3O^+]
11,4 ✓**(b)** = - log[H_3O^+] **OR/*OF*** [H_3O^+] = $10^{-11,4}$ Any one/*Enige een* ✓**(a)**
[H_3O^+] = 3,98 x 10^{-12}
[H_3O^+][OH^-] = 10^{-14}
✓**(c)**
(3,98 x 10^{-12})[OH^-] = 1 x 10^{-14}
[OH^-] = 2,51 x 10^{-3} mol·dm^{-3} ✓**(d)** (0,003)

OPTION 2/*OPSIE 2*

pH + pOH = 14
11,4 + pOH = 14 ✓**(b)** Any one/*Enige een* ✓**(a)**
pOH = 2,6
pOH = -log[OH^-] ✓
2,6 ✓**(c)** = -log[OH^-]
[OH^-] = 2,51 x 10^{-3} mol·dm^{-3} ✓**(d)** (0,003)

(4)

7.2.3 **POSITIVE MARKING FROM QUESTION 7.2.1. AND 7.2.2.**
POSITIEWE NASIEN VANAF VRAAG 7.2.1. EN 7.2.2.

Marking criteria:

a) Substitute [NaOH] = 0,00251 mol·dm^{-3} (answer from Q7.2.2) and 0,8 in $c = \frac{n}{V}$ ✓
b) Subtract: $n(NaOH)_{initial}$ (from Q7.2.1) – $n(NaOH)_{mixture}$ ✓✓
c) Use of ratio: $n(OH^-) = n(CH_3COOH)$ ✓
d) Substitute 0,5 and $\Delta n(CH_3COOH)$[calculated by subtraction] into $c = \frac{n}{V}$ ✓
e) Final correct answer: 0,096 mol·dm^{-3} ✓
Range: 0,095 to 0,1 mol·dm^{-3}

Nasienkriteria:

a) *Vervang [NaOH] = 0,00251 mol·dm^{-3} (antwoord van Q7.2.2) en 0,8 in* $c = \frac{n}{V}$ ✓
b) *Trek af:* $n(NaOH)_{aanvanklik}$ *(vanaf Q7.2.1) –* $n(NaOH)_{mengsel}$ ✓✓
c) *Gebruik verhouding:* $n(OH^-) = n(CH_3COOH)$ ✓
d) *Vervang 0,5 en* $\Delta n(CH_3COOH)$ *[bereken deur aftrekking] in* $c = \frac{n}{V}$ ✓
e) *Finale korrekte antwoord: 0,096 mol·dm^{-3}* ✓
Gebied: 0,095 tot 0,1 mol·dm^{-3}

n(NaOH)mixture = cV
= 0,00251 x 0,8 ✓**(a)**
= 0,002 mol (0,0024)

$n(NaOH)_{reacted}$ = 0,05 – 0,002 ✓✓**(b)**
= 0,048 mol (0,0476)

$n(NaOH)_{reacted} = n(CH_3COOH)_{used}$
= 0,048 mol ✓**(c)**

$[CH_3COOH] = \frac{n}{V}$
$= \frac{0,048}{0,5}$ ✓**(d)**
= 0,096 mol·dm^{-3} ✓**(e)**
(0,0952)

NOTE/*LET WEL*
IF/*INDIEN:*

- $\frac{c_a V_a}{c_b V_b} = \frac{1}{1}$ Max./*Maks.* $^1/_6$
- Answer from Q7.2.1 substituted in $c = \frac{n}{V}$ to obtain an answer of 0,01 mol·dm^{-3}./ *Antwoord van Q7.2.1 vervang in* $c = \frac{n}{V}$ *om 0,01 mol·dm^{-3} as antwoord te kry.* Max./*Maks.* $^1/_6$

(6)
[18]

QUESTION 8/*VRAAG 8*

8.1
8.1.1 Zn/zinc/*sink* ✓ (1)

8.1.2 MnO_4^- is a stronger oxidising agent ✓ than Zn^{2+}/Zn(II) ions ✓ and will oxidise Zn ✓ (to Zn^{2+}/Zn(II) ions).

MnO_4^- is 'n sterker oksideermiddel as Zn^{2+}/Zn(II)-ione *en sal Zn oksideer (na Zn^{2+}*/Zn(II)*-ione).*

OR/*OF*

Zn^{2+}/Zn(II) ion is a weaker oxidising agent ✓ than MnO_4^- ✓ and therefore MnO_4^- will be reduced ✓ (to Mn^{2+}/Mn(II) ions).

Zn^{2+}/Zn(II) ione is 'n swakker oksideermiddel as MnO_4^- en dus word MnO_4^- gereduseer (to Mn^{2+}/Mn(II)-ione). (3)

8.2
8.2.1 Provides path for movement of ions. / Completes the circuit. / Ensures electrical neutrality in the cell. / Restore charge balance. ✓

Verskaf pad vir beweging van ione. / Voltooi die stroombaan. / Verseker elektriese neutraliteit in die sel. / Herstel balans van lading. (1)

8.2.2 Mn to/*na* Ni ✓✓ (2)

8.2.3

OPTION 1/*OPTION 1*	**NOTE/*LET WEL***
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ = - 0,27✓– (- 1,18)✓ = 0,91 V ✓	• Accept any other correct formula from the data sheet. /*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv. $E°_{sel} = E°_{OM} - E°_{RM}$ gevolg deur korrekte vervangings* $^3/_4$

OPTION 2/*OPSIE 2*

✓ $Ni^{2+} + 2e^- \rightarrow Ni$ E = -0,27 ✓
✓ $Mn \rightarrow Mn^{2+} + 2e^-$ E = 1,18 ✓
$Ni^{2+} + Mn \rightarrow Mn^{2+} + Ni$ E = 0,91 V ✓ (4)

8.2.4 $Ni^{2+} + Mn$ ✓ → $Mn^{2+} + Ni$ ✓ Bal. ✓

Marking criteria/*Nasienkriteria:*
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* ⇌ and phases/*en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10* (3)

8.2.5 Increase/*Toeneem* ✓ (1)
[15]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE*:***
- The chemical process in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
- The use of electrical energy to produce a chemical change.
- The process during which an electric current passes through a solution / molten ionic compound.

***ENIGE EEN*:**
- *Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.* ***(2 of 0)***
- *Die gebruik van elektriese energie om 'n chemiese verandering te veroorsaak.*
- *Die proses waar 'n elektriese stroom deur 'n oplossing / gesmelte ioniese verbinding beweeg.* (2)

9.2.1 $Cr^{3+}(aq) + 3e^- \rightarrow Cr$ ✓✓

Marking criteria/*Nasienkriteria:*
- $Cr \leftarrow Cr^{3+}(aq) + 3e^-$ ($^2/_2$)
  $Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr$ ($^1/_2$)
  $Cr \rightleftharpoons Cr^{3+}(aq) + 3e^-$ ($^0/_2$)
  $Cr^{3+}(aq) + 3e^- \leftarrow Cr$ ($^0/_2$)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Cr^{3+}/*Indien lading (+) weggelaat op* Cr^{3+}:
  Example/*Voorbeeld:* $Cr^3(aq) + 3e^- \rightarrow Cr$ Max./*Maks:* $^1/_2$ (2)

9.2.2 $q = I\Delta t$ ✓
= (2,5)(10 x 60 x 60) ✓
= 9 x 10^4 C ✓ (90 000 C) (3)

9.2.3 **POSITIVE MARKING FROM QUESTION 9.2.2.**
POSITIEWE NASIEN VANAF VRAAG 9.2.2.

Marking criteria:	***Nasienkriteria:***
a) Substitute 1,6 x 10^{-19} C in $n = \frac{Q}{e}$ ✓ b) N(Cr) = n(electrons) divide by 3 ✓ c) n(Cr) = N(Cr) divided by N_A ✓ d) Substitution of 52 into $n = \frac{m}{M}$ ✓ e) m(Cr) + 2,2 ✓ f) Final answer: 18,32 (g) ✓ Range: *18,32 to 18,40* (g)	a) *Vervang 1,6 x 10^{-19} C in* $n = \frac{Q}{e}$ ✓ b) *N(Cr) = n(elektrone) gedeel deur 3* ✓ c) *n(Cr) = N(Cr) gedeel deur* N_A ✓ d) *Vervang 52 in* $n = \frac{m}{M}$ ✓ e) *m(Cr) + 2,2* ✓ f) *Finale antwoord: 18,32 (g)* ✓ *Gebied: 18,32 tot 18,40 (g)*
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n = \frac{Q}{e} / \frac{Q}{q_e}$ $= \frac{9 \times 10^4}{1,6 \times 10^{-19}}$ ✓**(a)** $= 5,63 \times 10^{23}$ electrons ↘ N(Cr atoms) $= \frac{5,63 \times 10^{23}}{3}$ ✓**(b)** $= 1,88 \times 10^{23}$ ↘ $n(Cr) = \frac{N}{N_A}$ $= \frac{1,88 \times 10^{23}}{6,02 \times 10^{23}}$ ✓**(c)** = 0,31 mol ↘ $n(Cr) = \frac{m}{M}$ m(Cr) = 0,31 x 52 ✓**(d)** = 16,12 g ↘ m(X) = 16,12 + 2,2 ✓**(e)** = 18,32 (g) ✓**(f)**	$n(Cr) = \frac{9 \times 10^4}{3 \times 96\,500}$ ✓✓**(a & c)** ✓**(b)** = 0,31 mol ↓ m(Cr) = 0,31 x 52 ✓**(d)** = 16,12 g ↓ m(X) = 16,12 + 2,2 ✓**(e)** = 18,32 (g) ✓**(f)**

(6)
[13]

TOTAL/*TOTAAL*: 150

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Province of the EASTERN CAPE EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2022

PHYSICAL SCIENCES P2 MARKING GUIDELINE/ *FISIESE WETENSKAPPE V2 NASIENRIGLYN*

MARKS/ *PUNTE*: **150**

This marking guideline consists of 19 pages./
Hierdie nasienriglyn bestaan uit 19 bladsye.

QUESTION/*VRAAG* 1

1.1	B ✓✓	(2)
1.2	A ✓✓	(2)
1.3	B ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	A ✓✓	(2)
1.7	B ✓✓	(2)
1.8	D ✓✓	(2)
1.9	B ✓✓	(2)
1.10	A ✓✓	(2)
		[20]

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QUESTION/*VRAAG* 2

2.1 It is a series of organic compounds that can be described by the same general formula. ✓✓ **(2 or 0)**

'n Reeks organiese verbindings wat deur dieselfde algemene formule beskryf kan word. ***(2 of 0)***

OR/*OF*

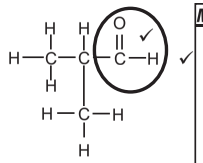
A series/group of organic compounds in which one member differs from the next with -CH_2- group. ✓✓ **(2 or 0)**

'n Reeks organiese verbindings waarin die een lid van die volgende verskil met 'n CH_2-groep. (2)

2.2.1 D ✓ (1)

2.2.2 C_nH_{2n-2} ✓ (1)

2.2.3



✓ ✓

Marking criteria/ Nasienkriteria
• Only functional group correct / *Slegs funksionele groep korrek*: Max/ *Maks ½*
• *Whole structure correct/ Hele struktuur korrek: 2/2*

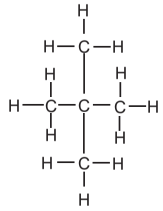
(2)

2.3 3-ethyl-2-methylhexanoic acid / *3-etiel-2-metielheksanoësuur*

Marking criteria
• Correct stem i.e hexanoic acid ✓
• All substituents (ethyl and methyl) correctly identified ✓
• IUPAC name completely correct including numbering, sequence and hyphens ✓
Nasienkriteria
• *Korrekte stam d.i heksanoësuur*
• *Alle substituente (etiel en metiel) korrek geïdentifiseer*
• *IUPAC-naam heeltemal korrek insluitende nommering, volgorde en koppeltekens*

(3)

2.4.1



Marking criteria/*Nasienkriteria*
• Longest chain contains 3 carbons / *Langste koolstofketting bevat 3 koolstowwe* ✓
• Two methyl substituents on C2 / *Twee metielsubstituente op C2* ✓
• Whole structure is correct / *Hele struktuur korrek* ✓

(3)

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2.4.2 $C_5H_{12} + 8\ O_2$ ✓→ $6\ H_2O + 5\ CO_2$ ✓ (bal ✓)

Marking criteria/ *Nasienkriteria*
• Reactants / *Reaktanse*
• Products / *Produkte*
• Balancing / *Balansering*

(3)
[15]

QUESTION/*VRAAG* 3

3.1.1

Marking criteria/Nasienkriteria
If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase.*

The temperature at which the vapour pressure of a liquid equals the atmospheric pressure. ✓✓

Die temperatuur waarby die dampdruk van die vloeistof gelyk is aan die atmosferiese druk. (2)

3.1.2 As the number of C atoms increases:

- The surface area/chain length/molecular mass of the alcohols increases ✓
- The strength of London forces/induced dipole forces/dispersion forces increase. ✓

Soos die aantal C-atome toeneem:

- *Die oppervlak-area/kettinglengte/molekulêre massa van die alkohole verhoog.*
- *Die sterkte van die Londonkragte/geïnduseerde dipoolkragte/ verspreidingskragte verhoog*

OR/*OF*

As the number of C atoms decreases:

- The surface area/chain length/molecular mass of the alcohols decreases ✓
- The strength of London forces/induced dipole forces/dispersion forces decrease. ✓

Soos die aantal C-atome afneem:

- *Die oppervlak-area/kettinglengte/molekulêre massa van die alkohole verlaag.*
- *Die sterkte van die Londonkragte/geïnduseerde dipoolkragte/ verspreidingskragte verswak* (2)

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3.1.3 **Marking criteria**
- Identify the intermolecular forces in both compounds. ✓✓
- Compare the strength of the intermolecular forces. ✓

Nasienkriteria
- *Die intermolekulêre kragte korrek geïdentifiseer in beide verbindings*
- *Vergelyk die sterkte van die intermolekulêre kragte*

- Alcohols have both (London forces) and hydrogen bonds ✓
- Ketones have both (London forces) and dipole-dipole forces ✓
- Hydrogen bonds in the alcohols are stronger than the dipole-dipole forces in ketones ✓

- *Alkohole het beide (Londonkragte) en waterstofbindings*
- *Ketone het beide (Londonkragte) en dipool-dipool kragte*
- *Waterstofbindings in die alkohole is sterker as die dipool-dipoolkragte in ketone*

OR/*OF*

- Alcohols have both (London forces) and hydrogen bonds ✓
- Ketones have both (London forces) and dipole-dipole forces ✓
- the dipole-dipole forces in Ketones are weaker than the hydrogen bonds in the alcohols ✓

- *Alkohole het beide (Londonkragte) en waterstofbindings*
- *Ketone het beide (Londonkragte) en dipool-dippol kragte*
- *Die dipool-dipoolkragte in ketone is swakker as die waterstofbindings in die alkohole* (3)

3.1.4 To have one independent variable✓ **OR** To have a fair test
*Om slegs een onafhanklike veranderlike te het **OF** Om 'n regverdige toets te hê* (1)

3.1.5 Ketone ✓

Lower boiling point / *Laer kookpunt* ✓ (2)

3.2.1 Propanoic acid / *Propanoësuur* ✓ (1)

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3.2.2 **Marking criteria**
- Identify the intermolecular forces correctly in both compounds. ✓
- Compare the strength of the intermolecular forces. ✓
- Compare the energy required to overcome the intermolecular forces. ✓

Nasienkriteria
- *Die intermolekulêre kragte is korrek in beide verbindings geïdentifiseer*
- *Vergelyk die sterkte van die intermolekulêre kragte.*
- *Vergelyk die energie wat benodig word om die intermolekulêre kragte te oorkom.*

- Both have hydrogen bonds
- Propan-1-ol has ONE site for hydrogen bonds
- Propanoic acid has TWO sites for hydrogen bonds ✓
- The intermolecular forces of propanoic acid are stronger than that of propan-1-ol ✓
- More energy is needed to overcome the intermolecular forces of propanoic acid. ✓

- *Beide het waterstofbindings*
- *Propan-1-ol het EEN plek vir waterstofbindings*
- *Propanoësuur het TWEE plekke vir waterstofbindings*
- *Die intermolekulêrekragte in propanoësuur is sterker as dié in propan-1-ol*
- *Meer energie word benodig om die intermolekulêre kragte te oorkom in propanoësuur*

OR/OF

- Both have hydrogen bonds.
- Propan-1-ol has ONE site for hydrogen bonds
- Propanoic acid has two sites for hydrogen bonds ✓
- The intermolecular forces of propan-1-ol are weaker than that of propanoic acid ✓
- Less energy is needed to overcome the intermolecular forces of propan-1-ol. ✓

- *Beide het waterstofbindings*
- *Propan-1-ol het EEN plek vir waterstofbindings*
- *Propanoësuur het TWEE plekke vir waterstofbindings*
- *Die intermolekulêrekragte in propan-1-ol is swakker as dié in propanoësuur.*
- *Minder energie word benodig om die intermolekulêre kragte te oorkom in propan-1-ol.* (3)

[14]

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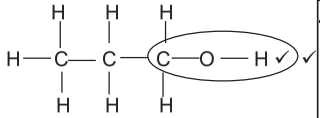
QUESTION/*VRAAG 4*

4.1.1 Esterification / condensation / *Esterifikasie / konsensasie*✓ (1)

4.1.2 (Mild) heat */ (Matige) hitte* ✓ (1)

4.1.3 

Marking criteria/ Nasienkriteria
- Only functional group correct *Slegs funksionele groep korrek*: Max/*Maks ½*
- *Whole structure correct/ Hele struktuur korrek: 2/2*

(2)

4.1.4 Propyl ✓ethanoate ✓ / *Propiel etanoaat* (2)

4.1.5 Pentanoic acid / *Propanoësuur* ✓✓ (2)

4.1.6 Substitution reaction / *Substitusie-reaksie* ✓ (1)

4.1.7 H_2O ✓ (1)

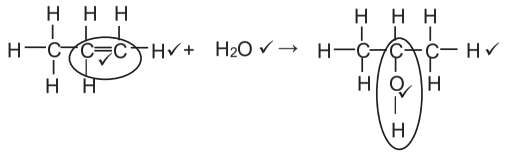
4.1.8 $CH_3CH_2CH_2C\ell$ ✓✓

Marking criteria/ Nasienkriteria
- Only functional group correct */ Slegs funksionele groep korrek*: Max/*Maks ½*
- *Whole structure correct / Hele struktuur korrek: 2/2*

(2)

4.2.1 (Concentrated / *Gekonsentreerde*) H_2SO_4 ✓ (2)

4.2.2 H_2O in excess ✓ / catalyst/ (Add small amount of $HC\ell/H_3PO_4$) (1)

4.2.3 

Marking criteria/ Nasienkriteria
(Organic molecules / *Organiese molekules*)
- Only functional group correct */ Slegs funksionele groep korrek*: Max/*Maks ½*
- *Whole structure correct/ Hele struktuur korrek: 2/2*

(5)
[20]

QUESTION/*VRAAG 5*

5.1

Marking criteria/ Nasienkriteria
If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase

ANY ONE
- Change in concentration ✓of reactant / product per (unit) time.✓
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed/reactants used reactants per (unit) time.

ENIGE EEN
- *Verandering in konsentrasie van reaktanse/produkte per (eenheid) tyd*
- *Verandering in hoeveelheid/getal mol/volume/massa van reaktanse of produkte per (eenheid) tyd.*
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/ reaktanse gebruik per (eenheid) tyd*

OR/*OF*

The rate of change in concentration / amount of moles / number of moles / volume / mass. **(2 or 0).**

*Die tempo van verandering in konsentrasie / hoeveelheid mol / getal mol/volume/massa **(2 of 0)*** (2)

5.2 Concentration / *Konsentrasie* (of/*van* HCℓ) ✓ (1)

5.3 Equal to / *Gelyk aan* ✓

The same amount of (the limiting reagent), $Na_2S_2O_3$, is used. ✓
Dieselfde hoeveelheid (van beperkde reagens) $Na_2S_2O_3$ was gebruik. (2)

5.4.1 Experiment 3 / *Eksperiment 3* ✓ (1)

5.4.2 For T_2

- Higher temperature increases kinetic energy of particles ✓
- Greater number of particles have sufficient energy. ✓
- More effective collision per unit time ✓

Vir T_2

- *Hoër temperatuur verhoog die kinetiese energie van die deeltjies*
- *Groter aantal deeltjies het genoeg energie*
- *Meer effektiewe botsings per eenheidstyd*

OR/*OF*

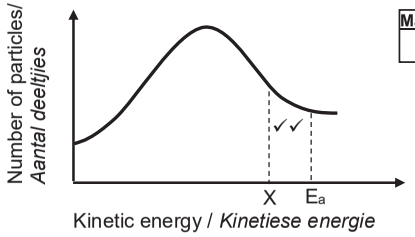
For T_1

- Lower temperature decreases kinetic energy of particles
- Fewer particles have sufficient energy.
- Less effective collision per unit time

Vir T_1

- *Laer temperatuur verlaag die kinetiese energie van die deeltjies*
- *Minder aantal deeltjies het genoeg energie*
- *Minder effektiewe botsings per eenheidstyd* (3)

5.4.3



Marking criteria/*Nasienkriteria*
• $X < E_a$

(2)

5.5

Marking criteria

- Formula n = m/M
- Substitution into n = m/M
- **Using** ratio HCℓ: $Na_2S_2O_3$ 2 : 1
- Substitution into rate equation
- Final answer

Nasienkriteria

- *Formule* n = m/M
- *Vervanging in* n = m/M
- ***Gebruik** van verhouding* HCℓ: $Na_2S_2O_3$ 2 : 1
- *Vervanging in tempo vergelyking*
- *Finale antwoord*

$n = \frac{m}{M}$ ✓

$n = \frac{0,7118}{158}$ ✓

$n\ (Na_2S_2O_3) = 4,505 \times 10^{-3}$ mol

$n\ (HCℓ) = 2\ (4,505 \times 10^{-3})$ ✓

$n\ (HCℓ) = 9,01 \times 10^{-3}$ mol

rate/ *tempo* $= -\frac{\Delta n}{\Delta t}$

rate/ *tempo* $= -\frac{0 - 9,01 \times 10^{-3}}{34}$ ✓

rate/ *tempo* = $2,65 \times 10^{-4}$ (mol·s^{-1}) ✓

Accept / *Aanvaar*

rate/ *tempo* $= \frac{\Delta n}{\Delta t}$

rate/*tempo* $= \frac{-9,01 \times 10^{-3}}{34}$ ✓

rate / *tempo* = $-2,65 \times 10^{-4}$ (mol·s^{-1}) ✓

(5)

5.6 REMAINS THE SAME / *BLY DIESELFDE* ✓ (1)

[17]

QUESTION/*VRAAG 6*

6.1.1 (A reaction in which) products can be converted back to its reactants ✓✓
(and vice versa)

(Is 'n reaksie waar) produkte terug na reaktanse, en omgekeerd, omgeskakel kan word. **(2 or/ *of* 0)** (2)

6.1.2 Turns more pink / *Raak meer pienk* ✓ (1)

6.1.3 Turns more blue / *Raak meer blou* ✓ (1)

6.1.4 Exothermic / *Eksotermies* ✓ (1)

6.1.5
- Increase in temperature shifted the equilibrium position left ✓/Reverse reaction is favoured
- Increase in temperature favours the endothermic reaction ✓

- *Toename in temperatuur verskuif die ewewigsposisie na links/ Terugwaartse reaksie word bevoordeel.*
- *Toename in temperatuur bevoordeel 'n endotermiese reaksie.* (2)

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6.2

OPTION 1: MOLE CALCULATIONS
OPSIE 1: MOL BEREKENINGE

Marking criteria:
a. Substitution into formula $n = \frac{N}{N_A}$ ✓
b. Using ratio $N_2O_4 : NO_2 = 1 : 2$ ✓
c. $n(NO_2)$ equilibrium = $n_{initial} + \Delta n$ ✓
d. $n(N_2O_4)$ equilibrium = n initial - Δn ✓
e. Divide **equilibrium** amounts of N_2O_4 and NO_2 by 4 dm^3 ✓
f. Correct K_C expression (formulae in square brackets) ✓
g. Substitution into equilibrium concentration into K_C expression ✓
h. Final answer ✓

Nasienkriteria:
a. *Vervanging in formule* $n = \frac{N}{N_A}$
b. ***Gebruik** verhouding* $N_2O_4 : NO_2 = 1 : 2$ ✓
c. $n(NO_2)$ ewewig = $n_{initial} + \Delta n$ ✓
d. *Deel **ewewig**hoeveelhede van N_2O_4 en NO_2 deur 4 dm^3*
e. *Korrekte K_c-uitdrukking (formules met vierkanthakies)*
f. *Vervanging in ewewigskonsentrasies in K_c-uitdrukking*
g. *Finale antwoord*

$n = \frac{N}{N_A}$

$n = \frac{3{,}01 \times 10^{23}}{6{,}02 \times 10^{23}}$ ✓ (a)

n = 0,5 mol

	N_2O_4 (g)	2 NO_2 (g)	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,5	-	
Change (mol) *Verandering (mol)*	0,4	0,8	✓ (b) ratio
Equilibrium (mol) *Ewewig (mol)*	0,1 ✓ (d)	0,8	✓ (c)
Concentration ($mol \cdot dm^{-3}$) *Konsentrasie ($mol \cdot dm^{-3}$)*	0,025	0,2	✓ (e)

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$K_c = \frac{[NO_2]^2}{[N_2O_4]}$ ✓ (f)

$K_c = \frac{(0,2)^2}{(0,025)}$ ✓ (g)

No K_c expression, correct substitution / *Geen K_c-uitdrukking, korrekte, korrekte substitusie.* Max / *Maks 7/8*
Wrong K_c expression/*Verkeerde K_c – uitdrukking.* Max. *Maks. 5/8*

$K_c = 1,6$ ✓ (h)

OPTION 2: CONCENTRATION CALCULATIONS/
***OPSIE 2:* KONSENTRASIEBEREKENINGE**

Marking criteria

a. Substitution into formula $n = \frac{N}{N_A}$ ✓
b. Using ratio N_2O_4: NO_2 = 1 : 2 ✓
c. c(NO_2) equilibrium = $c_{initial} + \Delta c$ ✓
d. c(N_2O_4) equilibrium = c initial – Δc ✓
e. Divide n initial and Δn of N_2O_4 by 4 dm^3 ✓
f. Correct K_C expression (formulae in square brackets) ✓
g. Substitution into equilibrium concentration into K_C expression ✓
h. Final answer ✓

Nasienkriteria:

a. *Vervanging in formule* $n = \frac{N}{N_A}$
b. ***Gebruik** verhouding N_2O_4 : NO_2 1 : 2* ✓(b)
c. *Ewewig* c(NO_2) = *begin c* + Δc
d. *Ewewig c (N_2O_4) = begin c* – Δc
e. *Deel **aanvangs en verandering** hoeveelhede van N_2O_4 en NO_2 deur 4 dm^3* ✓ (e)
f. *Korrekte K_c-uitdrukking (formules met vierkanthakies)*
g. *Vervanging in ewewigskonsentrasies in K_c-uitdrukking*
h. *Finale antwoord*

$n = \frac{N}{N_A}$

$n = \frac{3,01 \times 10^{23}}{6,02 \times 10^{23}}$ ✓ (a)

n = 0,5 mol

	N_2O_4 (g)	$2\ NO_2$ (g)
Initial concentration (mol·dm^{-3}) *Aanvangs konsentrasie (mol·dm^{-3})*	0,125	-
Change in concentration (mol·dm^{-3}) *Verandering in konsentrasie(mol·dm^{-3})*	0,1 ✓ (d)	0,2
Equilibrium concentration (mol·dm^{-3}) *Ewewig konsentrasie (mol·dm^{-3})*	0,025✓ (c)	0,2

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$ ✓ (f)

$K_c = \frac{(0,2)^2}{(0,025)}$ ✓ (g)

No K_c expression, correct substitution / *Geen K_c-uitdrukking, korrekte substitusie.* Max / *Maks 7/8*
Wrong K_c expression / *Verkeerde K_c -uitdrukking.* Max. *Maks. 5/8*

$K_c = 1,6$ ✓ (h) (8)

[15]

QUESTION/*VRAAG 7*

7.1.1 An acid is a proton (H^+ ion) donor / *'n Suur is 'n proton (H^+-ioon) skenker* ✓✓ (2)

7.1.2 $HC\ell$ and/*en* $C\ell^-$ ✓✓ **OR/*OF*** H_3O^+ and/*en* H_2O ✓✓ (2)

7.1.3 Solution **I.** ✓
- $HC\ell$ is a stronger acid than CH_3COOH / $HC\ell$ has a higher K_a ✓ (than CH_3COOH)
- $HC\ell$ will produce a higher concentration of H_3O^+ ✓ (than CH_3COOH)

OR
- CH_3COOH is a weaker acid than $HC\ell$ / CH_3COOH has a lower K_a (than $HC\ell$)
- CH_3COOH will produce a lower concentration of H_3O^+ (than $HC\ell$)

*Oplossing **I.***
- *$HC\ell$ is 'n sterker suur as CH_3COOH / $HC\ell$ het 'n hoër K_a-waarde as CH_3COOH*
- *$HC\ell$ sal 'n hoër konsentrasie van H_3O^+ produseer as CH_3COOH*

OF
- *CH_3COOH is 'n swakker suur as $HC\ell$ / CH_3COOH het 'n laer K_a-waarde as $HC\ell$*
- *CH_3COOH sal 'n laer konsentrasie H_3O^+ produseer as $HC\ell$* (3)

7.2.1
n = cV ✓
= 1 x10 / 1 000 ✓
= 0,01 mol ✓ (3)

7.2.2

Marking criteria	**Marking criteria**
• Formula pH = - log $[H_3O^+]$ ✓ • pH value substituted into formula ✓ • Substitution in K_w formula✓ • Substitution into n = cV✓ • Final answer✓ ***Nasienkriteria*** • *Formule pH = - log $[H_3O^+]$* • *pH-waarde vervang in formule* • *Vervanging in K_w formule* • *Vervanging in n = cV* • *Finale antwoord*	• Formula pOH + pH = 14 ✓ • pH value substituted into formula ✓ • Substitution in pOH formula✓ • Substitution into n = cV✓ • Final answer✓ ***Nasienkriteria*** • *Formule pOH + pH = 14* • *pH-waarde vervang in formule* • *Vervanging in pOH formule* • *Vervanging in n = cV* • *Finale antwoord*

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***
pH = - log $[H_3O^+]$ ✓	pOH + pH = 14 ✓
13 ✓ = - log $[H_3O^+]$	pOH + 13 ✓ = 14
$[H_3O^+] = 1 \times 10^{-13}$ mol·dm^{-3}	pOH = 1
$K_w = [OH^-][H_3O^+] = 1 \times 10^{-14}$	pOH = - log $[OH^-]$
$[OH^-][H_3O^+] = 1 \times 10^{-14}$	1 = - log $[OH^-]$ ✓
$[OH^-](1 \times 10^{-13}) = 1 \times 10^{-14}$ ✓	$[OH^-]$ = 0,1 mol·dm^{-3}
$[OH^-]$ = 0,1 mol·dm^{-3}	[NaOH] = 0,1 mol·dm^{-3}
[NaOH] = 0,1 mol·dm^{-3}	
OR/*OF*	
$c = \frac{n}{V}$	$c_1V_1 = c_2V_2$
From 7.2.1 / *Vanaf 7.2.1*	
$0,1 = \frac{0,01}{V}$ ✓	$(1)(10) = (0,1)V_2$ ✓
	V_2 = 100 cm^3
V = 0,1 (dm^3)✓	V = 0,1 (dm^3) ✓

(5)

7.2.3

Marking criteria	**Marking criteria /**
• Formula n = cV✓ • Substitution of acid values into n = cV **AND** ✓ **Using** ratio Acid : Base = 1 : 2 • Substitution of V and c into n = cV for V base reacting ✓ • Subtracting $V_{remaining} = V_{initial} - V_{reacting}$ ✓ • Final answer ✓ ***Nasienkriteria*** • *Formule n = cV* • *Vervanging van suur waardes in formule n = cV* ***EN*** ***Gebruik** verhouding Suur : Basis* = 1 : 2 • *Vervanging van V en c in n = cV vir V basis wat reageer* • *Aftrekking* $V_{oorbly} = V_{aanvangs} - V_{reageer}$ • *Finale antwoord*	• Formula $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ ✓ • Substitution LHS $\frac{c_aV_a}{c_bV_b}$ ✓ • Substitution RHS $\frac{n_a}{n_b}$ ✓ • Subtracting $V_{remaining} = V_{initial} - V_{reacting}$ ✓ • Final answer ✓ ***Nasienkriteria*** • *Formule* $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ • *Vervang LK* $\frac{c_aV_a}{c_bV_b}$ • *Vervang RK* $\frac{n_a}{n_b}$ • *Aftrekking* $V_{oorbly} = V_{aanvangs} - V_{reageer}$ • *Finale antwoord*

OPTION 1/*OPSIE 1*	**OPTION 2/OPSIE 2**
n acid reacting = cV✓ = 0,09 x 15/1 000 = 1,35 x 10^{-3} mol ✓ n base reacting= 2 x 1,35 x 10^{-3} mol = 2,7 x 10^{-3} mol n = cV 2,7 x 10^{-3} = 0,1 $V_{base\ reacting}$ */basis reageer*✓ 0,027 dm^3 = $V_{base\ reacting}$/ *basis reageer* $V_{remaining/oorbly}$ = 0,1 – 0,027 ✓ = 0,073 dm^3 ✓	$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ ✓ $\frac{(0,09)(15)}{(0,1)V_b}$ ✓ $= \frac{1}{2}$ ✓ V_b = 27 cm^3 V_b = 0,027 dm^3

(5)
[20]

QUESTION/*VRAAG 8*

8.1 Loss of electrons / *Verlies aan elektrone* ✓✓ **(2 or/*of* 0)** (2)

8.2.1 1 mol·dm^{-3} ✓ (1)

8.2.2 Platinum ✓ (1)

8.2.3 Cu ✓ (1)

8.2.4 $O_2 + 4H^+ + 4e^- \rightarrow 2\ H_2O$ ✓✓

Marking criteria / *Nasienkriteria*	
• $O_2 + 4H^+ + 4e^- \rightleftharpoons 2\ H_2O$	½
• $2\ H_2O \leftarrow O_2 + 4H^+ + 4e^-$	2/2
• $2\ H_2O \rightleftharpoons O_2 + 4H^+ + 4e^-$	0/2
• $2\ H_2O \rightarrow O_2 + 4H^+ + 4e^-$	0/2
• Ignore if the charge omitted on electron / *Ignoreer indien lading op elektron weggelaat is.*	

(2)

8.2.5 $2\ Cu + O_2 + 4\ H^+$ ✓→ $2\ Cu^{2+} + 2\ H_2O$ ✓ (✓ bal)

Marking criteria/*Nasienkriteria*
- Reactants/ *Reaktanse*
- Products / *Produkte*
- Balancing / *Balansering*

(3)

8.3.1 $E^\theta_{cell} = E^\theta_{cathode/reduction/oxidising\ agent} - E^\theta_{anode/oxidation/reducing\ agent}$ ✓

E^θ_{cell} = (1,23) ✓ – (0,34) ✓

E^θ_{cell} = 0,89 V ✓

Notes/*Aantekeninge*
- Any other formula using unconventional abbreviation , e.g. $E^o_{cell} = E^o_{OA} - E^o_{RA}$ followed by the correct substitution : ¾
- *Enige ander formule wat onkonvensionele afkortings gebruik bv.*
- *$E^o_{sel} = E^o_{OM} - E^o_{RM}$ gevolg met korrekte vervangings: ¾*

(4)

8.3.2 Concentration of the reactants decreases ✓
Rate of the forward reaction decreases ✓

Konsentrasie van reaktanse verlaag
Tempo van voortwaartse reaksie verlaag (2)

8.3.3 Equilibrium / *Ewewig* ✓ (1)
[17]

QUESTION/*VRAAG 9*

9.1.1

Marking criteria/ Nasienriglyne
If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase

(It is a cell in which) electrical energy ✓ is converted into chemical energy ✓

(Dit is 'n sel waarin) elektriese energie omgeskakel word na chemiese energie. (2)

9.1.2 $2\ C\ell^- \rightarrow C\ell_2(g) + 2e^-$ ✓✓

Ignore phases / *Ignoreer fases* (2)

Marking criteria / *Nasienkriteria*
- $2\ C\ell^- \rightleftharpoons C\ell_2(g) + 2e^-$ ½
- $C\ell_2(g) + 2e^- \leftarrow 2\ C\ell^-$ 2/2
- $C\ell_2(g) + 2e^- \rightleftharpoons 2\ C\ell^-$ 0/2

Ignore if the charge omitted on electron / *Ignoreer indien lading weggelaat is op elektron*

9.1.3 H_2 / Hydrogen gas / *Waterstofgas* (1)

9.1.4 H_2O is a stronger oxidising agent than Na^+ ✓
H_2O is reduced to H_2 ✓

H_2O is 'n sterker oksideermiddel as Na^+
H_2O word gereduseer na H_2 (2)

9.2.1 Cathode / *Katode* ✓ (1)

9.2.2 n_{Cu} = ½ x 6 ✓
= 3 mol

m_{Cu} = nM = 3 x 63,5✓

= 190,5 g
0,95 ✓$m_{IMPURE\ sample}$ = 190,5

$m_{IMPURE\ sample}$ = 200,53 g ✓

Marking criteria
- Use of ratio of electrons to Cu
- Subst. into n = m/M
- Division by 0,95
- Final answer

Nasienkriteria
- *Gebruik van verhouding van elektrone tot Cu*
- *Vervanging in n = m/M*
- *Deel deur 0,95*
- *Finale antwoord*

(4)
[12]

TOTAL/*TOTAAL*: 150

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Province of the EASTERN CAPE EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

JUNE/*JUNIE* 2022

PHYSICAL SCIENCES: CHEMISTRY P2 MARKING GUIDELINE/ *FISIESE WETENSKAPPE: CHEMIE V2 NASIENRIGLYN*

MARKS/*PUNTE*: 150

This marking guideline consists of 13 pages./
Hierdie nasienriglyn bestaan uit 13 bladsye.

QUESTION/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	B ✓✓	(2)
1.3	A ✓✓	(2)
1.4	C ✓✓	(2)
1.5	B ✓✓	(2)
1.6	D ✓✓	(2)
1.7	B ✓✓	(2)
1.8	A ✓✓	(2)
1.9	B ✓✓	(2)
1.10	D ✓✓	(2)
		[20]

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QUESTION/*VRAAG 2*

2.1 2.1.1 Alkyne ✓ (1)

2.1.2 Haloalkane ✓ (1)

2.2 2.2.1 E ✓ (1)

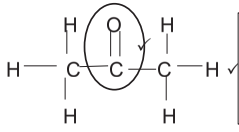
2.2.2 D ✓ (1)

2.3 2.3.1 Compound that contains carbon and hydrogen atoms only. ✓✓ (2 or 0)
Verbinding wat slegs koolstof- en waterstof-atome bevat. (2 of 0) (2)

2.3.2 UNSATURATED ✓ Contains triple bond ✓/multiple bonds (between the C-atoms in die hydrocarbon chain)
ONVERSADIG Bevat 'n drievoudige binding/ meervoudige bindings (tussen C-atome in die koolwaterstofketting) (2)

2.3.3 6-ethyl ✓-2-methyl ✓oct-4-yne ✓ / 6-ethyl-2-methyl-4-octyne
6-etiel-2-metielokt-4-yne / 6-etiel-2-metiel-4-oktyn (3)

2.4

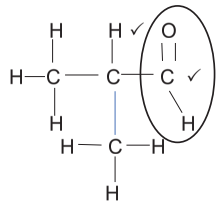


Marking criteria/*Nasienkriteria*:
- Whole structure correct/*Hele struktuur korrek: (2/2)*
- Only functional group correct
  Slegs funksionele groep korrek Max./*Maks. (1/2)*

(2)

2.5 2.5.1 Butanal ✓✓ (2)

2.5.2



Marking criteria/*Nasienriglyne*
- Whole structure correct/*Hele struktuur korrek: (2/2)*
- Only functional group correct
  Slegs funksionele groep korrek Max./*Maks. (1/2)*

(2)

2.6 2.6.1 Combustion ✓/Oxidation
Verbranding / Oksidasie (1)

2.6.2 $2\ C_6H_{14} + 19\ O_2$ ✓ → $12\ CO_2 + 14\ H_2O$ ✓ (✓ Balancing/ *balansering*) (3)

2.6.3 Compound A reacts exothermically with oxygen / releases heat when it reacts with oxygen. ✓
Verbinding A reageer eksotermies met suurstof / hitte word vrygestel wanneer dit met suurstof reageer. (1)

[22]

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QUESTION/*VRAAG 3*

3.1 3.1.1 Boiling point is the temperature ✓at which the vapour pressure of a liquid equals the atmospheric pressure. ✓
Kookpunt is die temperatuur waarby die dampdruk van 'n vloeistof gelyk is aan die atmosferiese druk. (2)

3.1.2 Functional group/ ✓Homologous series/ Type of intermolecular forces.
Funksionele groep / Homoloë reeks / Tipe intermolekulêrekragte. (1)

3.1.3 London forces ✓/induced dipole forces/dispersion forces.
Londonkragte/geïnduseerde dipool kragte/verspreidingskragte. (1)

3.1.4 **C** has hydrogen bonds ✓ (in addition to London forces)
B has dipole-dipole forces ✓(in addition to London forces)
Hydrogen bonds are stronger than dipole dipole-forces ✓
More energy is needed to overcome intermolecular forces in **C** ✓

***C** het waterstofbinding (bykomend tot Londonkragte)*
***B** het dipool-dipoolkragte (bykomend tot Londonkragte)*
Waterstofbindings is sterker as die dipool-dipoolkragte
*Meer energie word benodig om die intermolekulêrekragte te oorkom in **C***

OR/*OF*

C has hydrogen bonds ✓ (in addition to London forces)
B has dipole-dipole forces ✓(in addition to London forces)
Dipole dipole forces are weaker than hydrogen bonds ✓
Less energy is needed to overcome intermolecular forces in **B** ✓

***C** het waterstofbinding (bykomend tot Londonkragte)*
***B** het dipool-dipoolkragte (bykomend tot Londonkragte)*
Dipool-dipool is swakker as die waterstofbindings
*Minder energie word benodig om die intermolekulêrekragte te oorkom in **B***** (4)

3.2 3.2.1 Vapour pressure is the pressure exerted by a vapour ✓ in equilibrium with its liquid in a closed container./ ✓
Dampdruk is die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem. (2)

3.2.2 p_1 = 100 (kPa) ✓/101,3 (kPa) / 1 atmosphere / *atmosfeer* (1)

3.2.3 Gas ✓ **A** is above its boiling point / *Bo **A** se kookpunt* ✓ (2)

3.2.4 LOWER THAN/*LAER AS* ✓ (1)

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3.2.5 Compound C only reached its boiling point at 117,7 ˚C where its vapour pressure will equal 101,3 kPa. ✓✓
Verbinding C bereik eers sy kookpunt by 117,7 ˚C waar sy dampdruk eers gelyk aan 101,3 kPa gaan wees. (2)
[16]

QUESTION/*VRAAG* 4

4.1 Substitution ✓/Hydrolysis (of haloalkanes)
Substitusie / Hidrolise (van haloalkane) (1)

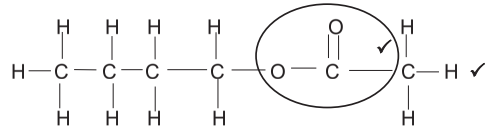
4.2 $CH_3CH_2CH_2CH_2OH$ ✓✓ (2)

4.3 Primary alcohol ✓
The carbon atom that contains the hydroxyl group (-OH) is bonded to one other carbon atom only. ✓
Primêre alkohol
Die koolstof-atoom wat die hidroksielgroep (-OH) bevat is verbind aan slegs een ander koolstof-atoom. (2)

4.4 Esterification/Condensation ✓
Esterifikasie / Kondensasie (1)

4.5 Butyl ethanoate / *Butiel-etanoaat* ✓✓

Marking criteria/*Nasienkriteria*:
- Functional group/*Funksionele groep.* ✓ (1/2)
- Whole structure correct/
  Hele struktuur korrek ✓ *(2/2)*



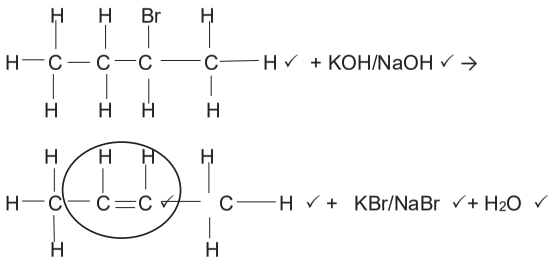
(4)

4.6 Dehydration / *Dehidrasie* ✓ (1)

4.7 (concentrated / *gekonsentreerde*) H_2SO_4 ✓ (1)

4.8 Compounds with same molecular formula ✓ but different positions of the functional group ✓/side chains/substituent on the parent chain./
Verbindings met dieselfde molekulêre formule maar verskillende posisies van die funksionele groep/sykettings/substituent op die stamketting. (2)

4.9



Marking criteria/ *Nasienkriteria*

Reactants / *Reaktanse*

- Organic molecule correct/ *Organiese molecule korrek* ✓
- KOH/NaOH ✓

Products / *Produkte*

- **Organic molecule / *Organiese molekule***
- Functional group/*Funksionele groep.* ✓ (1/2)
- Whole structure correct/
  Hele struktuur korrek ✓ *(2/2)*

Inorganic products / *Anorganiese produkte*

- KBr/NaBr ✓
- H_2O ✓

(6)
[20]

QUESTION 5/*VRAAG 5*

5.1 Change in concentration ✓per unit time. ✓/Amount of product formed/reactant used up per unit time.
Verandering in konsentrasie per eenheid tyd / Hoeveelheid produk gevorm / reaktanse opgebruik per eenheidstyd.

OR/*OF*

Rate of change in concentration **(2 or 0)**
*Tempo van verandering in konsentrasie **(2 of 0)*** (2)

5.2 Concentration ✓ and a catalyst. ✓/
Konsentrasie en 'n katalisator. (2)

5.3 5.3.1 Concentration (of H_2O_2) decreases / *Konsentrasie (van H_2O_2) verlaag* ✓✓ (2)

5.3.2 t = 5 000(s) ✓ (1)

5.3.3 Rate/*tempo* = $-\Delta c/\Delta t$ = - (1,0 – 0) ✓/(0 – 5 000) ✓
= 2 x 10^{-4} ✓mol·dm^{-3}·s^{-1} (3)

5.3.4 $\Delta c = 0{,}8$ mol·dm^{-3}

n (H_2O_2) = cV
= 0,8 x (0,15) ✓
= 0,12 mol

n (H_2O_2) = n (O_2) = 0,12 mol ✓ (Ratio / *verhouding*)

n = V/Vm ✓

0,12 = V/25 000 ✓

V = 3 000 cm^3 ✓/(3 dm^3) (5)

5.4 5.4.1 Decrease / *Verlaag* ✓ (1)

5.4.2 Remains the same / *Bly dieselfde* ✓ (1)

5.5 5.5.1 Minimum energy required for a reaction to take place. ✓✓/
Minimum energie benodig vir 'n reaksie om plaas te vind. (2)

5.5.2 Particles with sufficient kinetic energy to react. ✓/
Deeltjies met genoeg kinetiese energie om te reageer. (1)

5.5.3 E_2 ✓

Calatyst lowers the activation energy ✓
More particles have sufficient kinetic energy to react ✓
More effective collisions per unit time ✓/Frequency of effective collisions increases
'n Katalisator verlaag die aktiveringsenergie.
Meer deeltjies het genoeg kinetiese energie om te reageer
Meer effektiewe botsings per eenheid tyd / Frekwensies van die effektiewe botsings neem toe (4)
[24]

QUESTION 6/*VRAAG 6*

6.1 6.1.1 Reversible ✓ (reaction) / *Omkeerbare (reaksie)* (1)

6.1.2 HIGHER THAN / *HOËR AS* ✓✓ (2)

6.1.3 EQUAL TO / *GELYK AAN* ✓ (1)

6.2 **OPTION 1/ *OPSIE 1* : MOLE OPTION / *MOL OPSIE***
Marking Criteria/ *Nasienkriteria*:

- Divide by 17 to calculate $n(NH_3)_{equilibrium.}$ ✓
  Deel deur 17 om $n(NH_3)_{ewewig}$ te bereken.
- $\Delta n\ NH_3$ ✓
- Use mole ratio $N_2:H_2:NH_3$ / *Gebruik mol verhouding* $N_2:H_2:NH_3$ ✓
- n equilibrium / *ewewig* N_2 and/*en* H_2 ✓
- Divide 2 dm^3 all $n_{equilibrium}$ / *Deel deur 2 dm^3 in alle n_{ewewig}* ✓
- Correct K_c expression/*Korrekte K_c uitdrukking.* ✓
- Substitution into K_c expression ✓/*Vervanging in K_c uitdrukking.*
- Final answer / *Finale antwoord* (0,41) ✓

$n(NH_3) = m/M = 41,48/17$ ✓ $= 2,44$ mol

	N_2	$3\ H_2$	$2\ NH_3$	
n_i	4,88	6,18	0	
Δn	1,22	3,66	2,44 ✓	**Ratio / *verhouding***
n_e	3,66	2,52 ✓	2,44 ✓	
c_e	1,83	1,26	1,22 ✓	**(Div/by *deel met* 2 dm^3)**

$Kc = [NH_3]^2/[N_2].[H_2]^3$ ✓

$= 1,22^2/1,83 \times 1,26^3$ ✓

$= 0,41$ ✓

OPTION 2: CONCENTRATION / *OPSIE 2: KONSENTRASIE*
Marking criteria/ *Nasienkriteria*:

- Calculate c $(NH_3)_{equilibrium.}$ ✓
  Bereken $c(NH_3)_{ewewig}$
- Δc NH_3 ✓
- c_i N_2 and/*en* H_2 ✓
- Use conc. ratio N_2:H_2: NH_3/*Gebruik gekonsen. verhouding* N_2:H_2: NH_3 ✓
- c equilibrium /*ewewig* N_2 and/*en* H_2 ✓
- Correct K_c expression/*Korrekte* K_c *uitdrukking.* ✓
- Substitution into Kc expression ✓/*Vervanging in* K_c *uitdrukking.*
- Final answer/*Finale antwoord* (0,41) ✓

n (NH_3) = m/M = 41,48/17 = 2,44 mol

c_e (NH_3) = n/V = 2,44/2 ✓ = 1,22 mol·dm^{-3}

c_i (N_2) = n/V = 4,88/2 = 2,44 mol·dm^{-3}

c_i (H_2) = n/V = 6,18/2 = 3,09 mol·dm^{-3}

	N_2	3 H_2	2 NH_3	
c_i	2,44	3,09	0	
Δc	0,61	1,83	1,22 ✓	**Ratio / *verhouding***
c_e	1,83	1,26 ✓	1,22 ✓	

Kc = $[NH_3]^2/[N_2].[H_2]^3$ ✓

= $1,22^2/1.83 \times 1,26^3$ ✓

= 0,41 ✓ (8)

6.3 Temperature / *Temperatuur* ✓ (1)

6.4 **A** ✓
At a given temperature the yield of NH_3 is the highest ✓ (in graph **A**)
Increase pressure favours reaction which produces less gas moles ✓
Forward reaction is favoured ✓
By 'n gegewe temperatuur is die opbrengs van NH_3 *die hoogste (in grafiek* ***A****)*
Toename in druk bevoordeel die reaksie wat die minste gas mol produseer
Voorwaartse reaksie word bevoordeel (4)

6.5 6.5.1 Increase / *Toeneem* ✓ (1)

6.5.2 No effect / *Geen effek* ✓ (1)

6.5.3 Decrease/ *Afneem* ✓ (1)
[20]

QUESTION 7/*VRAAG 7*

7.1 7.1.1 An acid is a proton (H^+-ion) donor ✓✓
'n Suur is 'n proton (H^+-ioon) -skenker (2)

7.1.2 H_2O ✓ and / *en* $H_2SO_4^-$ ✓ (2)

7.1.3 H_2O or/*of* HSO_4^- (Any ONE / *Enige EEN* ✓) (1)

7.2 7.2.1 WEAK ACID ✓ Low Ka value/ Ka < 1 ✓
SWAKSUUR Lae Ka-waarde / Ka < 1 (2)

7.2.2 H_2SO_4 ✓ (1)

7.2.3 pH = - log $[H_3O^+]$ ✓

3 = - log $[H_3O^+]$ ✓

$[H_3O^+]$ = 1 x 10^{-3} mol·dm^{-3}

Marking criteria/ *Nasienkriteria*
- pH formula / formule
- Substitution / Substitusie
- Ratio / Verhouding
- Final answer / Finale antwoord

$[H_2SO_4]$ = ½ x 10^{-3} ✓

= 5 x 10^{-4} mol.dm^{-3} ✓ (4)

7.2.4 CO_3^{2-} + H_2O ✓ → HCO_3^- + OH^- ✓

Na_2CO_3 + H_2O → $NaHCO_3$ + NaOH

(Excess) OH^- formed / *(oormaat)* OH^- *word geproduseer* ✓ (3)

7.3.1 It is a solution of known concentration ✓✓
Dit is 'n oplossing van bekende konsentrasie (2)

7.3.2

OPTION 1 / *OPSIE 1:*	**OPTION 2 / *OPSIE 2:***
n = m/M n = 1,74/58 ✓ = 0,03 mol c = n/V = 0,03 / 0,2 ✓ = 0,15 mol·dm^{-3}	c = m/MV c = 1,74 / (58)(0,2) ✓✓ = 0,15 mol·dm^{-3}
OPTION 3 / *OPSIE 3:*	**OPTION 4 / *OPSIE 4:***
n = cV = (0,15)(0,2) ✓ n = 0,3 mol m = nM = (0,3)(58) ✓ = 1,74 g	m = cMV = (0,15)(58)(0,2) ✓✓ m = 1,74 g

(2)

7.3.3 **Marking guideline / *Nasienriglyn***

- Calculating mole for $Mg(OH)_2$ / *Bereken mol vir* $Mg(OH)_2$
- Calculating the diluted concentration for HCl / *Bereken die verdunde konsentrasie van HCl*
- Calculating the total mole for HCl / *Bereken die totale mol van HCl*
- Calculating the reacted mole for HCl / *Bereken die mol van HCl wat gereageer het*
- Determining the remaining mole for HCl / *Bepaal die mol van HCl wat oorbly*
- Use of formula c = n/V in calculating the concentration of excess ions / *Gebruik formule c = n/V om die konsentrasie van die oormaat ione te bereken*
- Substituting into / *Vervanging in* c = n/V
- Final answer/ *Finale antwoord*

$n [Mg(OH)_2] = cV$
$= 0,15 \times 0,04$ ✓
$= 0,006$ mol

$c_1V_1 = c_2V_2$
$5 \times 10 = c_2(100)$ ✓
$c_2 = 0,5$ mol·dm^{-3}

OR/OF

$n = cV$
$= (10)5 \times 10^{-3}$)
$n = 0,05$ mol
$c = \frac{n}{V}$ ✓
$= \frac{0,05}{0,1}$
$c = 0,5$ mol.dm^{-3}

n (HCl) $= cV$
$= 0,5 \times 0,05$ ✓
$= 0,025$ mol

n (HCl) reacting $= 2 \times 0,006$ ✓ $= 0,012$ mol

n (HCl) remaining $= 0,025 - 0,012$ ✓✓ $= 0,013$ mol

c (HCl) $= n/V$ ✓$= 0,013 / (0,09)$ ✓ $= 0,14$ mol·dm^{-3} ✓ (9)

[28]

TOTAL/*TOTAAL*: 150

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GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 21 pages.
Hierdie nasienriglyne bestaan uit 21 bladsye.

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QUESTION 1/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 D ✓✓ (2)

1.3 A ✓✓ (2)

1.4 B ✓✓ (2)

1.5 D ✓✓ (2)

1.6 D ✓✓ (2)

1.7 C ✓✓ (2)

1.8 B ✓✓ (2)

1.9 A ✓✓ (2)

1.10 B ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 A compound that contains a double bond/multiple bond/does NOT contain only single bonds (between C atoms). ✓✓ **(2 or 0)**
'n Verbinding wat dubbelbindings/meervoudige bindings/NIE net enkel-bindings (tussen C-atome) bevat NIE. ***(2 of 0)*** (2)

2.2
2.2.1 B / E ✓ (1)

2.2.2 Carbonyl (group bonded to two C atoms) ✓
Karboniel(groep gebind aan twee C-atome)

ACCEPT/*AANVAAR*
Ketone/*Ketoon*

(1)

2.2.3 F ✓✓ (2)

2.2.4 2,5-dichloro-3-methylhexane/*2,5-dichloro-3-metielheksaan*

Marking criteria:
- Correct stem i.e. hexane. ✓
- All substituents (dichloro and methyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Alle substituente (dichloro en metiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

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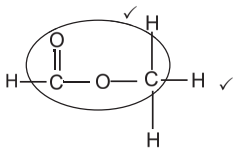
2.2.5 C_nH_{2n} ✓ (1)

2.3 Compounds with the same molecular formula, ✓ but different functional groups/homologous series. ✓
Verbindings met dieselfde molekulêre formule, maar verskillende funksionele groepe/homoloë reekse. (2)

2.4
2.4.1 Carboxylic acids/*Karboksielsure* ✓ (1)

2.4.2



Marking criteria/*Nasienkriteria*:
- Whole structure correct/
  Hele struktuur korrek: 2/2
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

IF/*INDIEN*
More than one functional group:
Meer as een funksionele groep: 0/2

IF/*INDIEN*
- Molecular formula/*Molekulêre formule* 0/2
- Condensed structural formula /*Gekondenseerde struktuurformule* 1/2

(2)

2.5
2.5.1 Ethanol/*Etanol* ✓ (1)

2.5.2 E ✓ **ACCEPT/*AANVAAR*:** C_2H_4 (1)

2.5.3 (Concentrated) sulphuric acid/H_2SO_4/(concentrated) phosphoric acid/H_3PO_4 ✓
(Gekonsentreerde) swawelsuur/ H_2SO_4/(gekonsentreerde) fosforsuur/ H_3PO_4 (1)
[18]

QUESTION 3/*VRAAG 3*

3.1 **Marking criteria/*Nasienkriteria:***
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The temperature at which solid and liquid phases are in equilibrium. ✓✓
Die temperatuur waarby die vastestof- en vloeistoffases van 'n stof in ewewig is. (2)

3.2 **Marking criteria**
- Identification of independent variable. ✓
- Stating the relationship between dependent and independent variable. ✓

Nasienkriteria
- *Identifikasie van onafhanklike veranderlike.* ✓
- *Stel verwantskap tussen afhanklike en onafhanklike veranderlikes.* ✓

- As the chain length/number of C atoms/molecular mass/surface area/strength of the intermolecular forces ✓ increases, the melting points increase. ✓
  OR
- As the chain length/ number of C atoms/molecular mass/surface area/strength of the intermolecular forces ✓ decreases, the melting points decrease. ✓

- *Wanneer die kettinglengte/aantal C-atome/molekulêre massa/oppervlak-area/sterkte van intermolekulêre kragte ✓ toeneem, neem die smeltpunte toe.*
  OF
- *Wanneer die kettinglengte/aantal C-atome/molekulêre massa/oppervlak-area/sterkte van intermolekulêre kragte afneem, neem die smeltpunte af.* (2)

3.3 London forces ✓
Londonkragte

ACCEPT/*AANVAAR*
Dispersion forces/induced dipole forces
Dispersiekragte/geïnduseerde dipoolkragte (1)

3.4
3.4.1 Liquid/*Vloeistof* ✓ (1)

3.4.2 Solid/*Vaste stof* ✓ (1)

3.5
3.5.1 Equal to/*Gelyk aan* ✓

Same molecular formula/Isomers/same number and types of atoms/same number of C and H atoms ✓
Dieselfde molekulêre formule/Isomere/dieselfde aantal en soort atome/ dieselfde aantal C- en H-atome (2)

3.5.2 Lower than/*Laer as* ✓ (1)

3.5.3

Marking criteria:
- Compare structures. ✓
- Compare the strength of intermolecular forces.✓
- Compare the energy required to overcome intermolecular forces. ✓

2,2-dimethylbutane:
- **Structure:**
  More branched/more compact/more spherical/smaller surface area (over which intermolecular forces act).✓
- **Intermolecular forces:**
  Weaker/less intermolecular forces/Van der Waals forces/London forces/dispersion forces. ✓
- **Energy:**
  Lesser energy needed to overcome or break intermolecular forces/Van der Waals forces. ✓

OR

Hexane
- **Structure:**
  Longer chain length/unbranched/less compact/less spherical/larger surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Stronger/more intermolecular forces/Van der Waals forces/London forces/dispersion forces. ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces/Van der Waals forces. ✓

Nasienkriteria:
- *Vergelyk strukture* ✓
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- Vergelyk die energie benodig om intermolekulêre kragte te oorkom. ✓

***2,2-dimetielbutaan*:**
- ***Struktuur*:**
  Meer vertak/meer kompak/meer sferies/kleiner oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte:***
  Swakker/minder intermolekulêre kragte/Van der Waalskragte/London-kragte/dispersiekragte. ✓
- ***Energie*:**
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte/ dispersiekragte/Londonkragte te oorkom/breek. ✓

OF

Heksaan
- ***Struktuur*:**
  Langer kettinglengte/onvertak/minder kompak/minder sferies/groter oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte:***
  Sterker/meer intermolekulêre kragte/Van der Waalskragte/Londonkragte/ dispersiekragte. ✓
- ***Energie*:**
  Meer energie benodig om intermolekulêre kragte/Van der Waalskragte/ dispersiekragte/Londonkragte te oorkom/breek. ✓

(3)
[13]

QUESTION 4/*VRAAG 4*

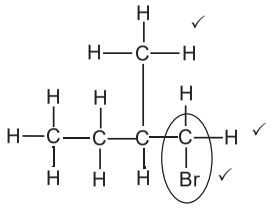
4.1

4.1.1 Substitution/Hydrolysis ✓
Substitusie/Hidrolise (1)

4.1.2 Primary (alcohol) ✓
ANY ONE:
- The C atom of the functional group is the terminal C atom.
- The C-atom bonded to the hydroxyl/-OH is bonded to (only) one other C-atom. ✓
- The hydroxyl/-OH is bonded to a C-atom which is bonded to two hydrogen atoms.
- The hydroxyl/-OH is bonded to a primary C atom/terminal C atom/first C atom.

Primêre (alkohol) ✓
ENIGE EEN:
- *Die C-atoom van die funksionele groep is die terminale C-atoom.*
- *Die C-atoom wat aan die hidroksiel/-OH gebind is, is aan (slegs) een ander C-atoom gebind.* ✓
- *Die hidroksiel/-OH is gebind aan 'n C-atoom wat aan twee waterstofatome gebind is.*
- *Die hidroksiel/-OH is aan 'n primêre C-atoom/*terminale C-atoom/eerste C-atoom gebind. (2)

4.1.3



Marking criteria:
- Four C atoms in longest chain. ✓
- One methyl substituent on C2. ✓
- Bromo substituent on C1. ✓

Nasienkriteria:
- *Vier C-atome in langste ketting.* ✓
- *Een metielsubstituent op C2.* ✓
- *Broomsubstituent op C1.* ✓

IF/*INDIEN*
Any error e.g. omission of H atoms, condensed or semi structural formula/*Enige fout bv. weglating van H-atome, gekondenseerde of semi-struktuurformule.* Max/*Maks.*: 2/3

(3)

4.1.4 Elimination/dehydrohalogenation/dehydrobromination ✓
Eliminasie/dehidrohalogenering/dehidrohalogenasie/dehidrobrominasie/ dehidrobromonering (1)

4.1.5 Alkenes/*Alkene* ✓ (1)

4.1.6 Addition/*Addisie* ✓ (1)

4.1.7 2-bromo-2-methyl✓butane ✓
2-bromo-2-metiel✓butaan ✓ (2)

4.2

NOTE/*LET WEL*:
- Penalise only once for the use of structural formulae or molecular formulae.
- *Penaliseer slegs een keer vir die gebruik van struktuurformules of molekulêre formules.*

4.2.1

Marking criteria:
- Correct condensed structure for but-2-ene. ✓
- React but-2-ene with H_2/H — H. ✓
- Indicate the catalyst Pt/Ni/Pd on arrow/at the equation. ✓
- Correct condensed formula for butane as product. ✓

IF: Any additional products or reactants - minus 1 mark

Nasienkriteria:
- *Korrekte gekondenseerde struktuur vir but-2-een.* ✓
- *Reageer but-2-een met H_2/H — H.* ✓
- *Dui die katalisator Pt/Ni/Pd op die pyl/by die vergelyking aan.* ✓
- *Korrekte gekondenseerde formule vir butaan as produk.* ✓

***INDIEN:** Enige addisionele reaktanse of produkte – minus 1 punt*

$CH_3CHCHCH_3$ ✓ + H_2 ✓ $\xrightarrow{Pt/Ni/Pd\ ✓}$ $CH_3CH_2CH_2CH_3$ ✓

ACCEPT/*AANVAAR*
As reactant/*reaktans*: $CH_3(CH)_2CH_3$ / $CH_3CH=CHCH_3$ / $CH_3-CH=CH-CH_3$
As product/*produk*: $CH_3(CH_2)_2CH_3$ / $CH_3-CH_2-CH_2-CH_3$ /$CH_3-(CH_2)_2-CH_3$ (4)

4.2.2 Elimination/Cracking ✓
Eliminasie/Kraking (1)

4.2.3 Propene/1-propene/prop-1-ene ✓✓
Propeen/1-propeen/prop-1-een (2)

4.2.4

Marking criteria:
- Correct condensed formula for propene as reactant. ✓
- React (propene) with Br_2/Br — Br ✓
- Correct condensed formula for 1,2-dibromopropane as product. ✓

IF: Any additional products or reactants - minus 1 mark

Nasienkriteria:
- *Korrekte gekondenseerde formule vir propeen as reaktans.* ✓
- *Reageer* (propeen) met *Br_2*/Br — Br. ✓
- *Korrekte gekondenseerde formule vir 1,2-dibromopropaan as produk.* ✓

***INDIEN:** Enige addisionele reaktanse of produkte – minus 1 punt*

CH_3CHCH_2 ✓ + Br_2 ✓ $\longrightarrow$ $CH_3CHBrCH_2Br$ ✓

ACCEPT/*AANVAAR*:
As reactant/*reaktans*: $CH_3CH=CH_2$ / $CH_2=CHCH_3$
As product/*produk*: $CH_3CHBrCH_2Br$ / $CH_3-\underset{\underset{Br}{|}}{CH}-\underset{\underset{Br}{|}}{CH_2}$ /

$BrCH_2CHBrCH_3$ / $\underset{\underset{Br}{|}}{CH_2}-\underset{\underset{Br}{|}}{CH}-CH_3$ (3)

[21]

QUESTION 5/*VRAAG 5*

5.1

NOTE/*LET WEL*
Give the mark for per unit time only if in context of reaction rate.
Gee die punt vir per eenheidtyd slegs indien in konteks van reaksietempo.

ANY ONE
- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- Rate of change in concentration/amount of moles/number of moles/volume/mass. ✓✓ **(2 or 0)**

ENIGE EEN
- *Verandering in konsentrasie* ✓ *van produkte/reaktanse per (eenheid) tyd.*✓
- *Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.*
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.*
- *Tempo van verandering in konsentrasie/ hoeveelheid mol/getal mol/ volume/ massa.* ✓✓ **(2 *of* 0)** (2)

5.2 Reaction rate decreases./Concentration of HCℓ decreases./Concentration of reactant decreases./Reactants are used up/Mass of $CaCO_3$ decreases or is used up. ✓
Reaksietempo neem af./Konsentrasie van HCℓ neem af./Konsentrasie van reaktans neem af./Reaktanse word opgebruik./Massa van $CaCO_3$ neem af of word opgebruik. ✓ (1)

5.3
5.3.1 Exothermic/*Eksotermies* ✓ (1)

5.3.2
- Gradient increases/becomes steeper. / Curve becomes steeper. ✓
- Reaction rate increases/More (or larger volume) of CO_2 is produced per unit time. ✓
- Temperature increases./Energy is released/Average kinetic energy of the molecules increases. ✓

- *Gradiënt neem toe/word steiler. / Kurwe word steiler.* ✓
- *Reaksietempo neem toe./Meer (of groter volume) CO_2 word produseer per eenheidtyd.* ✓
- *Temperatuur neem toe./Energie word vrygestel./Gemiddelde kinetiese energie van molekule neem toe.* ✓ (3)

5.4

Marking criteria

- m(pure $CaCO_3$) = $\frac{82,5}{100}$ x 15 ✓ / $V(CO_2)$ = $\frac{82,5}{100}$ x $V(CO_2)$ from/*uit* 15 g $CaCO_3$
- Divide by 100 $g \cdot mol^{-1}$. ✓
- Use mol ratio: $n(CO_2) = n(CaCO_3)$. ✓
- Multiply $n(CO_2)$ by 24 000 cm^3/24 dm^3. ✓
- Final answer: 2 976 cm^3 ✓
- **Range:** 2880 to 2970 cm^3 / 2,88 to 2,97 dm^3

Nasienkriteria

- m(*suiwer* $CaCO_3$) = $\frac{82,5}{100}$ *x 15* ✓ */ V(CO_2)* = $\frac{82,5}{100}$ *x V(CO_2) uit 15 g $CaCO_3$*
- *Deel deur 100 $g \cdot mol^{-1}$.* ✓
- *Gebruik molverhouding*: $n(CO_2) = n(CaCO_3)$. ✓
- *Vermenigvuldig* $n(CO_2)$ *met* 24 000 cm^3/24 dm^3. ✓
- *Finale antwoord*: 2 976 cm^3 ✓
  Gebied: 2880 *tot* 2970 cm^3 / 2,88 tot 2,97 dm^3

OPTION 1/*OPSIE 1*

m(pure/*suiwer* $CaCO_3$) = $\frac{82,5}{100}$ x 15 ✓
= 12,375 g

n(pure/*suiwer* $CaCO_3$) = $\frac{m}{M}$
= $\frac{12,375}{100}$ ✓
= 0,124 mol

$n(CO_2) = n(CaCO_3)$
= 0,124 mol ✓

$V(CO_2)$ = 0,124 x 24 000 ✓
= 2 976 cm^3 ✓

OR/*OF*

$V(CO_2)$ = 0,124 x 24 ✓
= 2,98 dm^3 ✓

OPTION 2/*OPSIE 2*

IF 15 g **PURE** $CaCO_3$ reacts:
INDIEN *15 g* ***SUIWER*** *$CaCO_3$ reageer:*

$n(CaCO_3)$ = $\frac{m}{M}$
= $\frac{15}{100}$ ✓
= 0,15 mol

$n(CO_2) = n(CaCO_3)$ ✓
= 0,15 mol

$n(CO_2)$ = $\frac{V}{V_M}$

0,15 = $\frac{V}{24\ 000}$ ✓ / 0,15 = $\frac{V}{24}$
V = 3 600 cm^3 / V = 3,6 dm^3

Actual CO_2 formed:
Werklike CO_2 gevorm:

$V(CO_2)$ = $\frac{82,5}{100}$ x 3 600 / 3,6 ✓
= 2 976 cm^3 / 2,976 dm^3 ✓ (5)

OPTION 3/*OPSIE 3*

IF 15 g **PURE** $CaCO_3$ reacts:/***INDIEN*** *15 g* ***SUIWER*** *$CaCO_3$ reageer:*

$n(CaCO_3)$ = $\frac{m}{M}$
= $\frac{15}{100}$ ✓
= 0,15 mol

$n(CO_2) = n(CaCO_3)$ ✓
= 0,15 mol

$n(CO_2)$ = $\frac{m}{M}$
$m(CO_2)$ = 0,15 x 44
= 6,6 g

82,5 = $\frac{m_{actual/werklik}}{6,6}$ ✓ x 100
$m_{(actual/werklik)}$ = 5,445 g

$n(CO_2)$ = $\frac{m}{M}$
= $\frac{5,445}{44}$
= 0,12375 mol

$n(CO_2)$ = $\frac{V}{V_M}$

0,12375 = $\frac{V}{24\ 000}$ ✓ / 0,12375 = $\frac{V}{24}$
V = 2 976 cm^3 / 2,976 dm^3 ✓ (5)

5.5 Increases/*Toeneem* ✓ (1)

5.6

- More ($CaCO_3$) particles with correct orientation/exposed./ Greater (exposed) surface area. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓

- *Meer ($CaCO_3$)-deeltjies met korrekte oriëntasie/blootgestel./ Groter (blootgestelde) reaksieoppervlakte.* ✓
- *Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.*✓

NOTE/*LET WEL*

- If explanation in terms of CONCENTRATION: No mark for bullet 1.
  Indien verduideliking in terme van KONSENTRASIE: Geen punt vir kolpunt 1.
- Bullets are marked independently./*Kolpunte word onafhanklik nagesien.*

(2)
[15]

QUESTION 6/*VRAAG 6*

6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓ **(2 or 0)**
OR
(The stage in a chemical reaction when the) concentrations of reactants and products remain constant. **(2 or 0)**

(Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. **(2 of 0)**
OF
(Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. **(2 of 0)** (2)

6.2
6.2.1 Negative/*Negatief* ✓ (1)

6.2.2
- Increase in temperature favours an endothermic reaction. **Accept:** Decrease in temperature favours an exothermic. ✓
- Reverse reaction is favoured./Concentration of reactants increases./ Concentration of products decreases. ✓
- (Forward) reaction is exothermic. **Accept:** Reverse reaction is endothermic. ✓

- *Toename in temperatuur bevoordeel 'n endotermiese reaksie.* ✓ ***Aanvaar:*** *Afname in temperatuur bevoordeel die eksotermiese reaksie.*
- *Terugwaartse reaksie word bevoordeel./Konsentrasie van reaktanse neem toe./Konsentrasie van produkte neem af.* ✓
- *(Voorwaartse) reaksie is eksotermies.* ***Aanvaar:*** *Terugwaartse reaksie is endotermies.* ✓ (3)

6.2.3

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:
a) Initial n(P) and n(Q_2) and n(PQ) from table. ✓
b) Change in n(P) = equilibrium n(P) – initial n(P).✓
c) **USING** ratio: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Equilibrium n(Q_2) = initial n(Q_2) + change in n(Q_2)
Equilibrium n(PQ) = initial n(PQ) - change in n(PQ) } ✓
e) Divide **equilibrium** amounts of P and Q_2 and PQ by 2 dm^3. ✓
f) Correct K_c expression (formulae in square brackets). ✓
g) Substitution of equilibrium concentrations into K_c expression. ✓
h) Final answer: 10,889 ✓

Nasienkriteria:
a) Aanvanklike n(P) en n(Q_2) en n(PQ) uit tabel.✓
b) Verandering in n(P) = ewewigs n(P) – aanvanklike n(P).✓
c) ***GEBRUIK*** *verhouding:* P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Ewewig n(Q_2) = aanvanklike n(Q_2) + verandering in n(Q_2)
Ewewig n(PQ) = *aanvanklike n(PQ) - verandering in n(PQ)* } ✓
e) Deel ***ewewigs****hoeveelhede van P en Q_2 en PQ deur 2 dm^3.* ✓
f) Korrekte K_c-uitdrukking (formules in vierkanthakies). ✓
g) Vervanging van ewewigskonsentrasies in K_c-uitdrukking. ✓
h) Finale antwoord: 10,89 / 10,889 ✓ (3)

OPTION 1/*OPSIE 1*

	P	Q_2	PQ	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,8	0,8	3,2	✓(a)
Change (mol) *Verandering (mol)*	0,4 ✓(b)	0,2	0,4	✓(c)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	1,2	1,0	2,8	✓(d)
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,6	0,5	1,4	✓(e)

$K_c = \frac{[PQ]^2}{[Q_2][P]^2}$ ✓(f)
$= \frac{1,4^2}{(0,5)(0,6)^2}$ ✓ (g)
= 10,89 ✓ (h)

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* 7/8

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* 5/8

OPTION 2/*OPSIE 2*

	PQ	P	Q_2	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	3,2	0,8	0,8	✓(a)
Change (mol) *Verandering (mol)*	0,4	0,4 ✓(b)	0,2	✓(c)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	2,8	1,2	✓(d) 1,0	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	1,4	0,6	0,5	✓(e)

Reverse reaction
Terugwaartse reaksie:

$K_c = \frac{[P]^2[Q_2]}{[PQ]^2}$ ✓(f)

$= \frac{(0,6)^2(0,5)}{(1,4)^2}$ ✓(g)

$K_c = 0,09$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

Forward reaction/*Voorwaartse reaksie:*

$K_c = \frac{1}{0,09}$
$= 10,89$ ✓ (h)

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:
a) Initial n(P) = 4 mol and $n(Q_2)$ = 2,4 mol and n(PQ) = 0 ✓
b) Change in n(P) = equilibrium n(P) – initial n(P) = 2,8 mol.✓
c) USING ratio: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Equilibrium $n(Q_2)$ = initial $n(Q_2)$ + change in $n(Q_2)$
Equilibrium n(PQ) = initial n(PQ) - change in n(PQ) ✓
e) Divide equilibrium amounts of P and Q2 and PQ by 2 dm^3. ✓
f) Correct Kc expression (formulae in square brackets). ✓
g) Substitution of equilibrium concentrations into K_c expression. ✓
h) Final answer: 10,89 / 10,889 ✓

Nasienkriteria:
a) Aanvanklike n(P) = 4 mol en $n(Q_2)$ = 2,4 mol en n(PQ) = 0.✓
b) Verandering in n(P) = ewewigs n(P) – aanvanklike n(P) = 2,8 mol.✓
c) GEBRUIK verhouding: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Ewewig $n(Q_2)$ = aanvanklike $n(Q_2)$ + verandering in $n(Q_2)$
Ewewig n(PQ) = aanvanklike n(PQ) - verandering in n(PQ) ✓
e) Deel ewewigshoeveelhede van P en Q_2 en PQ deur 2 dm^3. ✓
f) Korrekte K_c-uitdrukking (formules in vierkanthakies). ✓
g) Vervanging van ewewigskonsentrasies in K_c-uitdrukking. ✓
h) Finale antwoord: 10,89 / 10,889 ✓

OPTION 3/*OPSIE 3*

	P	Q_2	PQ	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	4	2,4	0	✓(a)
Change (mol) *Verandering (mol)*	2,8 ✓(b)	1,4	2,8	✓(c)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	1,2	1,0	2,8	✓(d)
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,6	0,5	1,4	✓(e)

$K_c = \frac{[PQ]^2}{[Q_2][P]^2}$ ✓(f)

$= \frac{1,4^2}{(0,5)(0,6)^2}$ ✓(g)

$= 10,89$ ✓ (h)

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria:
a) Initial c(P) and c(Q_2) and c(PQ) from table. ✓
b) Change in c(P) = equilibrium c(P) – initial c(P). ✓
c) **USING** ratio: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Equilibrium c(Q_2) = initial c(Q_2) + change in c(Q_2)
Equilibrium c(PQ) = initial c(PQ) - change in c(PQ) } ✓
e) Divide **initial** amounts of P and Q_2 and PQ by 2 dm^3. ✓
f) Correct K_c expression (formulae in square brackets). ✓
g) Substitution of equilibrium concentrations into K_c expression. ✓
h) Final answer: 10,89 / 10,889 ✓

Nasienriglyne:
a) Aanvanklike c(P) en c(Q_2) en c(PQ) uit tabel. ✓
b) Verandering in c(P) = ewewigs c(P) – aanvanklike c(P).
*c) **GEBRUIK** verhouding:* P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Ewewig c(Q_2) = aanvanklike c(Q_2) + verandering in c(Q_2)
Ewewig c(PQ) = *aanvanklike c(PQ) - verandering in c(PQ)* } ✓
*e) Deel **aanvangs**hoeveelhede van P en Q_2 en PQ deur 2 dm^3.* ✓
f) Korrekte K_c-uitdrukking (formules in vierkanthakies). ✓
g) Vervanging van ewewigskonsentrasies in K_c-uitdrukking. ✓
h) Finale antwoord: 10,89 / 10,889 ✓

OPTION 4/*OPSIE 4*

	P	Q_2	PQ	
			✓(a)	
Initial concentration (mol·dm^{-3}) / Aanvangskonsentrasie (mol·dm^{-3})	0,4	0,4	1,6	✓(e)
Change in concentration (mol·dm^{-3}) / *Verandering in* konsentrasie (mol·dm^{-3})	0,2 ✓(b)	0,1	0,2	✓(c)
Equilibrium concentration (mol·dm^{-3}) / *Ewewigskonsentrasie (mol·dm^{-3})*	0,6	0,5	1,4	✓(d)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2}$$ ✓ (f)

$$= \frac{1,4^2}{(0,5)(0,6)^2}$$ ✓ (g)

= 10,89 ✓ (h)

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* 7/8

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* 5/8

(8)

6.2.4 Remains the same/*Bly dieselfde* ✓

Only temperature can change K_c./Temperature remains constant. ✓
Slegs temperatuur kan K_c verander./Temperatuur bly konstant. (2)

6.3
6.3.1 Increases/*Toeneem* ✓ (1)

6.3.2 Decreases/*Afneem* ✓ (1)
[18]

QUESTION 7/VRAAG 7

7.1
7.1.1 (It is a) proton/H_3O^+ (ion)/H^+ (ion) donor. ✓✓
(Dit is 'n) proton/H_3O^+-(ioon)/H^+-(ioon)skenker. (2)

7.1.2 HSO_4^-/hydrogen sulphate ion/*waterstofsulfaatioon* ✓

ANY ONE:
- It acts as base in reaction **I** and as acid in reaction **II**. ✓
- Acts as acid and base.

ENIGE EEN:
- *Dit reageer as basis in reaksie **I** en as suur in reaksie **II**.*
- *Reageer as suur en basis.* (2)

7.1.3 HSO_4^-/Reaction (solution) II/*Reaksie (oplossing) II* ✓

Smaller K_a value/weaker acid ✓
Lower ion concentration/Incompletely ionised. ✓
Kleiner K_a-waarde/swakker suur ✓
Laer ioonkonsentrasie/Onvolledig geïoniseer. ✓ (3)

7.2
7.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
pH = -log[H_3O^+] ✓ 1,02 ✓= -log[H_3O^+] [H_3O^+] = 0,0955 mol·dm^{-3} ✓ Therefore/*Dus* [HCℓ] = 0,0955 mol·dm^{-3} (0,096/0,1 mol·dm^{-3})	pH = -log[H_3O^+] [H_3O^+] = 10^{-pH} ✓Any one/*Enige* = $10^{-1,02}$ ✓ = 0,0955 mol·dm^{-3} ✓ Therefore/*Dus* [HCℓ] = 0,0955 mol·dm^{-3} (0,096/0,1 mol·dm^{-3})

(3)

7.2.2 **POSITIVE MARKING FROM 7.2.1/*POSITIEWE NASIEN VAN VRAAG 7.2.1***

Marking citeria:

- Formula: $c = \frac{n}{V} / \frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$ ✓
- Calculate $n(Na_2CO_3)$: 0,075 x 0,025 ✓
- Calculate n(HCℓ): 0,0955 x 0,05 / 0,096 x 0,05 ✓
- Use ratios: $n(HCℓ) = 2n(Na_2CO_3)$ ✓
- $n(HCℓ)_{excess} = n(HCℓ)_{initial} – n(HCℓ)_{used}$ = 0,00475 – 0,0038 ✓✓
- Substitute 0,075 dm^3 in $c = \frac{n}{V}$ ✓
- Final answer: 0,013 mol·dm^{-3} ✓ (1,3 x 10^{-2} mol·dm^{-3})
  Range: 0,01 to 0,02 mol·dm^{-3}

Nasienkriteria:

- *Formule*: $c = \frac{n}{V} / \frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$ ✓
- *Bereken* $n(Na_2CO_3)$: 0,075 x 0,025 ✓
- *Bereken* n(HCℓ): 0,0955 x 0,05 / 0,096 x 0,05 ✓
- *Gebruik molverhouding*: $n(HCℓ) = 2n(Na_2CO_3)$ ✓
- $n(HCℓ)_{oormaat} = n(HCℓ)_{aanvanklik} – n(HCℓ)_{gebruik}$ = 0,00475 – 0,0038 ✓✓
- *Vervang* 0,075 dm^3 in $c = \frac{n}{V}$ ✓
- *Finale antwoord*: 0,013 mol·dm^{-3} ✓ (1,3 x 10^{-2} mol·dm^{-3})
  ***Gebied:** 0,01 tot 0,02 mol·dm^{-3}*

OPTION 1/*OPSIE 1*

$n(Na_2CO_3) = cV$ ✓
= 0,075 x 0,025 ✓
= 0,001875 mol (1,875 x 10^{-3}/0,002 mol)

$n(HCℓ)_{initial/aanvanklik} = cV$
= 0,096 x 0,05 ✓
= 0,00475 mol (4,75 x 10^{-3}/0,005 mol)

$n(HCℓ)_{used/gebruik} = 2n(Na_2CO_3)$ ✓
= 2(0,001875)
= 0,0038 mol (3,75 x 10^{-3}/0,004 mol)

$n(HCℓ)_{excess/oormaat}$ = 0,00475 – 0,0038 ✓✓
= 0,00095mol (9,5 x 10^{-4}/1 x 10^{-3} mol)

$c(HCℓ) = \frac{n}{V}$
$= \frac{0,00095}{0,075}$ ✓
= 0,013 mol·dm^{-3} ✓ (1,3 x 10^{-2} mol·dm^{-3})

OPTION 2/*OPSIE 2*

$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$ ✓
$\frac{c_a(50)✓}{(0,075)(25)✓} = \frac{2}{1}$ ✓

$c(HCℓ)_{rea}$ = 0,075 mol·dm^{-3}

$c(HCℓ)_{excess/oormaat}$ = 0,0955 - 0,075 ✓✓
= 0,0205 mol·dm^{-3}

$c_1V_1 = c_2V_2$
(0,0205)(50) = c_2(75) ✓
c_2 = 0,014 mol·dm^{-3} ✓

(8)
[18]

QUESTION 8/*VRAAG 8*

8.1 Chemical (energy) to electrical (energy) ✓
Chemiese (energie) na elektriese (energie) (1)

8.2

Marking criteria:

- Any formula: $c = \frac{m}{MV} / c = \frac{n}{V} / n = \frac{m}{M}$ ✓
- Substitute 1 mol·dm^{-3}.✓
- Substitute 170 g·mol^{-1} [or 108 + 14 + 3(16)] and 0,15 dm^3 in correct formulae. ✓
- Final answer: 25,50 g ✓

Nasienkriteria:

- *Enige formule*: $c = \frac{m}{MV} / c = \frac{n}{V} / n = \frac{m}{M}$ ✓
- *Vervang 1* mol·dm^{-3}.✓
- *Vervang 170 g·mol^{-1} [of 108 + 14 + 3(16)] en 0,15 dm^3 in korrekte formules*. ✓
- *Finale antwoord*: 25,50 g ✓

OPTION 1/*OPSIE 1*

$c = \frac{m}{MV}$ ✓
✓
$1 = \frac{m}{170 \times 0,15}$ ✓
m = 25,50 g ✓

OPTION 2/*OPSIE 2*

n = cV ✓
= 1 ✓ x 0,15
= 0,15 mol ✓

m = nM
= (0,15)(170)
= 25,50 g ✓

(4)

8.3 **ANY ONE:**
- A substance that loses/donates electrons. ✓✓
- A substance that is oxidised.
- A substance whose oxidation number increases.

ENIGE EEN:
- *'n Stof wat elektrone verloor/skenk.* ✓✓
- *'n Stof wat geoksideer word.*
- *'n Stof wat waarvan die oksidasiegetal toeneem.* (2)

8.4

8.4.1 Copper/Cu/*Koper* ✓ (1)

8.4.2

Marking criteria/*Nasienkriteria:*
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Ignore phases/*Ignoreer fases.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

$Cu(s) + 2Ag^+(aq)$ ✓ → $Cu^{2+}(aq) + 2Ag(s)$ ✓ Bal ✓

ACCEPT/*AANVAAR:*
$Cu(s) + 2AgNO_3(aq)$ ✓ → $Cu(NO_3)_2(aq) + 2Ag(s)$ ✓ Bal ✓

NOTE/*LET WEL*
- **IF** electrons are not cancelled – minus 1 mark
- ***INDIEN*** *elektrone nie gekanselleer is nie – minus 1 punt* (3)

8.5

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ = 0,80 ✓ – (0,34) ✓ = 0,46 V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $\frac{3}{4}$

OPTION 2/*OPSIE 2*

$2Ag^+ + 2e^- \rightarrow 2Ag$ ✓ $E^\theta = 0,80$ V ✓

$Cu \rightarrow Cu^{2+} + 2e^-$ $E^\theta = -0,34$ V ✓

$2Ag^+ + Cu \rightarrow 2Ag + Cu^{2+}$ $E^\theta = +0,46$ V ✓ (4)

8.6 Decreases/*Afneem* ✓ (1)

[16]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE*: (2 or 0)***
- A substance whose (aqueous) solution contains ions. ✓✓
- Substance that dissolves in water to give a solution that conducts electricity.
- A substance that forms ions in water / when melted.
- A solution that conducts electricity through the movement of ions.

ENIGE EEN*: *(2 of 0)
- *'n Stof waarvan die oplossing ione bevat.* ✓✓
- *'n Stof wat in water oplos om 'n oplossing te vorm wat elektrisiteit gelei.*
- *'n Stof wat ione in water vorm/ wanneer dit gesmelt word.*
- *'n Oplossing wat elektrisiteit gelei deur die beweging van ione.* (2)

9.2 Anode ✓

Chromium is oxidised./Oxidation takes place (at the anode)./Chromium (it) loses electrons./Mass decreases./$Cr \rightarrow Cr^{3+} + 3e^-$ ✓
Chroom word geoksideer./Oksidasie vind (by die anode) plaas./Chroom (dit) verloor elektrone./Massa neem af./$Cr \rightarrow Cr^{3+} + 3e^-$

NOTE/*LET WEL:*
If half-reaction is used, it must be correct/*Indien halfreaksie gebruik word, moet dit korrek wees*: $Cr \rightarrow Cr^{3+} + 3e^-$ (2)

9.3 $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ ✓✓

Ignore phases./*Ignoreer fases*.

Marking guidelines/*Nasienkriteria*
- $Cr^{3+} + 3e^- \rightleftharpoons Cr$ $\frac{1}{2}$ $Cr \rightleftharpoons Cr^{3+} + 3e^-$ $\frac{0}{2}$
  $Cr \leftarrow Cr^{3+} + 3e^-$ $\frac{2}{2}$ $Cr \rightarrow Cr^{3+} + 3e^-$ $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Cr^{3+}/*Indien lading (+) weggelaat op* Cr^{3+}: Max./*Maks:* $\frac{1}{2}$

  Example/*Voorbeeld:* $Cr^3 + 3e^- \rightarrow Cr$ ✓ (2)

9.4

Marking criteria:

- Substitute 52 g·mol^{-1} in $n = \frac{m}{M}$/ratio ✓
- Use mol ratio: n(electrons): n(Cr) = 3 : 1. ✓
- Number of electrons = n x 6,02 x 10^{23}/No of *Cr atoms = n x 6,02 x 10^{23}*/ratio. ✓
- Total charge = number of electrons x 1,6 x 10^{-19}/ratio. ✓
- Final answer: 11 113,85 C ✓
  Range*: 11 076,8 to 11 580 C*

Nasienkriteria:

- *Vervang 52 g·mol^{-1} in $n = \frac{m}{M}$/verhouding* ✓
- *Gebruik molverhouding: n(elektrone) : n(Cr^{3+}) = 3 : 1.* ✓
- *Aantal elektrone = n x 6,02 x 10^{23}/Aantal Cr-atome = n x 6,02 x 10^{23}/verhouding.*✓
- *Totale lading = aantal elektrone x 1,6 x 10^{-19}/verhouding.* ✓
- *Finale antwoord: 11 113,85 C* ✓
  Gebied: *11 076,8 tot 11 580 C*

OPTION 1/*OPSIE 1*

$n = \frac{m}{M}$

$= \frac{2}{52}$✓

= 0,038 mol (0,04 mol)

$n(e^-) = 3n(Cr)$ ✓

= 3(0,038)

= 0,115 mol (0,12 mol)

Number (e^-) = 0,115 x 6,02 x 10^{23} ✓

= 6,946 x 10^{22}

Q = 6,95 x 10^{22} x 1,6 x 10^{-19} ✓

= 11 113,85 C ✓

OPTION 2/*OPSIE 2*

$n = \frac{m}{M}$

$= \frac{2}{52}$✓

= 0,038 mol (0,04 mol)

Number Cr atoms

= 0,038 x 6,02 x 10^{23} ✓

= 2,315 x 10^{22}

Number (e^-) = 3N(Cr) ✓

= 3(2,315 x 10^{22})

= 6,946 x 10^{22}

Q = 6,95 x 10^{22} x 1,6 x 10^{-19} ✓

= 11 113,85 C ✓

OPTION 3/*OPSIE 3*

$n = \frac{m}{M}$

$= \frac{2}{52}$✓

= 0,038 mol

$n(e^-) = 3n(Cr)$ ✓

= 3(0,038)

= 0,115 mol

1 mol …. 96 500 C ✓

0,115 mol 11 134,62 C ✓✓

(5)

[11]

TOTAL/*TOTAAL*: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/*SENIOR SERTIFIKAAT*
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

SEPTEMBER 2021(2)

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

This memorandum consists of 17 pages.
Hierdie memorandum bestaan uit 17 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	D ✓✓	(2)
1.2	A ✓✓	(2)
1.3	B ✓✓	(2)
1.4	D ✓✓	(2)
1.5	A ✓✓	(2)
1.6	B ✓✓	(2)
1.7	A ✓✓	(2)
1.8	D ✓✓	(2)
1.9	C ✓✓	(2)
1.10	C ✓✓	(2)

[20]

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QUESTION 2/*VRAAG 2*

2.1
2.1.1 C ✓ (1)

2.1.2 B/E ✓ (1)

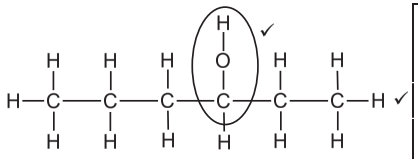
2.1.3 E ✓ (1)

2.2
2.2.1 2-bromo-4-ethyl-3,3-dimethylhexane/*2-broom-4-etiel-3,3-dimetielheksaan*

Marking criteria/*Nasienkriteria*
- Correct stem i.e. hexane./*Korrekte stam: heksaan*. ✓
- All substituents (bromo, ethyl and dimethyl) correctly identified./*Alle substituente (broom, etiel en dimetiel) korrek geïdentifiseer.* ✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used./*Substituente korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik.* ✓

(3)

2.2.2



Marking criteria/*Nasienkriteria:*
- Six carbons in longest chain. *Ses koolstowwe in die langste ketting.* ✓
- Hydroxyl group on third carbon./*Hidroksielgroep op tweede koolstof.* ✓

Notes/*Aantekeninge*:
- One or more H atoms omitted/*Een of meer H-atome uitgelaat:* ½
- Condensed or semi-structural formula:/*Gekondenseerde of semi-struktuur-formule:* ½

(2)

2.2.3 Pentanal / *Pentanaal* ✓✓

Marking criteria/*Nasienkriteria:*
- Correct functional group i.e. -al/*Korrekte funksionele groep d.i. -al.* ✓
- Whole name correct/*Hele naam korrek.* ✓✓

(2)

2.3
2.3.1 Oxidation/combustion/*oksidasie/verbranding* ✓ (1)

2.3.2 C_8H_{18} ✓✓ **(2 or/*of* 0)** (2)

Physical Sciences P1/*Fisiese Wetenskappe V1* DBE/September 2021(2)
SC/NSC/*SS/NSS* – Marking Guidelines/*Nasienriglyne*
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2.3.3

OPTION 1/OPSIE 1	**Marking criteria/*Nasienkriteria***
$V(CO_2) = 8 \times V_B$ $= 8(50)$ $= 400\ cm^3$ $V(H_2O) = \frac{18}{2}V_B$ ✓ $= 9(50)$ $= 450\ cm^3$ Total volume gas formed/*Totale volume gas gevorm* ✓ $= 400 + 450$ $= 850\ cm^3$ ✓	• Use volume ratio/*Gebruik volume verhouding:* $V(CO_2) : V(B) = 2 : 1$ and/*en* $V(H_2O) : V(B) = 9 : 1$ ✓ • Add/*Tel bymekaar:* $V(CO_2)$ and/*en* $V(H_2O)$ ✓ • Final answer/*Finale antwoord:* $850\ cm^3$ ✓
OPTION 2/*OPSIE 2*	
2 mol C_XH_Y ..... 16 + 18 = 34 mol gas ✓ 50 mol C_XH_Y ..... 25 x 34 ✓ mol gas Total moles gas formed/*Totale volume gas gevorm* = $850\ cm^3$ ✓	

(3)
[16]

QUESTION 3/*VRAAG 3*

3.1 No/*Nee* ✓ (1)

3.2 There is more than one independent variable. ✓
Daar is meer as een onafhanklike veranderlike.

OR/*OF*
Positions of functional groups and branching/chain length differ.
Posises van funksionele groepe en vertakking/kettinglengte verskil.

OR/*OF*
Compounds **A** and **B/C** are positional isomers and compounds **B** and **C** are chain isomers.
*Verbindings **A** en **B/C** is posisie-isomere en verbindings **B** en **C** is kettingisomere.* (1)

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3.3

- B/butan-2-ol is less branched / less compact / less spherical/ has a longer chain length / has a larger surface area (over which intermolecular forces act).✓
- B/butan-2-ol has stronger / more intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓
- More energy needed to overcome or break intermolecular forces / Van der Waals forces in B/butan-2-ol. ✓
- *B/butan-2-ol is minder vertak / minder kompak / minder sferies / het 'n langer kettinglengte / het 'n groter oppervlak (waaroor intermolekulêre kragte werk).*
- *B/butan-2-ol het sterker / meer intermolekulêre kragte / Van der Waalskragte / London-kragte / dispersiekragte.*
- *Meer energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / London-kragte te oorkom in B/butan-2-ol.*

OR/*OF*

- C/2-methylpropan-2-ol is more branched / more compact / more spherical / has a smaller surface area (over which intermolecular forces act).✓
- C/2-methylpropan-2-ol has weaker / less intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓
- Less energy needed to overcome or break intermolecular forces / Van der Waals forces in C/2-methylpropan-2-ol. ✓
- *C/2-metielpropan-2-ol is meer vertak / meer kompak / meer sferies / het 'n kleiner oppervlak (waaroor intermolekulêre kragte werk).*
- *C/2-metielpropan-2-ol het swakker/minder intermolekulêre kragte / Van der Waalskragte / Londonkragte / dispersiekragte.*
- *Minder energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / Londonkragte te oorkom in C/ 2-metielpropan-2-ol.*

(3)

3.4

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

Compounds with the same molecular formula, but different positions of the side chain/substituents/functional groups on parent chain. ✓✓
Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituente/funksionele groepe op die stamketting. (2)

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3.5

3.5.1 A & B ✓ (1)

3.5.2 C ✓

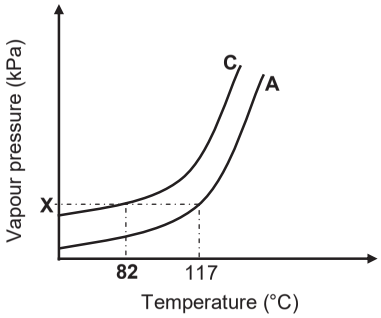
The C-atom bonded to the functional group/OH-group/hydroxyl (group) is bonded to three other C-atoms. ✓
Die C-atoom aan die funksionele groep/OH-groep/hidroksiel(groep) gebind is, is aan drie ander C-atome gebind.

OR/*OF*
The functional group/OH-group/hydroxyl (group) is bonded to a tertiary C-atom.
Die funksionele groep/OH-groep/hidroksiel(groep) is aan 'n tersiêre C-atoom gebind. (2)

3.6

3.6.1 101,3 (kPa) / 1,013 x 10^5 Pa / 1 atm / 760 mmHg ✓ (1)

3.6.2



Marking criteria/*Nasienkriteria*:
- Curve C is above A.
  Kurwe C is bokant A. ✓
- Value 82 °C on curve C where vapour pressure is X/ 101,3 kPa.
  Waarde 82 °C op kurwe C waar dampdruk gelyk is aan X/ 101,3 kPa. ✓

IF/*INDIEN*:
- Curves start at same point/*Indien kurwes by dieselfde punt begin:* Max./*Maks.* ½
- Straight line graph/*Reguitlyn grafiek.* Max./*Maks.* ½

(2)
[13]

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QUESTION 4/*VRAAG 4*

4.1

4.1.1 Substitution/halogenation/bromination ✓
Substitusie/halogenering/brominering (1)

4.1.2 Substitution/hydrolysis/*Substitusie/hidrolise* ✓ (1)

4.1.3 1-bromopropane/*1-bromopropaan* ✓✓

IF/*INDIEN*:
Bromopropane/*bromopropaan* **OR/*OF***
2-bromopropane/2-bromopropaan Max./*Maks.* $\frac{1}{2}$

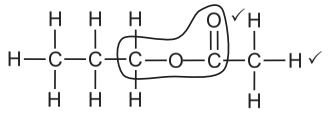
(2)

4.1.4 H_2SO_4/(concentrated) sulphuric acid/(gekonsentreerde)

swaelsuur ✓ (1)

4.1.5 Ethanoic acid/*Etanoësuur* ✓✓ (2)

4.1.6



Marking criteria/*Nasienkriteria:*
- Functional group correct. ✓
  Funksionele groep korrek.
- Whole structure correct. ✓✓
  Hele struktuur korrek.

Notes/*Aantekeninge*:
- One or more H atoms omitted: / *Een of meer H-atome uitgelaat:* $\frac{1}{2}$
- Condensed or semi-structural formula: / *Gekondenseerde of semi-struktuur-formule:* $\frac{1}{2}$

(2)

Physical Sciences P2/*Fisiese Wetenskappe V2*
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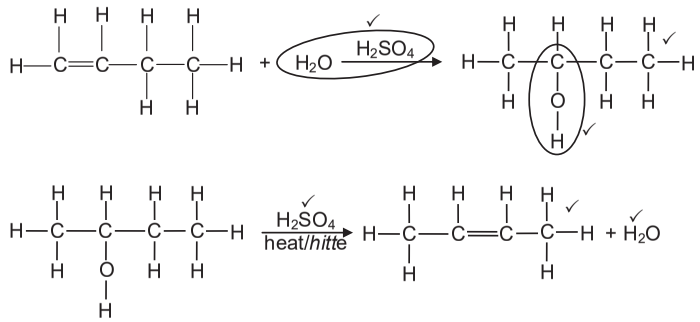
4.2



Notes/*Aantekeninge:*
- Condensed or semistructural formula: Max. $\frac{5}{6}$
  Gekondenseerde of semistruktuurformule: *Maks.* $\frac{5}{6}$
- Molecular formula/*Molekulêre formule*: Max./*Maks.* $\frac{3}{6}$
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- Any additional reactants or products: Max. $\frac{5}{6}$
  Enige addisionele reaktanse of produkte: *Maks.* $\frac{5}{6}$
- If arrow in equation omitted: Max. $\frac{5}{6}$
  Indien pyltjie in vergelyking uitgelaat is: *Maks.* $\frac{5}{6}$

(6)
[15]

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QUESTION 5/*VRAAG 5*

5.1
5.1.1 Kinetic energy/*kinetiese energie* ✓ (1)

5.1.2 Number of particles/molecules ✓
Aantal deeltjies/molekule (1)

5.2
5.2.1 Activation energy/*Aktiveringsenergie* ✓ (1)

5.2.2 Increase/*Toeneem* ✓ (1)

5.3
- A catalyst provides an alternative pathway of lower activation energy. ✓
- More molecules have sufficient kinetic energy. ✓
- More effective collisions per unit time./Frequency of efffective collisions increases. ✓
- Increase raction rate. ✓
- *'n Katalisator verskaf 'n alternatiewe roete van laer aktiveringsenergie.*
- *Meer molekule het voldoende kinetiese energie.*
- *Meer effektiewe botsings per eenheidtyd./Frekwensie van effektiewe botsings neem toe.*
- *Verhoog reaksietempo.* ✓ (4)

5.4
5.4.1 Temperature / Surface area / Amount or mass of $CaCO_3$ ✓
Temperatuur / Reaksie-oppervlak / Hoeveelheid of massa $CaCO_3$ (1)

5.4.2

Criteria for conclusion/*Kriteria vir gevolgtrekking*:	
Dependent (reaction rate) and independent (concentration) variables correctly identified./*Afhanklike(reaksietempo) en onafhanklike (konsentrasie) veranderlikes korrek geïdentifiseer.*	✓
Relationship between the independent and dependent variables correctly stated. *Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.*	✓

Example/*Voorbeeld*:
Reaction rate is directly proportional to concentration.
Reaksietempo is direk eweredig aan konsentrasie.

IF/*INDIEN*
Reaction rate increases with increase in concentration. *Reaksietempo neem toe met toename in konsentrasie.* **OR/*OF*** *Reaksietempo is eweredig aan konsentrasie.* Reaction rate is proportional to concentration. *Max./Maks.* ½

(2)

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5.5

Marking criteria/*Nasienkriteria:*
- Substitute 50 $cm^3 \cdot min^{-1}$ and 26 minutes in rate = $\frac{\Delta V}{\Delta t}$ ✓
- Substitute/ *Vervang* 1 300 cm^3 /1,3 dm^3 **OR/*OF*** 24 000 $cm^3 \cdot mol^{-1}$/ 24 $dm^3 \cdot mol^{-1}$ in n = $\frac{V}{V_m}$ ✓
- Use ratio/*Gebruik verhouding* $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute/*Vervang* 100 $g \cdot mol^{-1}$ in n = $\frac{m}{M}$ ✓
- Calculate % purity/*Bereken % suiwerheid* = $\frac{m(CaCO_3)}{m(\text{Sample/ } monster)}$ ✓ x 100
- Final answer/*Finale antwoord:* 90,33% ✓
  Range/*Gebied*: 83,33% to 90,33%



OPTION 1

Rate/*tempo* = $\frac{\Delta V}{\Delta t}$

$50 = \frac{\Delta V}{26}$ ✓

ΔV = 1 300 cm^3

$n(CO_2) = \frac{1300}{24\,000}$ ✓ **OR** $\frac{1,3}{24}$

= 0,0542 mol

$n(CaCO_3) = n(CO_2)$

= 0,0542 mol ✓

$m(CaCO_3) = nM$ ✓

= 0,0542 x 100

= 5,42 g

% purity/*suiwerheid* = $\frac{5,42}{6}$ ✓ x 100

= 90,33% ✓

OPTION 2:

Rate/*tempo* = $\frac{50}{24\,000}$ ✓

= 0,00208 $mol \cdot min^{-1}$ ✓

$n(CO_2)$ = 0,00208 x 26

= 0,0542 mol

$n(CaCO_3) = n(CO_2)$ = 0,0542 mol ✓

$m(CaCO_3) = nM$ ✓

= 0,0542(100)

= 5,42 g

% purity/*suiwerheid* = $\frac{5,42}{6}$ ✓ x 100

= 90,33% ✓

(6)
[17]

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QUESTION 6/*VRAAG 6*

6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓ **(2 or 0)**
Die stadium in 'n chemiese reaksie waar die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ***(2 of 0)***

OR/*OF*
The stage in a chemical reaction when the concentrations of reactants and products remain constant. **(2 or 0)**
Die stadium in 'n chemiese reaksie waar die konsentrasies van die reaktanse en produkte konstant bly. ***(2 of 0)*** (2)

6.2 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT AANTAL MOL GEBRUIK

Marking criteria/*Nasienkriteria*

- Substitute/*Vervang* 18 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- $\Delta n(CO_2) = \Delta n(C) = 0{,}225$ mol. ✓
- Use mole ratio/Gebruik $n(C) : n(H_2O) : n(CO_2) : n(H_2) = ! : 2 : 1 : 2$ ✓
- Equilibrium/*Ewewig* $n(H_2O)$ = initial/*aanvaklike* $n(H_2O) - \Delta n(H_2O)$
  Equilibrium/*Ewewig* $n(H_2)$ = initial/*aanvanklike* $n(H_2) + \Delta n(H_2)$
  Equilibrium/*Ewewig* $n(CO_2)$ = initial/*aanvanklike* $n(CO_2) + \Delta n(CO_2)$ } ✓
- Divide equilibrium moles of H_2O, H_2 AND/*EN* CO_2 by/*deur* 2 dm^3.✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,00948 ✓
  Range/*Gebied*: 0,00948 to/*tot* 0,01 (9,48 x 10^{-3} to/*tot* 1 x 10^{-2})

OPTION 1/*OPSIE 1*

$n(H_2O)_{initial/aanvanklik} = \frac{m}{M} = \frac{36}{18}$✓ = 2 mol

	H_2O	H_2	CO_2	
Initial amount (moles) *Aanvangs hoeveelheid (mol)*	2			
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,45	0,45	0,225 ✓	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	1,55	0,45	0,225	✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,775	0,225	0,1125	Divide by/ Deel deur 2 dm^3 ✓

$K_c = \frac{[H_2]^2[CO_2]}{[H_2O]^2}$ ✓
$= \frac{[0{,}225]^2[0{,}1125]}{[0{,}775]^2}$ ✓
$= 0{,}00948$ ✓

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

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CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

- Substitute/*Vervang* 18 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Divide initial/*Deel aanvanklike* $n(H_2O)$ AND $\Delta n(CO_2)$ by/*deur* 2 dm^3.✓
- $\Delta n(CO_2) = \Delta n(C) = 0{,}225$ mol OR/*OF* $\Delta c(CO_2) = 0{,}1125$ mol·dm^{-3}. ✓
- Use mole ratio/*Gebruik molverhouding* $n(H_2O) : n(CO_2) : n(H_2) = 2 : 1 : 2$ ✓
- Equilibrium/*Ewewig* $c(H_2O)$ = initial/*aanvanklike* $c(H_2O) - \Delta c(H_2O)$
  Equilibrium/*Ewewig* $c(H_2)$ = initial/*aanvanklike* $c(H_2) + \Delta c(H_2)$
  Equilibrium/*Ewewig* $c(CO_2)$ = initial/*aanvanklike* $c(CO_2) + \Delta c(CO_2)$ } ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,00948 ✓
  Range/*Gebied*: 0,00948 – 0,01)

OPTION 2/*OPSIE 2*

$n(H_2O)_{initial/aanvanklik} = \frac{m}{M} = \frac{36}{18}$✓ = 2 mol

	H_2O	H_2	CO_2	
Initial concentration (mol·dm^{-3}) Aanvangskonsentrasie (mol·dm^{-3})	1			Divide by/ *Deel deur* 2 dm^3 ✓
Change (mol·dm^{-3}) ✓ *Verandering (*mol·dm^{-3}*)*	0,225	0,225	0,1125 ✓	ratio ✓ *verhouding*
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,775	0,225	0,1125	

$K_c = \frac{[H_2]^2[CO_2]}{[H_2O]^2}$ ✓
$= \frac{[0{,}225]^2[0{,}1125]}{[0{,}775]^2}$ ✓
$= 0{,}00948$ ✓

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

(8)

6.3

6.3.1 Steam is used up./Amount of steam decreases./Concentration of steam decreases./Reactants are used up. ✓
Water word opgebruik./Hoeveelheid stoom neem af./Konsentrasie van stoom neem af./Reaktanse word opgebruik. (1)

6.3.2 Catalyst was added./*Katalisator is bygevoeg*. ✓ (1)

6.3.3 Endothermic/*Endotermies* ✓ (1)

6.3.4 (-)
- The forward reaction is favoured./*Die voorwaartse reaksie word bevoordeel.* ✓
- Increase in temperature favours the endothermic reaction. ✓
  Toename in temperatuur bevoordeel die endotermiese reaksie. (2)

[15]

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QUESTION 7/VRAAG 7

7.1 A base forms hydroxide ions (OH^-) in water/aqueous solution/OH^-(aq). ✓✓
'n Basis vorm hidroksiedione (OH^-) in water/waterige oplossing/OH^-(aq).

IF/*INDIEN*:
A base ionises to form hydroxide ions (OH^-). ✓
'n Basis ioniseer om hidroksiedione (OH^-) te vorm. *Max./Maks.* ½

(2)

7.2 $n(KOH) = cV$
$= 0,1 \times 0,4$ ✓
$= 0,04$ mol
$n(OH^-) = n(KOH) = 0,04$ mol✓



(2)

7.3
7.3.1 **POSITIVE MARKING FROM Q7.2/*POSITIEWE NASIEN VANAF V7.2***

Marking criteria/*Nasienkriteria*
- Use formula/*Gebruik formule*: pH = $-\log[H_3O^+]$
- Substitute/*Vervang* pH = 13/pOH = 1
- Substitute/*Vervang* 1 x 10^{-13} in K_w/Calculate/*Bereken* pOH
- Substitute/*Vervang* of 0,1 x 0,9
- Calculate/*Bereken* $n(OH^-) = n(\text{in C}) - n(\text{in B})$ ✓
- Use mol ratio/*Gebruik molverhouding*: $n(Ba(OH)_2) : n(OH^-) = 1 : 2$. ✓
- Substitute/*Vervang* 0,5 dm^3. ✓
- Final answer/*Finale antwoord*: 0,05 mol·dm^{-3} ✓
  Range/*Gebied*: 0,05 to 0,06 mol·dm^{-3}

OPTION 1/*OPSIE 1*

pH = $-\log[H_3O^+]$ **OR/*OF*** $[H_3O^+] = 10^{-pH}$ ✓
13 ✓= $-\log[H_3O^+]$ **OR/*OF*** $[H_3O] = 10^{-13}$
$[H_3O^+] = 1 \times 10^{-13}$ mol·dm^{-3}
↓
$[H_3O^+][OH^-] = 1 \times 10^{-14}$
$(1 \times 10^{-13})[OH^-] = 1 \times 10^{-14}$ ✓
$[OH^-] = 0,1$ mol·dm^{-3}
↓
$n(OH^-) = cV$
$= 0,1 \times 0,9$ ✓
$= 0,09$ mol

OPTION 2/*OPSIE 2*

pOH = 14 - 13 = 1 ✓
pOH = $-\log[OH^-]$ ✓
1 ✓ = $-\log[OH^-]$
$[OH^-] = 0,1$ mol·dm^{-3}
↓
$n(OH^-) = cV$
$= 0,1 \times 0,9$ ✓
$= 0,09$ mol

↓

$n(OH^-)$ from/*van* $Ba(OH)_2$ in beaker/*beker* **C** = 0,09 - 0,04✓
= 0,05 mol

$n[Ba(OH)_2] = ½\ n(OH^-)$
$= ½\ (0,05)$ ✓
$= 0,025$ mol

$c[Ba(OH)_2] = \frac{n}{V}$
$= \frac{0,025}{0,5}$ ✓
$\therefore x = 0,05$ mol·dm^{-3} ✓

(8)

Physical Sciences P1/*Fisiese Wetenskappe V1* DBE/September 2021(2)
SC/NSC/*SS/NSS* – Marking Guidelines/*Nasienriglyne*
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7.3.2 Weak (acid)/*Swak (suur)* ✓
Ionises/dissociates incompletely/partially. ✓
Ioniseer/dissosieer onvolledig/gedeeltelik. (2)

7.3.3 **POSITIVE MARKING FROM Q7.3.1/*POSITIEWE NASIEN VANAF V7.3.1***

Marking criteria/*Nasienkriteria*
- Formula/*Formule*: $c = \frac{n}{V}$ / $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$. ✓
- Substitution of/*Vervanging van* 0,1 x 15 / 0,1 x 0,015 ✓ **OR/*OF***
  Use/*Gebruik* $V_a = 30$ cm^3
- Use mol ratio/*Gebruik molverhouding* 1 : 1 ✓
- Final answer/*Finale antwoord*: 0,05 mol·dm^{-3}.✓

OPTION 1/*OPSIE 1*

$n(OH^-) = cV$ ✓
$= 0,1 \times 0,015$ ✓
$= 0,0015$ mol
↓
$n(CH_3COOH) = n(OH^-)$
$= 0,0015$ mol ✓
↓
$c = \frac{n}{V}$
$= \frac{0,0015}{0,03}$
$= 0,05$ mol·dm^{-3} ✓

OPTION 2/*OPSIE 2*

$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓
$\frac{c_a \times 30}{0,1 \times 15}$ ✓$= \frac{1}{1}$ ✓
$c_a = 0,05$ mol·dm^{-3} ✓

(4)
[18]

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QUESTION 8/*VRAAG 8*

8.1

8.1.1 Zinc/Zn ✓ (1)



8.1.2 Platinum/Pt /Carbon/C/*Koolstof* ✓ (1)

8.1.3 Iron(III) ions/Fe^{3+}(aq)/Fe^{3+} ions/*Yster(III)-ione/*Fe^{3+}*-ione* ✓ (1)

8.2

8.2.1 Conductor (to complete circuit). /Provides surface area for the reaction to take place. ✓
Geleier (om die stroombaan te voltooi./Verskaf oppervlak vir die reaksie om plaas te vind. (1)

8.2.2 $Fe^{3+} + e^- \rightarrow Fe^{2+}$ ✓✓

Marking criteria/*Nasienkriteria*
- $Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ ½ $Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$ 0/2
  $Fe^{2+} \leftarrow Fe^{3+} + e^-$ 2/2 $Fe^{2+} \rightarrow Fe^{3+} + e^-$ 0/2
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Fe^{2+} and/or Fe^{3+} *Indien lading (+) weggelaat op* Fe^{2+} and/or Fe^{3+} Max./*Maks:* ½ Example/*Voorbeeld:* $Fe^3 + e^- \rightarrow Fe^2$

(2)

8.2.3 $2Fe^{3+}(aq) + Zn$ ✓ $\rightarrow 2Fe^{2+}(aq) + Zn^{2+}(aq)$ ✓ Bal ✓

Notes/*Aantekeninge*
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* → and phases / *en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

8.3

OPTION 1/*OPSIE 1*

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
= 0,77 ✓– (-0,76) ✓
= 1,53 V ✓

Notes/*Aantekeninge*
- Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* ¾

OPTION 2/*OPSIE 2*

$Fe^{3+} + e \rightarrow Fe^{2+}$ ✓ $E^\theta = 0,77$ V ✓
$Zn \rightarrow Zn^{2+}(aq) + 2e^-$ $E^\theta = 0,76$ V ✓
$Zn + 2Fe^{3+} \rightarrow Zn^{2+} + 2Fe^{2+}$ $E^\theta = 1,53$ V ✓

(4)

8.4 Decreases/*Verlaag* ✓ (1)

[14]

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QUESTION 9/*VRAAG 9*

9.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

ANY ONE/*ENIGE EEN:*
- The chemical process in which electrical energy is converted to chemical energy. ✓✓
  Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.
- The use of electrical energy to produce a chemical change.
  Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.
- Decomposition of an ionic compound by means of electrical energy.
  Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.
- The process during which an electric current passes through a solution/ ionic liquid/molten ionic compound.
  Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg. (2)

9.2 Copper(II) ions/Cu^{2+}/*koper(II)-ione* ✓
Zinc(II) ions/Zn^{2+}/*sink(II)-ione* ✓ (2)

9.3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓

Notes/*Aantekeninge*
$Cu^{2+} + 2e^- \rightleftharpoons Cu$ (½) $Cu \leftarrow Cu^{2+} + 2e^-$ (2/2)
$Cu \rightleftharpoons Cu^{2+} + 2e^-$ (0/2) $Cu^{2+} + 2e \leftarrow Cu$ (0/2)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Cu^{2+}/*Indien lading (+) weggelaat op* Cu^{2+} Max./*Maks:* ½ Example/*Voorbeeld:* $Cu^2 + 2e^- \rightarrow Cu$
- Ignore phases. / *Ignoreer fases.*

(2)

9.4 Zn^{2+} is a weaker oxidising agent ✓ than Cu^{2+} ✓ and will not be reduced to Zn. ✓
Zn^{2+} is 'n swakker oksideermiddel as Cu^{2+} en sal nie na Zn gereduseer word nie. (3)

9.5 $n(Cu) = ½n_{electrons/elektrone}$
= ½(0,6) ✓
= 0,3 mol
m = nM
= 0,3 x 63,5 ✓
= 19,05 g ✓

Marking criteria/*Nasienkriteria*
- Use mol ratio/*Gebruik molverhouding*: n(Cu) : n(electrons) = 1 : 2. ✓
- Substitute/*Vervang* 63,5 g·mol^{-1} in m = nM ✓
- Final answer/*Finale antwoord*: 19,05 g ✓

(3)

[12]

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QUESTION 10/*VRAAG 10*

10.1

10.1.1 Nitrogen/N_2/*Stikstof* ✓ (1)

10.1.2 Iron/Iron(II) oxide/Fe/FeO/*yster/yster(II)oksied* ✓ (1)

10.1.3 Ammonia/NH_3/*ammoniak* ✓ (1)

10.1.4 (Fractional) distillation (of liquid air) ✓
(Fraksionele) distillasie (van vloeibare lug) (1)

10.1.5 $2NH_3 + H_2SO_4$✓ → $(NH_4)_2SO_4$✓ bal ✓

Notes/*Aantekeninge*		
• Reactants ✓ *Reaktanse* ✓	Products ✓ *Produkte* ✓	Balancing ✓ *Balansering* ✓
• Ignore/*Ignoreer* ⇌ and phases / *en fases*		
• Marking rule 6.3.10/*Nasienreël 6.3.10*		

(3)

10.2

Marking criteria/*Nasienkriteria*
- Calculate/*Bereken* m(N,P,K). ✓
- Determine/*Bepaal* m(x). ✓
- Final answer/*Finale antwoord:* 3 : 6 : 5 ✓



OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
%(N, P, K) = 35%	%(N, P, K) = 35%
$m(N,P,K) = \frac{35}{100} \times 40$ ✓	$m(N,P,K) = \frac{35}{100} \times 40$ ✓
= 14 kg	= 14 kg
m(N + P + K) = 5 + x + 2x ✓	m(N & P) = 14 – 5 = 9 kg ✓
= 14	
x = 3 kg	$x = \frac{1}{3} \times 9 = 3$ kg
	2x = 6 kg
N : P : K = 3 : 6 : 5 ✓	N : P : K = 3 : 6 : 5 ✓

(3)
[10]

TOTAL/*TOTAAL*: 150

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PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages./
Hierdie nasienriglyne bestaan uit 19 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	C ✓✓	(2)
1.2	D ✓✓	(2)
1.3	C ✓✓	(2)
1.4	B ✓✓	(2)
1.5	D ✓✓	(2)
1.6	C ✓✓	(2)
1.7	B ✓✓	(2)
1.8	B ✓✓	(2)
1.9	A ✓✓	(2)
1.10	B ✓✓	(2)

[20]

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QUESTION 2/*VRAAG 2*

2.1
2.1.1 F ✓ (1)

2.1.2 B & F ✓ (1)

2.1.3 C ✓ (1)

2.2
2.2.1 Haloalkane / alkyl halide ✓
Haloalkaan/alkielhalied (1)

2.2.2 3,5-dibromooctane ✓✓✓
3,5-dibroomoktaan

Marking criteria/*Nasienkriteria:*
- Octane/*Oktaan* ✓
- Dibromo/*Dibroom* ✓
- Substituents (dibromo) correctly numbered, hyphens, commas correctly used./ *Substituente (dibroom) korrek genommer, koppeltekens en kommas korrek gebruik.* ✓

(3)

2.3
2.3.1 Pentan-3-one ✓✓
Pentan-3-oon
OR/*OF*
3-pentanone✓✓
3-pentanoon (2)

Marking criteria/*Nasienkriteria:*
- Pentanone/*pentanoon* ✓
- Correct position of functional group. ✓ *Korrekte posisie van funksionele groep.*

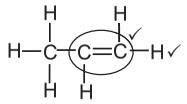
2.3.2 3-methyl✓butan-2-one✓/*3-metielbutan-2-oon*
OR/*OF*
3-methyl✓butanone✓/*3-metielbutanoon*
OR/*OF*
methyl✓butanone✓/*metielbutanoon*
OR/*OF*
3-methyl✓- 2-butanone✓/*3-metiel-2-butanoon* (2)

2.4
2.4.1 Hexyl✓ methanoate ✓
Heksielmetanoaat (2)

2.4.2  **OR/*OF*** (1)

2.5
2.5.1 Cracking/Elimination ✓
Kraking/eliminasie (1)

2.5.2 C_7H_{16} ✓✓ (2)

2.5.3 

Notes/*Aantekeninge*
- Functional group/*Funksionele groep*: ✓
- Whole structure correct/*Hele struktuur korrek*: ✓

(2)
[19]

QUESTION 3/*VRAAG 3*

3.1 **Marking guidelines/*Nasienkriteria:***
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓
Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistoffase in 'n geslote sisteem. (2)

3.2 Functional group/Type of intermolecular forces/Homologous series ✓
Funksionele groep/Tipe intermolekulêre kragte/Homoloë reeks (1)

3.3 B ✓ (1)

3.4 **Marking criteria/*Nasienkriteria***
- State hydrogen bonding in **A**./*Noem waterstofbinding in **A**.* ✓
- State dipole-dipole forces in **B**./*Noem dipool-dipoolkragte in **B**.*✓
- Compare strengths of IMFs./*Vergelyk sterktes van IMKe.* ✓
- Compare energies required./*Vergelyk energieë benodig.* ✓

- Compound **A**/butan-1-ol has hydrogen bonding (dipole-dipole and London forces) between molecules. ✓
- Compound **B**/butan-2-one has dipole-dipole forces (and London forces) between molecules. ✓
- Intermolecular forces in compound **A**/butan-1-ol are stronger than intermolecular forces in compound B/butan-2-one. ✓
  OR
  Intermolecular forces in compound **B**/butan-2-one are weaker than intermolecular forces in compound **A**/butan-1-ol. ✓
- More energy is needed to overcome/break intermolecular forces in compound **A**/*butan-ol* than in compound **B**/butan-2-one. ✓

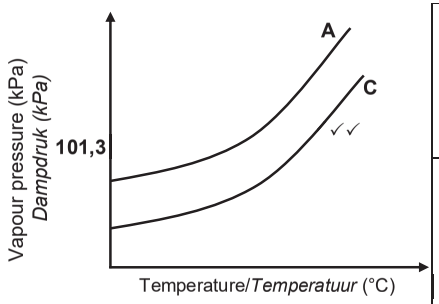
- *Verbinding **A**/butan-1-ol het waterstofbindings (dipool-dipoolkragte en Londonkragte) tussen molekule.*
- *Verbinding **B**/butan-2-oon het dipool-dipoolkragte (en London kragte) tussen molekule.* ✓
- *Intermolekulêre kragte in verbinding **A**/butan-1-ol is sterker as intermolekulêre kragte in verbinding **B**/butan-2-oon.*
  OF
  *Intermolekulêre kragte in verbinding **B**/butan-2-oon is swakker as intermolekulêre kragte in verbinding **A**/butan-1-ol.*
- *Meer energie is nodig om intermolekulêre kragte te oorkom/breek in verbinding **A**/butan-1-ol as in verbinding **B**/butan-2-oon.* (4)

3.5

3.5.1 Boiling point (of compound **A**/butan-1-ol) ✓
*Kookpunt (van verbinding **A**/butan-1-ol)* (1)

3.5.2 Gas ✓ (1)

3.5.3



Marking criteria/*Nasienkriteria*:
- Curve **C** starts below curve **A**/*Kurwe **C** begin onder kurwe **A**.* ✓
- Curve **C** remains below curve **A**/ *Kurwe **C** bly onder kurwe **A**.* ✓

Accept/*Aanvaar*
- If **C** is labelled as **B** / *Indien **C** as **B** benoem is*
- If graph below graph **A** is unlabelled /*Indien grafiek onder grafiek **A** nie benoemis nie*

Note/*Let Wel*
If both graphs unlabelled / *Indien beide grafiek nie benoem is nie:*
0 marks / *0 punte*

(2)
[12]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 Heat/sunlight/ultraviolet light/radiation/light ✓
Hitte/sonlig/ultravioletlig/straling/lig (1)

4.1.2 HBr/hydrogen bromide/*waterstofbromied* ✓ (1)

4.1.3 Hydrolysis/*hidrolise* ✓ (1)

4.1.4 H_2O/water✓
Accept/*Aanvaar*
hydrogen oxide/*waterstofoksied*

OR/*OF*
NaOH/KOH/LiOH/sodium hydroxide/potassium hydroxide/lithium hydroxide
NaOH/KOH/LiOH/Natriumhidroksied/kaliumhidroksied/litiumhidroksied (1)

4.1.5 2-bromo✓propane ✓
2-bromopropaan (2)

4.2

Marking criteria/*Nasienkriteria*:
(Mark bullets independently. / Sien *kolpunte onafhanklik na.)*
- React chloroethane with (conc) NaOH or NaOH in ethanol. ✓
- Indicate heat/Δ (on the arrow) or as a reactant in the reaction of chloroethane. ✓
- Correct condensed formula for ethene as product.✓
- Product NaCℓ in the reaction of chloroethane. ✓
- Product H_2O in the reaction of chloroethane. ✓
- React ethene with H_2.✓
- Indicate Pt on the arrow of / at the reaction of ethene with H_2. ✓
- Correct condensed formula of ethane as product. ✓

.
- *Reageer chloroetaan met (gekons) NaOH of NaOH in etanol.*✓
- *Dui hitte/Δ (op die pyl) of as 'n reaktant in die reaksie van chloroetaan.* ✓
- *Korrekte gekondenseerde formule vir eteen as produk.* ✓
- *Produk NaCℓ in die reaksie van chloroetaan.*✓
- *Produk H_2O in die reaksie van chloroetaan.*✓
- *Reageer eteen met H_2* ✓
- *Dui Pt aan op die pyl / by die reaksie van eteen met H_2.* ✓
- *Korrekte gekondenseerde formule vir etaan as produk.* ✓

$$CH_3CH_2C\ell + \text{(conc/gekons) NaOH} \checkmark \xrightarrow[\Delta]{\checkmark} CH_2CH_2 \checkmark + NaC\ell \checkmark + H_2O \checkmark$$

$$CH_2CH_2 + H_2 \checkmark \xrightarrow{Pt \checkmark} CH_3CH_3 \checkmark$$

Note/*Let wel*
Any additional reactants or products: *Deduct one mark per reaction*
Enige addisionele reaktanse of produkte: Trek een punt af per reaksie

(8)
[14]

QUESTION 5/*VRAAG 5*

5.1

NOTE/*LET WEL*
Give the mark for per unit time only if in context of reaction rate.
Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.

ANY ONE/*ENIGE EEN*

- Change in concentration ✓ of products/reactants per (unit) time. ✓
  Verandering in konsentrasie van produkte/reaktanse per (eenheid)tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
  Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid)tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
  Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid)tyd.
- Rate of change in concentration/amount/number of moles/volume/mass.
  Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/ massa. ✓✓ **(2 or/*of* 0)** (2)

5.2

- Time/*tyd* ✓
- Volume of gas/CO_2/carbon dioxide (in gas syringe)✓
  Volume gas/CO_2/koolstofdioksied (in gasspuit)

OR/*OF*

- Time taken for $A\ell_2(CO_3)_3$ to be used up. ✓✓
  Tyd geneem vir die $A\ell_2(CO_3)_3$ om opgebruik te word.

Accept/*Aanvaar*
Measure volume of gas/CO_2 at regular time intervals. ✓✓
Meet volume van gas/CO_2 met gereelde tydintervalle. (2)

5.3

Experiment II/*Eksperiment II:*

- More (HCℓ) particles per unit volume./More particles with correct orientation. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- Higher reaction rate. ✓
- *Meer (*HCℓ)-*deeltjies per eenheid volume./Meer deeltjies met korrekte oriëntasie.*
- *Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.*
- *Hoër reaksietempo.* (3)

OR/*OF*

Experiment I/*Eksperiment I:*

- Less (HCℓ) particles per unit volume. ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
- Lower reaction rate. ✓
- *Minder (*HCℓ) *deeltjies per eenheidvolume.*
- *Minder effektiewe botsings per eenheidtyd./ Laer frekwensie van effektiewe botsings.*
- *Laer reaksietempo.*

5.4

OPTION 1/*OPSIE 1*

ave rate/*gem tempo* = $-\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = -\frac{n_f - 0,016}{2,5\,(-0)}$ ✓ ✓

$n[A\ell_2(CO_3)_3] = 0,005$ (mol) ✓

OPTION 2/*OPSIE 2*

ave rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n[A\ell_2(CO_3)_3] = 0,016 - 0,011$ ✓
$= 0,005$ mol ✓

Marking criteria/*Nasienkriteria*

- Substitute average rate and Δt./ *Vervang gemiddelde tempo en Δt.* ✓
- Substitute/*Vervang* Δn. ✓
- Final answer/*Finale antwoord:* 0,005 (mol) ✓

NOTE/*LET WEL*

- Accept negative answers when the negative sign in front of the formula is omitted./*Aanvaar negatiewe antwoord wanneer die negatiewe teken voor die formule uitgelaat is.*
- Do not penalise if initial and final mole values or time values are swopped. / *Moenie penaliseer indien aanvanklike en finale molwaardes omgeruil is nie.*

OPTION 3/*OPSIE 3*

With reference to CO_2/*Met verwysing na CO_2*

ave. rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n(CO_2) = 0,011$ mol

$n(CO_2) : n(A\ell_2(CO_3)_3$
3 : 1
$0,011 : 3,67 \times 10^{-3}$ mol ✓

$n(A\ell_2(CO_3)_3$ left/*oor* $= 0,016 - 3,67 \times 10^{-3} = 1,23 \times 10^{-2}$ mol ✓

OPTION 4/*OPSIE 4*
With reference to HCℓ/*Met verwysing na HCℓ*

ave. rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n(HC\ell) = 0,011$ mol

$n[A\ell_2(CO_3)_3] = \frac{0,011}{6} = 0,0018$ mol ✓

$n[A\ell_2(CO_3)_3]$ left/*oor* = 0,016 – 0,0018 = 0,0142 mol ✓

OPTION 5/*OPSIE 5*
With reference to $A\ell C\ell_3$/*Met verwysing na $A\ell C\ell_3$*

ave. rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n(A\ell C\ell_3) = 0,011$ mol

$n[A\ell_2(CO_3)_3] = 0,0055$ mol ✓

$n[A\ell_2(CO_3)_3]$ left/*oor* = 0,016 – 0,0055 = 0,0105 mol ✓ (3)

5.5

Marking criteria/*Nasienkriteria:*
- Use mol ratio/*Gebruik molverhouding*: $n(CO_2) : n(A\ell_2(CO_3)_3) = 3 : 1$ ✓
- Substitute 24 000 $cm^3 \cdot mol^{-1}$/24 $dm^3 \cdot mol^{-1}$ in $n = \frac{V}{V_M}$ or in ratio. ✓

  Vervang 24 000 $cm^3 \cdot mol^{-1}$/24 $dm^3 \cdot mol^{-1}$ in $n = \frac{V}{V_M}$ of in verhouding.
- Final answer/*Finale antwoord:* 1 152 cm^3 / 1,152 dm^3 ✓

OPTION 1/*OPSIE 1*

$n(CO_2) = 3n[A\ell_2(CO_3)_3]$
$= 3(0,016)$ ✓
$= 0,048$ mol

$n(CO_2) = \frac{V}{V_M}$

$\therefore 0,048 = \frac{V}{24000}$ ✓

$V(CO_2) = 1\ 152\ cm^3$ (1,152 dm^3) ✓

OPTION 2/*OPSIE 2*

$n(CO_2) = 3n[A\ell_2(CO_3)_3]$
$= 3(0,016)$ ✓
$= 0,048$ mol

1 mol ……24 000 cm^3
0,048 mol ……V

$V(CO_2) = \frac{0,048 \times 24000}{1}$ ✓
$= 1\ 152\ cm^3$ (1,152 dm^3) ✓ (3)

[13]

QUESTION 6/*VRAAG 6*

6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓
(Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. **(2 or/*of* 0)**

OR/*OF*
(The stage in a chemical reaction when the) concentrations of reactants and products remain constant.
(Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. **(2 or/*of* 0)** (2)

6.2
6.2.1 X ✓
ANY ONE/*ENIGE EEN*
- The concentration of products increases (from 0 – 6 min.).
  Die konsentrasie van die produkte neem toe (van 0 - 6 min.).
- The concentration of reactants decreases (from 0 – 6 min.).
  Die konsentrasie van die reaktanse neem af (van 0 – 6 min.).
- No products were present initially. ✓
  Geen produkte was aanvanklik teenwoordig nie.
- The curve begins at zero./*Die kurwe begin by nul.* (2)

6.2.2 Higher than/*Hoër as* ✓ (1)

6.3 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT AANTAL MOL GEBRUIK

Marking criteria/*Nasienkriteria*
- Calculate/*Bereken* mol HI: $n(HI)_{ini/aanv.} = 1(0,5)$. ✓
- Use mol ratio/*Gebruik molverhouding:* 2:1:1 / $n(HI) = 2n(H_2) = 2n(I_2)$. ✓
- $n(H_2)_{equilibrium/ewewig} = n(H_2)_{formed/gevorm}$
  $n(I_2)_{equilibrium/ewewig} = n(I_2)_{formed/gevorm}$ ✓
  Note: If Δn not shown award mark for equal $n_{equilibrium}$
  ***Let wel**: Indien Δn nie aangedui is nie, ken punt toe vir gelyke n_{ewewig}*
- $n((HI)_{equilibrium/ewewig} = n(HI)_{initial/aanvanklik} - n(HI)_{change/verandering}$. ✓
- Divide $n(HI)_{equil}$ & $n(H_2)_{equil}$ & $n(H_2)_{equil}$ by 0,5 dm^3. ✓
  Deel $n(HI)_{ewewig}$ & $n(H_2)_{ewewig}$ & $n(H_2)_{ewewig}$ deur 0,5 dm^3.
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitute 0,04 into K_c expression. ✓
  Vervang 0,04 in K_c-uitdrukking.
- Substitute equilibrium concentrations in K_c expression. ✓
  Vervang ewewigskonsentrasies in K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,07 mol ✓
  Range/*Gebied*: 0,07 – 0,072 mol

OPTION 1/*OPSIE 1*

n(HI) = 1(0,5) = 0,5 mol

	HI	H_2	I_2	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,5 ✓	0	0	
Change (mol) *Verandering (mol)*	2x	x	x	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,5-2x ✓	x	x ✓	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{0,5-2x}{0,5}$	$\frac{x}{0,5}$	$\frac{x}{0,5}$	divide by 0,5 ✓ *deel deur 0,5*

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓

$0,04 \overset{\checkmark}{=} \frac{(\frac{x}{0,5})(\frac{x}{0,5})}{(\frac{0,5-2x}{0,5})^2}$ ✓

x = 0,071 mol ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{8}{9}$

Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{6}{9}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria/*Nasienkriteria:*

- Use initial/*Gebruik aanvanklike* c(HI) = 1 $mol \cdot dm^{-3}$. ✓
- Use mol ratio/*Gebruik molverhouding:* 2 : 1: 1 / n(HI) = $2n(H_2)$ = $2n(I_2)$. ✓
- $c(H_2)_{equilibrium/ewewig} = c(H_2)_{formed/gevorm}$ } ✓
  $c(I_2)_{equilibrium/ewewig} = c(I_2)_{formed/gevorm}$
  Note: If Δc not shown award mark for equal $c_{equilibrium}$
  ***Let wel**: Indien Δc nie aangedui is nie, ken punt toe vir gelyke c_{ewewig}*
- $c(HI)_{equilibrium/ewewig} = c(HI)_{initial} - c(HI)_{change}$. ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitution of 0,04 into K_c expression. ✓
  Vervang 0,04 in K_c-uitdrukking.
- Substitution of equilibrium concentrations into K_c expression. ✓
  Vervanging van ewewigskonsentrasies in K_c-uitdrukking.
- Multiply concentration by 0,5 dm^3. ✓
  Vermenigvuldig konsentrasie met 0,5 dm^3.
- Final answer/*Finale antwoord*: 0,07 mol ✓
  Range/*Gebied*: 0,07 to/*tot* 0,072 mol

OPTION 2/*OPSIE 2*

	HI	H_2	I_2
Initial concentration ($mol \cdot dm^{-3}$) *Aanvangskonsentrasie ($mol \cdot dm^{-3}$)*	1 ✓	0	0
Change ($mol \cdot dm^{-3}$) *Verandering* ($mol \cdot dm^{-3}$)	2x	x	x
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie* ($mol \cdot dm^{-3}$)	1-2x ✓	x	x ✓

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓

$0,04 \overset{\checkmark}{=} \frac{(x)(x)}{(1-2x)^2}$ ✓

x = 0,143 $mol \cdot dm^{-3}$

$n(I_2)$ = cV
= 0,143 x 0,5 ✓
= 0,072 mol ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{8}{9}$

Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{6}{9}$

(9)

6.4

6.4.1 Both forward and reverse/*Beide voorwaartse en terugwaartse* ✓ (1)

6.4.2 Positive/*Positief* ✓

- The forward reaction is favoured. ✓
  Die voorwaartse reaksie word bevoordeel.
- An increase in temperature favours the endothermic reaction. ✓
  'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The forward reaction is endothermic. ✓
  Die voorwaartse reaksie is endotermies.

(4)
[19]

QUESTION 7/VRAAG 7

7.1 Standard solution/*Standaardoplossing* ✓ (1)

7.2

7.2.1

Marking criteria/*Nasienkriteria*:

- Any one of the formulae/*Enige een van die formules*: $c = \frac{m}{MV}$ / $n = \frac{m}{M}$ / $c = \frac{n}{V}$ ✓
- Substitution of 40 g·mol^{-1} into correct formula. ✓
  Vervanging van 40 g·mol^{-1} in korrekte formule.
- Substitution of 0,25 dm^3 into correct formula. ✓
  Vervanging van 0,25 dm^3 in korrekte formule.
- Final answer/*Finale antwoord*: 0,2 mol·dm^{-3} ✓

OPTION 1/*OPSIE 1*

$c = \frac{m}{MV}$ ✓

$= \frac{2}{40 \times 0,25}$ ✓

= 0,20 mol·dm^{-3} ✓

OPTION 2/*OPSIE 2*

$n = \frac{m}{M}$

$= \frac{2}{40}$ ✓

= 0,05 mol

Any one formula/ *enige formule* ✓

$c = \frac{n}{V}$

$= \frac{0,05}{0,25}$ ✓

= 0,20 mol·dm^{-3} ✓

(4)

7.2.2 **POSITIVE MARKING FROM 7.2.1./*POSITIEWE NASIEN VAN 7.2.1.***

OPTION 1/*OPSIE 1*

$[H_3O^+][OH^-] = 1 \times 10^{-14}$

$[H_3O^+](0,2) = 1 \times 10^{-14}$ ✓

$[H_3O^+] = 5 \times 10^{-14}$ mol·dm^{-3}

↓

pH = -log$[H_3O^+]$ ✓

= -log(5×10^{-14}) ✓

= 13,30 ✓

OPTION 2/*OPSIE 2*

pOH = -log$[OH^-]$ ✓

= -log(0,2) ✓

= 0,6989 (0,7)

↓

pH + pOH = 14

pH = 14 – 0,6989 ✓

= 13,30 ✓

(4)

7.3 **POSITIVE MARKING FROM QUESTION 7.2.**
POSITIEWE NASIEN VANAF VRAAG 7.2.

Marking criteria/*Nasienkriteria*:

- Substitution to calculate n(NaOH)./*Vervanging om* n(NaOH) *te bereken.* ✓
- Use mol ratio/*Gebruik molverhouding*: $n(HC\ell)_{excess/oormaat}$: n(NaOH) = 1 : 1. ✓
- Substitute/*Vervang* 100 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Use mol ratio *Gebruik molverhouding*: $n(HC\ell)_{reacted/oormaat}$: $n(CaCO_3)$ = 2 : 1. ✓
- $n(HC\ell)_{initial/aanvanklik} = n(HC\ell)_{excess/oormaat} + n(HC\ell)_{reacted/reageer}$ ✓✓
- Substitute 0,05 dm^3 to calculate either $c(HC\ell)_{initial}$ or $c(HC\ell)_{reacted}$ ✓
  Vervang 0,05 dm^3 om $c(HC\ell)_{aanvanklik}$ of $c(HC\ell)_{reageer}$ te bereken.
- Final answer/*Finale antwoord*: 0,7 mol·dm^{-3} ✓
  Range/*Gebied:* 0,70 to/*tot* 0,90 mol·dm^{-3}

OPTION 1/*OPSIE 1*

$n(NaOH)_{used/gebruik} = c_b V_b$

= 0,2 x 0,025 ✓

= 5 x 10^{-3} mol

OPTION 2/*OPSIE 2*

$n(NaOH)_{used/gebruik} = \frac{25}{250} \times \frac{2}{40}$ ✓

= 5 x 10^{-3} mol

↓

$n(HC\ell)_{excess/oormaat}$ = n(NaOH) = 5 x 10^{-3} mol ✓

$n(CaCO_3) = \frac{m}{M}$

$= \frac{1,5}{100}$ ✓

= 0,015 mol (0,02 mol)

↓

$n(HC\ell)_{reacted/reageer} = 2n(CaCO_3)$ = 0,03 mol ✓ (0,04 mol)

$n(HC\ell)_{ini/aanv.}$ = 5 x 10^{-3} + 0,03 ✓✓

= 0,035 mol (0,045 mol)

$c(HC\ell)_{ini/aanv} = \frac{n}{V}$

$= \frac{0,035}{0,05}$ ✓

= 0,70 mol·dm^{-3} ✓ (0,90 mol·dm^{-3})

OPTION 3/*OPSIE 3*

$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$

$\frac{c_a(0,05)}{(0,2)(0,025)} = \frac{1}{1}$ ✓

$c_a = c(HC\ell)_{excess/oormaat}$

$= 0,1 \text{ mol·dm}^{-3}$

OPTION/*OPSIE 4*

$(NaOH)_{used/gebruik} = c_bV_b$

$= (0,2)(0,025)$ ✓

$= 0,005$ mol

$n(HC\ell)_{excess/oormaat} = n(NaOH)$ ✓

$= 0,005$ mol

$c(HC\ell)_{excess/oormaat} = \frac{0,005}{0,05}$

$= 0,1 \text{ mol·dm}^{-3}$

$n(CaCO_3) = \frac{m}{M}$

$= \frac{1,5}{100}$ ✓

$= 0,015$ mol

$n(CaCO_3) : n(HC\ell) = 1 : 2$

$n(HC\ell)_{reacted/reageer} = 2(0,015)$ ✓

$= 0,03$ mol

$c(HC\ell)_{reacted/reageer} = \frac{n}{V}$

$= \frac{0,03}{0,05}$ ✓

$= 0,6 \text{ mol·dm}^{-3}$

$c(HC\ell)_{initial/aanvanklik} = c(HC\ell)_{reacted/reageer} + c(HC\ell)_{excess/oormaat}$

$= 0,6 + 0,1$ ✓✓

$= 0,7 \text{ mol·dm}^{-3}$ ✓

(8)

[17]

QUESTION 8/*VRAAG 8*

8.1

8.1.1 Gain of electrons./*Opneem van elektrone*. ✓✓ **(2 or/*of* 0)** (2)

8.1.2 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

Ignore phases/*Ignoreer fases.*

Marking criteria /*Nasienkriteria:*

- $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ ($2/2$)
  $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ ($1/2$)
  $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ ($0/2$)
  $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ ($0/2$)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on OH^-/*Indien lading (-) weggelaat op* OH^-:
  Example/*Voorbeeld:* $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH(aq)$ ✓ Max./*Maks:* $1/2$

(2)

8.1.3 $2Na(s) + 2H_2O(\ell)$ ✓ $\rightarrow H_2(g) + 2OH^-(aq) + 2Na^+(aq)$ ✓ Bal ✓

OR/*OF*

$2Na(s) + 2H_2O(\ell)$ ✓ $\rightarrow H_2(g) + 2NaOH(aq)$ ✓ Bal ✓

Ignore phases/*Ignoreer fases.*

Marking criteria/*Nasienkriteria:*

- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Ignore phases/*Ignoreer fases.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

(3)

8.1.4 Formation of hydroxide ions / OH^- / sodium hydroxide/base/ alkaline/ pH > 7 ✓
Vorming van hidroksied / OH^- / natriumhidroksied / basis / alkalies / pH > 7 (1)

8.1.5 Cu is a weaker reducing agent ✓ than H_2 (and OH^-) ✓ and H_2O will not be reduced ✓ (to H_2 and OH^-).
Cu is 'n swakker reduseermiddel as H_2 (and OH^-) *en* H_2O *sal nie gereduseer word nie na* H_2 *(en* OH^-*).*

OR/*OF*

H_2 (and OH^-) are stronger reducing agent ✓ than Cu and H_2O ✓ will not be reduced✓ (to H_2 and OH^-).
H_2 (en OH^-) is 'n sterker reduseermiddel as Cu en H_2O sal nie gereduseer word (na H_2 en OH^-). (3)

8.2

8.2.1 Phase separator/boundary/difference ✓
Fase skeiding/grens/verskil (1)

8.2.2 Chemical (energy) to electrical (energy) ✓
Chemiese (energie) na elektriese (energie) (1)

8.2.3

OPTION/*OPSIE 1*	**Notes/*Aantekeninge***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = 0,77 ✓ - (-0,13) ✓ E^{θ}_{cell} = 0,90 V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E^{\theta}_{cell} = E^{\theta}_{OA} - E^{\theta}_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E^{\theta}_{sel} = E^{\theta}_{OM} - E^{\theta}_{RM}$ *gevolg deur korrekte vervangings: Max/Maks:* $\frac{3}{4}$

OPTION/*OPSIE 2*

✓	$Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$	0,13 (V) ✓
	$2Fe^{3+}(aq) + 2e^- \rightarrow 2Fe^{2+}(aq)$	0,77 (V) ✓
	$Pb^{2+}(aq) + 2Fe^{3+}(aq) \rightarrow Pb(s) + 2Fe^{2+}(aq)$	0,90 V ✓

(4)
[17]

QUESTION 9/*VRAAG 9*

9.1 Electrolytic (cell)/*Elektrolitiese (sel)* ✓

(-)

Cells have a battery/DC power source/ /Electrical energy is converted to chemical energy. ✓
Selle het batterye/GS kragbron/ Elektriese energie is omgeskakel na chemiese energie. (2)

9.2

9.2.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓

Notes/*Aantekeninge*

$2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ $(\frac{1}{2})$ $\quad$ $C\ell_2 + 2e^- \leftarrow 2C\ell^-$ $(\frac{2}{2})$

$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $(\frac{0}{2})$ $\quad$ $2C\ell^- \leftarrow C\ell_2 + 2e^-$ $(\frac{0}{2})$

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on $C\ell^-$/*Indien lading (-) weggelaat op* $C\ell^-$:
  Example/*Voorbeeld:* $2C\ell(aq) \rightarrow C\ell_2(g) + 2e^-$ Max./*Maks:* $\frac{1}{2}$

(2)

9.2.2 $A\ell^{3+} + 3e^- \rightarrow A\ell$ ✓✓

Notes/*Aantekeninge*

$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$ $(\frac{1}{2})$ $\quad$ $A\ell \leftarrow A\ell^{3+} + 3e^-$ $(\frac{2}{2})$

$A\ell \rightleftharpoons A\ell^{3+} + 3e^-$ $(\frac{0}{2})$ $\quad$ $A\ell^{3+} + 3e \leftarrow A\ell$ $(\frac{0}{2})$

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on $A\ell^{3+}$ /*Indien lading (+) weggelaat op* $A\ell^{3+}$:
  Example/*Voorbeeld:* $A\ell^3(aq) + 3e^- \rightarrow A\ell(s)$ Max./*Maks:* $\frac{1}{2}$

(2)

9.2.3 Cu/copper/*koper* ✓ (1)

9.3 **ANY ONE/*ENIGE EEN***

- The electrode/carbon/C reacts with oxygen. ✓
  Die elektrode/koolstof/C reageer met suurstof.
- $C + O_2 \rightarrow CO_2$
- Oxidation takes place./Electrons are lost.
  Oksidasie vind plaas./Elektrone word verloor.
- Oxygen corrodes the carbon electrode.
  Suurstof roes die koolstof elektrode. (1)

[8]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Sulphur dioxide/SO_2/*swaweldioksied* ✓ (1)

10.1.2 Sulphur trioxide/SO_3/*swaweltrioksied* ✓ (1)

10.1.3 Vanadium pentoxide/V_2O_5/ Vanadium(V) oxide ✓
Vanadiumpentoksied/Vanadium(V) oksied (1)

10.1.4 $H_2SO_4 + 2NH_3$ ✓ $\rightarrow (NH_4)_2SO_4$ ✓ bal ✓

Marking guidelines/*Nasienkriteria:*

- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* → and phases / *en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

10.2

10.2.1 The ratio of nitrogen (N), phosphorous (P) and potassium (K) in a fertiliser./The ratio of the primary nutrients ✓
Die verhouding van stikstof (N), fosfor (P) en kalium (K) in die kunsmis. / Die verhouding van primêre nutriënte. (1)

10.2.2

OPTION 1/OPSIE 1

Mass N in 4 kg NH_4NO_3 / Massa N in 4 kg NH_4NO_3

$m(N) = \frac{28}{80} \times 4$ ✓

$= 1,4$ kg

$m(K) = 2m(N)$ ✓

$= 2,8$ kg

$m(P) = 3m(N)$ ✓

$= 4,2$ kg

m(fertiliser/kunsmis) = 1,4 + 2,8 + 4,2

= 8,4 kg ✓

OPTION 2/*OPSIE 2*

Mass N in 4 kg NH_4NO_3/*Massa N in 4 kg* NH_4NO_3:

$m(N) = \frac{28}{80} \times 4$ ✓

$= 1,4$ kg

N : P : K

1 : 3 : 2

∴ m(fertiliser/*kunsmis*) = (6)✓(1,4)✓

= 8,4 kg ✓

OPTION 3/*OPSIE 3*

$\%\ N = \frac{(2)(14)}{80} \times 100 = 35\%$

Nitrogen in 4 kg = 35% of/*van* 4 = 1,4 kg ✓

N : P : K

1 : 3 : 2

1,4 : 4,2✓ : 2,8 ✓

Total mass of fertiliser /*Totale massa kunsmis* = 1,4 + 4,2 + 2,8

= 8,4 kg ✓ (4)

[11]

TOTAL/*TOTAAL*: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/*SENIOR SERTIFIKAAT*
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2020

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 17 pages./
Hierdie nasienriglyne bestaan uit 17 bladsye.

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Please turn over/*Blaai om asseblief*

QUESTION 1/*VRAAG 1*

1.1	C ✓✓	(2)
1.2	D ✓✓	(2)
1.3	C ✓✓	(2)
1.4	B ✓✓	(2)
1.5	D ✓✓	(2)
1.6	B ✓✓	(2)
1.7	B ✓✓	(2)
1.8	C ✓✓	(2)
1.9	A ✓✓	(2)
1.10	C ✓✓	(2)

[20]

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QUESTION 2/*VRAAG 2*

2.1.1 Ketones/*Ketone* ✓ (1)

2.1.2 Pentanal/*Pentanaal* ✓✓

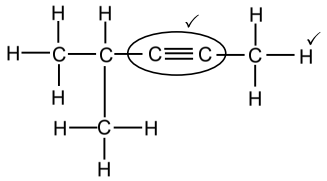
ACCEPT/*AANVAAR*
2,2-dimethylpropanal/*2,2-dimethylpropanaal*
2-methylbutanal/*2-metielbutanaal*
3-methylbutanal/*3-metielbutanaal* (2)

Marking criteria/*Nasienriglyne*
- Correct functional group,i.e. – al / *Korrekte funksionele groep d.i. al* ✓
- Whole name correct/*Hele naam korrek* ✓

2.2.1 5 – bromo-2,3 – dimethylhexane/*5 – bromo-2,3 – dimetielheksaan*

Marking criteria/*Nasienriglyne:*
- Correct stem i.e. hexane./*Korrekte stam d.i. heksaan.* ✓
- All substituents (bromo and dimethyl) correctly identified./*Alle substituente (bromo en dimetiel) korrek geïdentifiseer.* ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas./*IUPAC-naam heeltemal korrek insluitende volgorde, koppeltekens en kommas .* ✓ (3)

2.2.2



Marking criteria/*Nasienriglyne*
- Whole structure correct/*Hele struktuur korrek:* 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

IF/*INDIEN*
More than one functional group/*Meer as een funksionele groep* 0/2 (2)

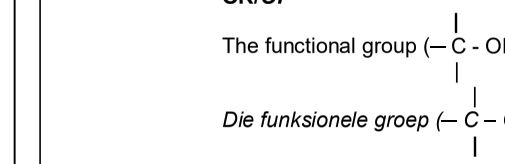
IF/*INDIEN*
Molecular formula/*Molekulêre formule* 0/2
Condensed structural formula /*Gekondenseerde struktuurformule* 1/2

2.3.1 The C atom bonded to the hydroxyl group is bonded to only one other C-atom. ✓✓ **(2 or 0)**
Die C-atoom wat aan die hidroksielgroep gebind is, is aan slegs een ander C-atoom gebind. ***(2 or 0)***

OR/*OF*
The hydroxyl group/-OH/ is bonded to a C atom which is bonded to two hydrogens atoms. **(2 or 0)**
Die hidroksielgroep/funksionele groep is gebind aan 'n C-atoom wat aan twee waterstofatome gebind is. ***(2 of 0)***

OR/*OF*
The hydroxyl group/functional group/-OH is bonded to:
a primary C atom / the first C atom **(2 or 0)**
Die hidroksielgroep/funksionele groep/-OH aan
'n primêre C-atoom gebind / die eerste C-atoom gebind ***(2 of 0)***

OR/*OF*



The functional group (— C - OH) is bonded to only one other C-atom.

Die funksionele groep (— C – OH) is aan slegs een ander C-atoom gebind. (2)

2.3.2 Esterification/condensation ✓
Verestering/esterifikasie/kondensasie (1)

2.3.3 Butanoic acid/*Butanoësuur* ✓ (1)
[12]

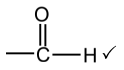
QUESTION 3/*VRAAG 3*

3.1

Marking criteria/*Nasienriglyne*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The temperature at which the vapour pressure equals atmospheric (external) pressure. ✓✓
Die temperatuur waar die dampdruk gelyk is aan atmosferiese (eksterne) druk. (2)

3.2


(1)

3.3
- Increase in the number of C-atoms increases molecular mass/size/chain length/surface area. ✓
- Strength of the intermolecular forces increases/More sites for London forces. ✓
- More energy is needed to overcome/break intermolecular forces. ✓

- *Toename in aantal C-atome verhoog molekulêre massa/molekulêre grootte/kettinglengte/reaksie-oppervlak.*
- *Sterkte van die intermolekulêre kragte verhoog./Meer punte vir Londonkragte.*
- *Meer energie benodig om intermolekulêre kragte te oorkom/breek.* (3)

3.4.1 C ✓ (1)

3.4.2 B ✓

Marking criteria/*Nasienriglyne*
- Compare strength of intermolecular forces of A, B and C. ✓
- Compare boiling points/energy required to overcome intermolecular forces of alcohols/A and aldehydes/B. ✓
  OR
  Alcohols have the highest boiling point.
- Compare boiling points/ energy required to overcome intermolecular force of aldehydes/B and alkanes/C .✓
  OR
  Alkanes have the lowest boiling point.

- *Vergelyk sterkte van intermolekulêre kragte van A, B en C.* ✓
- *Vergelyk kookpunte /energie benodig om intermolekulêre kragte van alkohole/A en aldehiede/B te oorkom.* ✓
  OF
  Alkohole het die hoogste kookpunt.
- *Vergelyk kookpunte /energie benodig om intermolekulêre kragte van aldehiede/B en alkane/C.*✓
  OF
  Alkane het die laagste kookpunt.

Aldehydes/B have (in addition to London forces) dipole-dipole forces which are stronger than London forces, but weaker than hydrogen bonds. ✓
Therefore aldehydes/B have lower boiling points/require less energy to overcome intermolecular forces than alcohols/A,✓but higher boiling points / require more energy to overcome intermolecular forces than alkanes/C. ✓

Aldehiede/B het (in toevoeging tot Londonkragte) dipool-dipoolkragte wat sterker is as Londonkragte, maar swakker is as waterstofbinding.
Dus het aldehiede/B laer kookpunte/benodig minder energie om intermolekulêre kragte te oorkom as alkohole/A, maar hoër kookpunte/benodig meer energie om intermolekulêre kragte te oorkom as alkane/C.

OR/*OF*
Aldehydes/B have stronger intermolecular forces than alkanes, but weaker intermolecular forces than alcohols/A. ✓
Therefore aldehydes/B have higher boiling points/ more energy required to overcome intermolecular forces than alkanes/C, ✓ but lower boiling points/ less energy to overcome intermolecular forces than alcohols/A. ✓

Aldehiede/B het sterker intermolekulêre kragte as alkane/C, maar swakker intermolekulêre kragte as alkohole/A.
Dus het aldehiede/B laer kookpunte/ benodig minder energie om intermolekulêre kragte te oorkom as alkohole/A, maar hoër kookpunte/ benodig meer energie om intermolekulêre kragte te oorkom as alkane/C. (4)

3.5 Butanal ✓✓
Butanaal

Marking criteria/*Nasienriglyne*
- Correct stem, i.e. but/*Korrekte stam d.i. but* ✓
- Whole name correct/*Hele naam korrek* ✓

(2)

3.6 Pentan-1-ol ✓✓
OR/*OF*
1-pentanol ✓✓ (2)
[15]

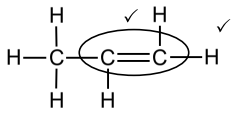
QUESTION 4/*VRAAG 4*

4.1

Marking criteria/*Nasienriglyne*
- Addition reaction / reaction of alkene / reaction of C – C double bond /reaction of unsaturated hydrocarbon✓
  Addisie reaksie / reaksie van 'n alkeen /reaksie van C – C dubbelbinding/reaksie van 'n onversadigde koolwaterstof.
- (Addition of) hydrogen halide/HX/ hydrogen and halide. ✓
  (Addisie van) waterstofhalied/HX/waterstof en halied.

The addition ✓of a hydrogen halide/HX ✓to an alkene.
Die addisie van 'n waterstofhalied/HX aan 'n alkeen. (2)

4.2



Marking criteria/*Nasienriglyne*
- Whole structure correct:
  Hele struktuur korrek: 2/2
- Only functional group correct/*Slegs funksionele groep korrek:* Max/Maks: 1/2

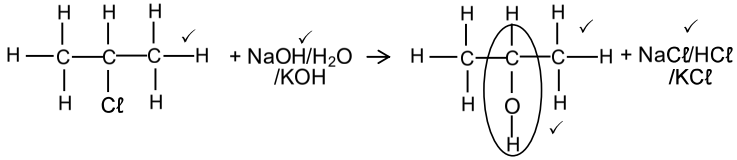
(2)

4.3.1 Cracking/*Kraking* ✓ (1)

4.3.2 C_8H_{18} ✓ (1)

4.4 1,2–dibromo ✓ propane ✓
1,2-dibromopropaan/1,2-dibroompropaan (2)

4.5.1



Marking criteria for the alcohol/*Nasienriglyne vir die alkohol*
- Whole structure of alcohol correct/*Hele struktuur van alkohol korrek:* 2/2
- Only functional group correct/*Slegs funksionele groep korrek:* 1/2

Notes/*Aantekeninge:*
- If 1-chloropropane used as reactant, 2 marks for the primary alcohol.
  Indien 1-chloropropaan as reaktanse gebruik is, 2 punte vir die primêre alkohol.
- Condensed or semi-structural formula: Max. 4/5
  Gekondenseerde of semistruktuurformule: *Maks.* 4/5
- Molecular formula/*Molekulêre formule*: 2/5
- Any additional reactants or products: Max. 4/5
  Enige addisionele reaktanse of produkte: Maks. 4/5
- If arrow in completely correct equation omitted: Max. 4/5
  Indien pyltjie in volledige korrekte vergelyking uitgelaat is: *Maks.* 4/5
- The product NaCℓ/KCℓ/HCℓ must be marked in conjunction with reactant NaOH/KOH/H_2O.
  Die produk NaCℓ/KCℓ/HCℓ moet in samehang met die reaktans NaOH/KOH / H_2O nagesien word.

(5)

4.5.2
- (Mild) heat/*(Matige) hitte* ✓
- Dilute strong base/NaOH/LiOH/KOH **OR** water/H_2O ✓
  Verdunde sterk basis/NaOH/LiOH/KOH ***OF*** *water/H_2O* (2)

[15]

QUESTION 5/*VRAAG 5*

5.1.1 (Reaction) rate/*Reaksietempo* ✓ (1)

5.1.2 Surface area/state of division /particle size ✓
Reaksie-oppervlak/*toestand van verdeeldheid/deeltjie grootte* (1)

5.2.1 (Decreasing gradient indicates) rate of reaction is decreasing. ✓
(*Afnemende gradiënt dui aan dat) reaksietempo afneem.* (1)

5.2.2 (Gradient is zero, indicates) reaction rate is zero ✓
(*Gradiënt is nul, wat aandui dat) reaksietempo nul is.* (1)

5.3 ave rate/*gem tempo* $= \frac{\Delta V}{\Delta t}$

$= \frac{500\ ^{\checkmark}(-0)}{60^{\checkmark}(-0)} = 8{,}33\ (cm^3 \cdot s^{-1})$ ✓ (3)

5.4 Equal to/*Gelyk aan* ✓ (1)

5.5 Greater than/*Groter as* ✓

Experiment C/*Eksperiment C*:
- Surface area of $CaCO_3$ powder is greater than that of $CaCO_3$ granules./ More particles are exposed /More particles with correct orientation ✓
- More effective collisions per unit time/Higher frequency of effective collisions. ✓
- Increase in reaction rate.✓
- *Reaksieoppervlak van $CaCO_3$-poeier is groter (as die van $CaCO_3$-korrels /Meer deeltjies met korrekte oriëntasie.*
- *Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings*
- *Toename in reaksie tempo*

OR/*OF*

Experiment A/*Eksperiment A:*
- Surface area of $CaCO_3$ granules is smaller/Fewer particles are exposed (than that of powdered $CaCO_3$). Less particles with correct orientation ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
- Decrease in reaction rate.✓.
- *Reaksieoppervlak van $CaCO_3$ is kleiner/Minder deeltjies is blootgestel (as die van die verpoeierde $CaCO_3$).*/ *Minder deeltjies met korrekte oriëntasie*
- *Minder effektiewe botsings per eenheidtyd./Laer frekwensie van effektiewe botsings.*
- *Afname in reaksie tempo* (4)

5.6

Marking criteria/*Nasienriglyne:*

- Divide volume by 25,7 in / *Deel volume deur 25,7 in* $n = \frac{V}{V_M}$. ✓

  If no substitution step shown, award mark for answer: 0,0195 mol
  Indien geen vervanging stap getoon is nie, ken punt toe vir antwoord: 0,0195 mol
- Ratio/*Verhouding*: $n(CO_2) = n(CaCO_3)$. ✓
- Substitute/*Vervang* 100 in $n = \frac{m}{M}$ or in ratio / *of in verhouding*. ✓
- Final answer/*Finale antwoord:* 1,95 g to/*tot* 2 g. ✓

OPTION 1/*OPSIE 1*

$n(CO_2) = \frac{V}{V_m} = \frac{0,5}{25,7}$ ✓
= 0,0195 mol
$n(CaCO_3) = n(CO_2) = 0,0195$ mol ✓

$m(CaCO_3) = nM$
= 0,0195(100)
= 1,95 g ✓

OPTION 2/*OPSIE 2*

25,7 dm^3 .....1 mol
0,5 dm^3 .....0,0195 mol ✓

100 g ✓.....1 mol
x .....0,0195 mol ✓

$x = m(CaCO_3) = 1,95$ g ✓

OPTION 3/*OPSIE 3*

$n(CO_2) = \frac{V}{V_m} = \frac{0,5}{25,7}$ ✓
= 0,0195 mol
0,0195 mol $CO_2 \equiv 0,856$ g CO_2 ✓
$m(CO_2)$ produced : $m(CaCO_3)$
44 g : 100 g ✓
0,856 : x
x = 1,95 g ✓$CaCO_3$

(4)
[16]

QUESTION 6/*VRAAG 6*

6.1 Products can be converted back to reactants. ✓
Produkte kan omgeskakel word na reaktanse.

OR/*OF*

Both forward and reverse reactions can take place.
Beide voor-en terugwaartse reaksies kan plaasvind.

OR/*OF*

A reaction which can take place in both directions.
'n Reaksie wat in beide rigtings kan plaasvind. (1)

6.2.1 Remains the same/*Bly dieselfde* ✓ (1)

6.2.2 Increases/*Toeneem* ✓ (1)

6.3
- (When pressure is increased) the reaction that leads to the smaller amount of gas / side with less molecules/number of moles is favoured. ✓
  (Wanneer die druk verhoog word,) word die reaksie wat tot die kleiner hoeveelheid gas /minder gas molekule/aantal mol lei, bevoordeel.
- The reverse reaction is favoured. ✓
  Die terugwaartse reaksie word bevoordeel. (2)

6.4 Endothermic/*Endotermies* ✓

- K_c decreases with decrease in temperature. ✓
- Reverse reaction is favoured. / Concentration of reactants increases. / Concentration of products decreases./Yield decreases ✓
- Decrease in temperature favours an exothermic reaction. ✓

- *K_c neem af met afname in temperatuur.*
- *Terugwaartse reaksie word bevoordeel./Konsentrasie van reaktanse neem toe./Konsentrasie van produkte neem af./Opbrengs neem af*
- *Afname in temperatuur bevoordeel 'n eksotermiese reaksie.*

OR/*OF*

- K_c increases with increase in temperature. ✓
- Forward reaction is favoured. / Concentration of reactants decreases. / Concentration of products increases./Yield increases ✓
- Increase in temperature favours an endothermic reaction. ✓

- *K_c neem toename met toename in temperatuur.*
- *Voorwaartse reaksie word bevoordeel./Konsentrasie van produkte neem toe./Konsentrasie van reaktanse neem af./Opbrengs neem toe*
- *Toename in temperatuur bevoordeel 'n endotermiese reaksie* (4)

6.5

CALCULATIONS USING NUMBER OF MOLES
Mark allocation
- Correct K_c expression (formulae in square brackets). ✓
- Substitution of equilibrium concentrations into K_c expression. ✓
- Substitution of K_c value. ✓
- Multiply equilibrium concentrations of I_2 and I by 12,3 dm^3. ✓ (**OPTION 1**)
- Multiply equilibrium concentrations of I by 12,3 dm^3 and divide equilibrium mol of I_2 by 12,3 dm^3. ✓(**OPTION 2**)
- Change in n(I) = n(I at equilibrium). ✓
- **USING** ratio/***GEBRUIK*** *verhouding:* $I_2 : I = 1 : 2$ ✓
- Initial $n(I_2)$ = equilibrium $n(I_2)$ + change in $n(I_2)$. ✓
- Substitute 254 $g \cdot mol^{-1}$ as molar mass for I_2.✓
- Final answer: (26 g - 27,94 g). ✓

BEREKENINGE WAT AANTAL MOL GEBRUIK
Puntetoekenning:
- *Korrekte K_c-uitdrukking (formules in vierkanthakies).*
- *Vervanging van ewewigskonsentrasies in K_c-uitdrukking.*
- *Vervanging van K_c-waarde.* ✓
- *Vermenigvuldig ewewigskonsentrasies van I_2 en I met 12,3 dm^3.(**OPSIE 1**)*
  *Vermenigvuldig ewewigskonsentrasies van I met 12,3 dm^3 en deel ewewigsmol I_2 met 12,3 dm^3(**OPSIE 2**)*
- *Verandering in n(I) = n(I by ewewig)*
- ***GEBRUIK*** *verhouding:* $I_2 : I = 1 : 2$ ✓
- *Aanvanklike $n(I_2)$ = ewewigs $n(I_2)$ + verandering in $n(I_2)$.*
- *Vervang 254 $g \cdot mol^{-1}$ as molêre massa van I_2.*
- *Finale antwoord: (26 g – 27,94 g)*

OPTION 1/*OPSIE 1*

$K_c = \frac{[I]^2}{[I_2]}$ ✓

$3,76 \times 10^{-3} = \frac{(4,79 \times 10^{-3})^2}{[I_2]}$ ✓✓

$\therefore [I_2] = 6,102 \times 10^{-3}$ mol·dm^{-3}

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* 8/9

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* 6/9

	I_2	I	
Initial mass (g) *Aanvangsmassa (g)*	(0,1045)(254) ✓ = 26,543 g ✓		
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,1045	0	
Change (mol) *Verandering (mol)*	✓ 0,0295	0,0589 ✓	Using ratio ✓
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,0751	0,0589	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	6,102 x 10^{-3}	4,79 x 10^{-3}	x12,3 ✓

OPTION 2/*OPSIE 2*

	I_2	I	
Initial amount (moles) *Aanvangshoeveelheid (mol)*	x	0	
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,0295 ✓	0,0589	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	x - 0,0295	0,0589 ✓	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	$\frac{x - 0,0295}{12,3}$	4,79 x 10^{-3}	x 12,3 and divide by 12,3✓

$K_c = \frac{[I]^2}{[I_2]}$ ✓

$3,76 \times 10^{-3}$ ✓= $\frac{(4,79 \times 10^{-3})^2}{\frac{x - 0,0295}{12,3}}$ ✓

$x = 0,1045$ mol

$\therefore m = nM$ ✓

$= (0,1045)(254)$

$= 26,543$ g ✓

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* 8/9

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* 6/9

CALCULATIONS USING CONCENTRATION

Mark allocation

- Correct K_c expression (formulae in square brackets). ✓
- Substitution of equilibrium concentrations into K_c expression. ✓
- Substitution of K_c value ✓
- Change in n(I) = n(I at equilibrium). ✓
- **USING** ratio: $I_2 : I = 1 : 2$ ✓
- Initial $[I_2]$ = equilibrium $[I_2]$ + change in $[I_2]$. ✓
- Divide by 12,3 dm^3. ✓
- Substitute 254 g·mol^{-1} as molar mass for I_2.✓
- Final answer 26,543 g. ✓

BEREKENINGE WAT KONSENTRASIE GEBRUIK

Puntetoekenning

- *Korrekte K_c-uitdrukking (formules in vierkanthakies).*
- *Vervanging van ewewigskonsentrasies in K_c-uitdrukking.*
- *Vervanging van K_c-waarde.*
- *Verandering in n(I) = n(I by ewewig).*
- ***GEBRUIK** verhouding $I_2 : I = 1 : 2$*
- *Aanvanklike $[I_2]$ = ewewigs $[I_2]$ + verandering in $[I_2]$.*
- *Deel deur 12,3 dm^3.* ✓
- *Vervang 254 g·mol^{-1} as molêre massa van I_2.*
- *Finale antwoord: 26,543 g*

OPTION 3/*OPSIE 3*

$K_c = \frac{[I]^2}{[I_2]}$ ✓

$3,76 \times 10^{-3}$ ✓= $\frac{(4,79 \times 10^{-3})^2}{[I_2]}$ ✓

$[I_2] = 6,102 \times 10^{-3}$ mol·dm^{-3}

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* 8/9

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* 6/9

	I_2	I	
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	✓ 8,497x10^{-3}	0	
Change (mol·dm^{-3}) *Verandering* (mol·dm^{-3})	2,395x10^{-3}	4,79x10^{-3} ✓	Using ratio ✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	6,102 x 10^{-3}	4,79 x 10^{-3}	

$c = \frac{m}{MV}$

$8,497 \times 10^{-3} = \frac{m}{(254)(12,3)}$ ✓✓

$\therefore m = 26,546$ g ✓

(9)

[18]

QUESTION 7/*VRAAG 7*

7.1.1 (-) Weak/*Swak* ✓

Ionises/Dissociates incompletely/partially (in water) ✓
Ioniseer/Dissosieer/onvolledig/gedeeltelik (in water) (2)

7.1.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
pH = -log[H_3O^+] ✓ 3,85 ✓ = -log[H_3O^+] [H_3O^+] = 1,41 x 10^{-4} mol·dm^{-3} ✓	[H_3O^+] = 10^{-pH} ✓ = $10^{-3,85}$ ✓ = 1,41 x 10^{-4} mol·dm^{-3} ✓

(3)

7.1.3 Greater than/*Groter as* ✓ (1)

7.1.4 $CH_3COO^-(aq) + H_2O(\ell)$ ✓ ⇌ $CH_3COOH(aq) + OH^-(aq)$ ✓

OR/*OF*

$CH_3COONa(aq) + H_2O(\ell)$ ✓ ⇌ $CH_3COOH(aq) + NaOH(aq)$ ✓

Due to formation of hydroxide/OH^- / the solution is basic/alkaline /pH > 7. ✓
As gevolg van die vorming van hidroksied/OH^- is die oplossing basies/ alkalies /pH > 7 (3)

7.2.1

Marking criteria/*Nasienriglyne*

- Substitute/*vervang*: 1 x 0,0145 **OR/*OF*** 1 x 14,5 in $c = \frac{n}{V} / \frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$. ✓
- Use/*Gebruik*: $n(CH_3COOH) : n(NaOH) = 1:1$ ✓
- Final answer/*Finale antwoord*: 0,0145 mol ✓

OPTION 1/*OPSIE 1*

$n(NaOH)_{reacted} = cV$
= 1(0,0145) ✓
= 0,0145 mol

$n(CH_3COOH)_{diluted} = n(NaOH)$ ✓
= 0,0145mol ✓

(3)

7.2.2 **POSITIVE MARKING FROM 7.2.1./*POSITEWE NASIEN VANAF VRAAG 7.2.1.***

Marking criteria/*Nasienriglyne*

- Calculate mass/*Bereken massa* CH_3COOH in 25 cm^3 (1,13 g). ✓
- Formula/*Formule*: $n = \frac{m}{M}$. ✓
- Substitute/*Vervang*: M = 60 g·mol^{-1}. ✓
- $n(CH_3COOH)_{reacted/reageer} = n_{initial/begin} - n_{unreacted/nie\ reageer}$ ✓
- USE mol ratio/*GEBRUIK molverhouding*: $n(CaCO_3) : n(CH_3COOH) = 1 : 2$.✓
- Substitution of/*Vervanging van* 100 g·mol^{-1} in m = nM. ✓
- Calculate percentage/*Bereken persentasie*: $\frac{0,217}{1,2} \times 100$ ✓
- Final answer/*Finale antwoord*: 18,08% ✓ (17,92 – 22,92)

$m(CH_3COOH) = \frac{4,52}{100} \times 25$ ✓ = 1,13 g

$n(CH_3COOH)_{ini/aanv.} = \frac{m}{M}$ ✓

$= \frac{1,13}{60}$ ✓ = 0,01883 mol

$n(CH_3COOH)_{rea} = 0,01883 - 0,0145 = 0,0043$ mol ✓

$n(CaCO_3) = \frac{1}{2} n(CH_3COOH)$

= 0,5(0,0043) ✓
= 0,00217 mol

$m(CaCO_3) = nM$ ✓
= 0,00217(100) = 0,217 g

% $CaCO_3 = \frac{0,217}{1,2} \times 100$ ✓
= 18,08 % ✓

(8)
[20]

QUESTION 8/*VRAAG 8*

8.1 Provides path for movement of ions./Ensures(electrical)neutrality in the cell. ✓
Verskaf pad vir beweging van ione./Verseker (elektriese) neutraliteit in die sel. (1)

8.2 (The electrode) where oxidation takes place/electrons are lost. ✓✓
(Die elektrode) waar oksidasie plaasvind/elektrone verloor word. (2)

8.3 Mg/Magnesium ✓ (1)

8.4.1 $2H^+ + 2e^- \rightarrow H_2$ ✓✓

Marking criteria/*Nasienriglyne*

$H_2 \leftarrow 2H^+ + 2e^-$ $(2/2)$ $2H^+ + 2e^- \rightleftharpoons H_2$ $(1/2)$

$H_2 \rightleftharpoons 2H^+ + 2e^-$ $(0/2)$ $2H^+ + 2e \leftarrow H_2$ $(0/2)$

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on H^+/*Indien lading (+) weggelaat op* H^+*:*

  Example/*Voorbeeld:* $2H + 2e^- \rightarrow H_2$ ✓ Max./*Maks:* $1/2$

(2)

8.4.2 Magnesium/Mg ✓ (1)

8.5

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ $= 0$ ✓ $- (-2,36)$ ✓ $E^\theta_{cell} = 2,36$ V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $3/4$

OPTION 2/*OPSIE 2*

✓ $2H^+ + 2e^- \rightarrow H_2$ $E^\theta = 0$ V ✓

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$ $E^\theta = +2,36$ V ✓

$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ $E^\theta = +2,36$ V ✓

(4)

8.6 H_2 is a stronger reducing agent ✓ than Cu ✓ and therefore Cu^{2+}/Cu ions are reduced/H_2 is oxidised ✓ Electrons flow from H_2 to Cu.

H_2 is 'n sterker reduseermiddel as Cu en dus word Cu^{2+}/Cu-ione gereduseer/H_2 is geoksideer. Elektrone vloei vanaf H_2 na Cu. (3)

[14]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE/*ENIGE EEN:***

- The chemical process in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
- The use of electrical energy to produce a chemical change. **(2 or 0)**
- Decomposition of an ionic compound by means of electrical energy. **(2 or 0)**
- The process during which and electric current passes through a solution/ionic liquid/molten ionic compound. **(2 or 0)**

- *Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie. **(2 of 0)***
- *Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring. **(2 of 0)***
- *Ontbinding van 'n ioniese verbinding met behulp van elektriese energie. **(2 of 0)***
- *Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg. **(2 of 0)*** (2)

9.2 Battery/cell/ power source ✓
Battery/sel/kragbron (1)

9.3 Silver nitrate/$AgNO_3$/ Silver ethanoate/CH_3COOAg / Silver fluoride /AgF/ Silver perchlorate $AgC\ell O_4$. ✓
Silwernitraat/$AgNO_3$/ Silweretanoaat/CH_3COOAg / Silverfloried / AgF / Silwerperchloraat / $AgC\ell O_4$ (1)

9.4 (-) Remains the same/*Bly dieselfde* ✓

Rate of oxidation is equal to the rate of reduction. ✓
Tempo van oksidasie is gelyk aan die tempo van reduksie. (2)

9.5 $Ag \rightarrow Ag^+ + e^-$ ✓✓

Notes/*Aantekeninge*

$Ag^+ + e^- \leftarrow Ag$ $(2/2)$ $Ag \rightleftharpoons Ag^+ + e^-$ $(1/2)$

$Ag \leftarrow Ag^+ + e^-$ $(0/2)$ $Ag^+ + e^- \rightleftharpoons Ag$ $(0/2)$

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Ag^+/*Indien lading (+) weggelaat op* Ag^+*:*

  Example/*Voorbeeld:* $Ag \rightarrow Ag + e^-$ ✓

(2)

[8]

QUESTION 10/*VRAAG 10*

10.1.1 (Liquid) Air/*(Vloeibare)Lug* ✓ (1)

10.1.2 Natural gas/methane/oil/coal/coke✓
Aardgas/metaan/olie/steenkool/kooks (1)

10.1.3 Iron/iron oxide/Fe/FeO ✓
Yster/ysteroksied/Fe/FeO (1)

10.1.4 NH_3/Ammonia/*Ammoniak* ✓ (1)

10.1.5 Ostwald (process)/*Ostwald(proses)* ✓ (1)

10.1.6 $NH_3 + HNO_3$ ✓ → NH_4NO_3 ✓ Bal ✓

Marking criteria/*Nasienriglyne*		
• Reactants ✓	Products ✓	Balancing ✓
Reaktanse	*Produkte*	*Balansering*
• Ignore double arrows./*Ignoreer dubbelpyle.*		
• Marking rule 6.3.10./*Nasienreël 6.3.10.*		

(3)

10.2.1 NPK ratio/Ratio of primary nutrients ✓
NPK-verhouding/Verhouding van primêre voedingstowwe (1)

10.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{4}{9}$ ✓ x $\frac{X}{100}$ x 20 ✓ = 2,315 kg X = 26 ✓ (26,04)	m(P) = 2,315 kg Mass of 1 part P = $\frac{2,315}{4}$ = 0,57575 Mass of N = (0,57575)(2) = 1,1575 kg Mass of K = (0,57575)(3) = 1,73625 kg Total mass of fertiliser: 1,1575 + 2,315 + 1,73625 = 5,20875 kg ✓ X = $\frac{5,20875}{20}$ x 100 ✓= 26,04 ✓

(3)
[12]

TOTAL/*TOTAAL*: 150

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Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE 12/*GRAAD 12*

SEPTEMBER 2020

PHYSICAL SCIENCES P2 MARKING GUIDELINE/ *FISIESE WETENSKAPPE V2 NASIENRIGLYN*

MARKS / *PUNTE*: **150**

This marking guideline consists of 21 pages.
Hierdie nasienriglyn bestaan uit 21 bladsye

QUESTION 1/*VRAAG 1*

1.1	D	✓✓	(2)
1.2	C	✓✓	(2)
1.3	A	✓✓	(2)
1.4	A	✓✓	(2)
1.5	C	✓✓	(2)
1.6	B	✓✓	(2)
1.7	B	✓✓	(2)
1.8	D	✓✓	(2)
1.9	D	✓✓	(2)
1.10	B	✓✓	(2)
			[20]

QUESTION 2/*VRAAG 2*

2.1 A series of organic compounds that can be described by the same general formula ✓✓

'n Reeks organiese verbindings wat met dieselfde algemene formule beskryf kan word

OR/*OF*

A series of organic compounds in which members differ by the number of $-CH_2$ units

'n Reeks organiese verbindings waarin een lid van die volgende met die aantal CH_2-eenhede verskil. (2)

2.2 A compound that contains carbon and hydrogen (atoms) only ✓✓

'n Verbinding wat slegs koolstof en waterstof (atome) bevat **(2 or/*of* 0)** (2)

2.3.1 C_nH_{2n+2} ✓ (1)

2.3.2 4-ethyl ✓-2,2-dimethyl ✓hexane ✓

4-etiel-2,2-dimetielheksaan (3)

Marking criteria/*Nasienkriteria*
- Hexane/*Heksaan* ✓
- Methyl/*Metiel* and/*en* ethy**l** *etiel* ✓
- whole name correct/*Hele naam korrek* 3/3

Deduct 1 mark for any error, hyphens omitted, incorrect sequence etc/ *Trek 1 punt af vir foute, koppeltekkens wat weggelaat is, verkeerde volgorde ens*
ens

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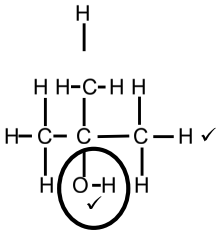
2.4.1



Marking criteria/*Nasienkriteria*
- Whole structure correct (2/2)
- *Hele struktuur korrek (2/2)*
- Functional group correct (1/2)
- *Funksionele groep korrek (1/2)*

(2)

2.4.2 Butan-2-one ✓✓ OR 2-butanone

Butan-2-oon OF 2-Butanoon (2)

Marking criteria/*Nasienkriteria*
- Functional group and correct position ✓ E.g pent-2-one (1/2)
- *Funksionele groep en korrekte posisie b.v pent-2-oon (1/2)*
- Whole name correct (2/2)
- *Hele naam korrek (2/2)*

2.4.3 The functional group can only be in position 1 ✓

Die funksionele groep kan slegs by posisie 1 wees.

OR/*OF*

Side chain / branch / methyl group can only be in position 2

Syketting / tak / metielgroep kan slegs by posisie 2 wees (1)

2.5.1 Polymerisation ✓
Polimerisasie (1)

2.5.2 Contains single bonds only ✓ **(1 or 0)**
Bevat slegs enkelbindings ***(1 of 0)*** (1)

2.5.3 Use in plastics (toy cars) ✓
Gebruik in plastiek (speelgoedmotors.) (1)

[16]

QUESTION 3/ *VRAAG 3*

3.1 The temperature at which the vapour pressure ✓of a liquid equals the atmospheric/external pressure. ✓

Die temperatuur waarteen die dampdruk van 'n vloeistof gelyk is aan die atmosferiese / eksterne druk. (2)

3.2 To ensure a fair test ✓/To ensure there is one independent variable

Om 'n billike toets te verseker / Om te verseker dat daar een onafhanklike veranderlike is. (1)

3.3 Hexane has London forces ✓ (only)
Pentanal has dipole-dipole forces ✓ (and London forces)

Heksaan het (slegs) Londonkragte
Pentanal het dipool-dipoolkragte (en Londonkragte)

Dipole-dipole forces are stronger ✓ (than the london forces in hexane) ✓
OR London forces are weaker (than the Dipole-dipole forces in pentanal)

Dipool-dipoolkragte is sterker (as die Londonkragte in heksaan)
OF Londonkragte is swakker (as die dipool-dipoolkragte in pentanal)

More energy is required to overcome the intermolecular /Dipole-dipole forces in Pentanal ✓

Meer energie word benodig om die intermolekulêrekragte/dipool-dipoolkragte in pentanal te oorkom (4)

3.4 Higher than ✓
Hoër as (1)

3.5 Chain isomer of pentan-2-ol (2-methylbutan-2-ol) has a shorter chain length/ smaller surface area than pentan-2-ol ✓

Kettingisomeer van pentan-2-ol (2-metielbutaan-2-ol) het 'n korter kettinglengte / kleiner oppervlakte as pentan-2-ol

London forces ✓ in the isomer of pentan-2-ol (2-methylbutan-2-ol) will be weaker (than that of pentan-2-ol). ✓

Londonkragte in die isomeer van pentan-2-ol (2-metielbutaan-2-ol) sal swakker (as dié van pentan-2-ol) wees.

OR/*OF*

Pentan-2-ol has a larger chain length/ surface area than its chain isomer

Pentan-2-ol het 'n groter kettinglengte / oppervlakte as sy kettingisomeer

London forces in butan-2-ol is stronger (than that of the isomer of pentan-2-ol (2-methylbutan-2-ol)

Londonskragte in butan-2-ol is sterker (as dié van die isomeer van pentan-2-ol (2-methylbutan-2-ol) (3)

3.6 $2\ C_6H_{14} + 19\ O_2 \rightarrow 12\ CO_2 + 14\ H_2O$

Marking criteria/*Nasienkriteria*
- Reactants/*Reaktante* ✓
- Products /*Produkte*✓
- Balancing/*Balansering* ✓

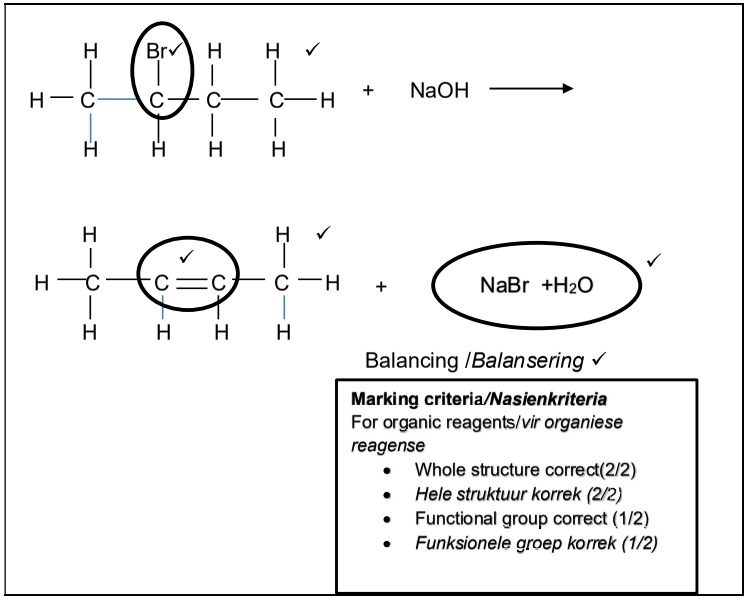
(3)
[14]

QUESTION 4/*VRAAG 4*

4.1.1 Substitution ✓/Hydrolysis
Substitusie/ Hidroliese (1)

4.1.2 Butan-2-ol ✓✓ OR/*OF* 2-butanol (2)

4.2



Balancing /*Balansering* ✓

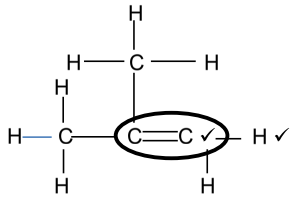
Marking criteria/*Nasienkriteria*
For organic reagents/*vir organiese reagense*
- Whole structure correct(2/2)
- *Hele struktuur korrek (2/2)*
- Functional group correct (1/2)
- *Funksionele groep korrek (1/2)*

(6)

4.3 4.3.1 Hydrogenation ✓*Hidrogenasie* (1)

4.3.2 Platinum/Palladium/Nickel ✓ (1)

4.3.3



Marking criteria/*Nasienkriteria*
For organic reagents/*vir organiese reagense*
- Whole structure correct (2/2)
- *Hele struktuur korrek (2/2)*
- Functional group correct (1/2)
- *Funksionele groep korrek (1/2)*

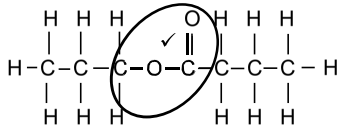
(2)

4.4 4.4.1 Esterification/Condensation ✓ *Esterifikasie/ Kondensasie / verestering* (1)

4.4.2 Heat/Add a catalyst/H_2SO_4 ✓*Hitte/Voeg 'n katalisator by/H_2SO_4* (1)

4.4.3 Water/H_2O ✓ (1)

4.4.4



Propyl ✓butanoate ✓

Propielbutanoaat (4)

Marking criteria/*Nasienkriteria*
- Whole structure correct (2/2)
- *Hele struktuur korrek (2/2)*
- Functional group correct (1/2)
- *Funksionele groep korrek (1/2)*
- Name correct (2/2)
- *Naam korrek (2/2)*

[20]

QUESTION 5/*VRAAG 5*

5.1 The change in concentration of reactants or products per unit time. ✓✓

Die verandering in konsentrasie van reaktante of produkte per tydeenheid. (2)

5.2 Carbon dioxide/CO_2 ✓
Koolstofdioksied/CO_2 (1)

5.3 Stopwatch ✓
Stophorlosie (1)

5.4 Rate/*Tempo* = -Δ m/Δt

Rate/*Tempo* = –(200 -184,80) ✓ / (5 – 0) ✓

Rate/*Tempo* = 3,04 ($g \cdot min^{-1}$) ✓

Accept /Aanvaar

Rate = (184,80 –200) / (5 – 0)
= - 3,04 ($g \cdot min^{-1}$)

Rate/*Temp* = (200 –184,80) /(5 – 0)
Rate/*Tempo* = 3,04 ($g \cdot min^{-1}$) (3)

5.5 $m_{CO2\ produced}$ = 200- 184,80 ✓
= 15.2 g

nCO_2 = m/M ✓

= 15,2 /44 ✓

= 0,35 mol

$nCaCO_{3\ reacting}$ = 0.35 mol ✓

(Ratio/*Verhouding*)

$mCaCO_{3\ reacting/reageer}$ = n.M

= 0.35 x 100 ✓

= 35 g ✓ (6)

Marking guidelines/*Nasienriglyne*
- Mass of CO_2 */Massa van CO_2*
- Formula/*Formule* n = m/M
- Substitution of/*Substitusie van* 44 into/ *in* n = m/M
- Use of ratio/ *Gebruik van verhouding* CaCO3: CO2 (1:1)
- Substitution of/ *Subtitusie van* 100 into/*in* n = m/M
- Final answer/*Finale antwoord*

5.6.1 Temperature/*Temperatuur* ✓ (1)

5.6.2 B ✓ (1)

5.6.3 Higher temperature increases average kinetic energy of the particles increases./ *Hoër temperatuur verhoog die gemiddelde kinetiese energie van die deeltjies.* ✓

More particles have sufficient kinetic energy (to collide effectively) ✓/ More particles have E_k greater or equal to E_a

Meer deeltjies het genoeg kinetiese energie (om effektief te bots) / Meer deeltjies het E_k groter of gelyk aan E_a

More effective collisions per unit time/ *Meer effektiewe botsings per tydseenheid* ✓ (3)

5.7.1 What effect will the concentration (of a substance) have on the rate of reaction? ✓✓
Watter effek sal die konsentrasie (van 'n stof) op die reaksietempo het?

OR/*OF*
What is the relationship between reaction rate and concentration?
Wat is die verhouding tussen reaksietempo en konsentrasie?

OR/*OF*
How does concentration affect reaction rate?
Hoe beïnvloed konsentrasie die reaksietempo?

Marking criteria/*Nasienkriteria*
For organic reagents/*vir organiese reagense*
- Independent variable and dependent variable correct
  Onafhanklike veranderlike en afhanklike veranderlike korrek
- In the form of a question/ *in die vorm van 'n vraag*

(2)

5.7.2 LOWER THAN/*LAER AS*✓ (1)

5.7.3 EQUAL TO/*GELYK AAN* (1)

5.8 The same amount of $CaCO_3$ (the limiting reagent) is used in both experiments ✓✓
In beide eksperimente word dieselfde hoeveelheid $CaCO_3$ (die beperkende reagens) gebruik (2)
[24]

QUESTION 6/ *VRAAG 6*

6.1 Reaction in which products can be converted back to reactants ✓✓
Reaksie waarin produkte teruggeskakel kan word na reaktante (2)

6.2 FORWARD REACTION/ VOORWAARTSE REAKSIE ✓ (1)

6.3 No/ *Nee* ✓

The rate of forward reaction is equal to the rate of reverse reaction ✓✓
/Reaction reached equilibrium

Die tempo van voorwaartse reaksie is gelyk aan die tempo van terugwaartse reaksie / Reaksie bereik ewewig (3)

6.4.1 Increases / *Verhoog* ✓ (1)

6.4.2 Remains the same / *Bly dieselfde* ✓ (1)

6.4.3 Increases / *Verhoog* ✓ (1)

6.5 The amount of HI remains constant./ *Die hoeveelheid stof van HI bly konstant* ✓
The volume decreases/ *Die volume neem af*
The concentration increases according to c = n/V / *Die konsentrasie verhoog volgend c=n/v* ✓ (2)

6.6.1 High yield/ *Hoë opbrengs* ✓ Kc is large/ *groot* ✓ OR / *OF* Kc >1 (2)

6.6.2 EXOTHERMIC / *EKSOTERMIES* ✓

(−)

The value Kc decreases with an increase in temperature./ *Die waarde van Kc neemaf met 'n toename in temperatuur.* ✓
As temperature increases, the [prdoducts] decreases / *Soos die temperatuur verhoog, neem die [produkte] af* ✓
Reverse reaction is favoured by an increase in temperature/ *Die terugwaartse reaksie word bevoordeel deur 'n toename in temperatuur.* ✓

OR/*OF*

The value Kc increases with a decrease in temperature./ *Die waarde van Kc verhoog met die afname in temperatuur.*
As temperature decreases the [products] increases / *Soos die temperatuur verlaag, neem die [produkte] toe.*
Forward reaction is favoured by a decrease in temperature/ *Die terugwaartse reaksie word bevoordeel deur 'n toename in temperatuur* (4)

6.7.1 $Kc = [HI]^2/[H_2].[I_2]$ ✓

$50,3$✓ $= [HI]^2/(0.46)(0,39)$ ✓

$[HI] = 3\ mol.dm^{-3}$ ✓ (4)

6.7.2 **POSITIVE MARKING FROM 6.7.1 / *POSITIEWE NASIEN VANAF 6.7.1***

OPTION 1 : CALCULATIONS USING NUMBER OF MOLES
OPSIE 1 : BEREKENINGE DEUR DIE GEBRUIK VAN MOL

Marking Criteria for Mole Option/ *Nasienkriteria vir Mol Opsie*

- Multiplication/ *Vermenigvulding* of/ *van* c equilibrium/ *ewewig* by/ *met* 0,5 dm^3 for/ *vir* I_2 ,H_2 and HI
- Calculations of moles of/ *Berekening van mole vir* HI reacting/ *reageer*✓
- Using mole ratio/ *gerbuik van mol verhouding* 2 n(HI) = n(H_2) = n (I_2) reacting ✓
- Calculation of / *Berekening van* n (H_2) initial and/ *en* n (I_2) initial ($\Delta n + n_{equilibrium}$)✓
- Multiplication / *Vermenigvuldinging* of / *van* n (I_2) by 2 to find / om te vind n (HI) theoretical / *teoreties* ✓✓
- Substitution into Yield/ *Substiteer in opbrengs* = $n_{produced}/n_{theoretical}$ x 100 ✓
- Final answer / *finale antwoord* ✓ **(RANGE / *GEBIED*: 78,95% – 79,37%)**

CALCULATION USING MOLES / *BEREKEN DEUR DIE GEBRUIK VAN MOL*

	H_2	I_2	2HI
n_i	0,98	0,945 ✓	0
Δn	0,75	0,75 ✓ Ratio	1,5 ✓
$n_{equilibrium}$ / *ewewig*	0,23	0,195	1,5 ✓ (x 0,5 dm^3)
$c_{equilibrium}$ / *ewewig*	0.46	0,39	3

I_2 is the limiting reagent / *I_2 is die beperkende reagens*

n (HI) theoretical / *teoreties* = 2 (n I_2 initial / *begin*) = 2 ✓x (0,945) = 1,89 mol

% Yield / *Opbrengs* = $n_{produced}/n_{theoretical}$ X 100 = 1,5/1,89 x 100✓ = 79,37 %✓

H_2 used as limiting reagent Max 3/7
H_2 gebruik as beperkende reagens maks 3/7

OPTION 2: CALCULATION USING CONCENTRATIONS
OPSIE 2: BEREKENING DEUR KONSENTRASIE

Marking Criteria for concentration Option / *Nasienkriteria vir konsentrasie opsie*

- Calculations of / *Berekening van* $c_{HI\ reacting}$✓
- Using mole ratio / *Gebruik van mol verhouding* 2 c(HI) = c(H_2) = c(N_2) reacting /*reageer* ✓
- Calculation of / *Berekening van* $cH_{2\ initial\ /\ begin}$ and $c_{I2\ initial\ /\ begin}$ ($\Delta c + c_{equilibrium\ /\ ewewig}$)✓
- Multiplication of / *Vermenigvuldiging van* c_{I2} by 2 to find / *om te vind* n_{HI} theoretical / *teoreties* ✓✓
- Substitution into Yield / *Substiteer in opbrengs* = $n_{HIproduced}/n_{Hitheoretical}$ x 100 ✓
- Final answer / *Finale antwoord* ✓
  (RANGE / *GEBIED*: 78,95% -79,37%)

	H_2	I_2	2HI
c_i	1,96	1,89✓	0
Δc	1,5	1,5✓ (Ratio)	3✓ ($c_{HI\ equil}$)
$c_{equilibrium}$	0.46	0,39	3

I_2 is the limiting reagent / *I_2 is die beperkende reagens*

C (HI) theoretical / *teoreties* = 2 x 1,89✓✓ = 3,78 $mol.dm^{-3}$

% Yield / *Opbrengs* = $c_{produced}/c_{theoretical}$ x 100 =3/3,78 x 100✓ =79,37%✓

H_2 used as limiting reagent Max 3/7
H_2 gebruik as beperkende reagens maks 3/7

(7)
[28]

QUESTION 7 / *VRAAG 7*

7.1.1 An acid is a substance that donates protons /H^+ions ✓✓

'n Suur is 'n stof wat protone / H^+ -ione skenk (2)

7.1.2 $H_2PO_4^-$ ✓ (1)

7.1.3 Reaction **I** : Reverse reaction it accepts a proton (H^+) / acts as a base ✓
*Reaksie **I**: Terugwaartse reaksie, dit aanvaar 'n proton (H^+) / dien as basis*
Reaction **II**: Foward reaction donates a proton (H^+)/ act as an acid. ✓
*Reaksie **II**: Foward-reaksie skenk 'n proton (H^+) / dien as 'n suur* (2)

7.1.4 HPO_4^{2-} ✓

The conjugate base of a weak acid/ *Die gekonjugeerde basis van 'n swak suur* ✓
lower K_a value is the stronger base/ *laer K_a-waarde is die sterker* basis ✓ (3)

7.2.1 Reaction of a salt with water/ *Reaksie van 'n sout met water* ✓✓ (2)

7.2.2 $C_2HO_4^-$ ✓✓ (2)

7.2.3 (Excess) OH^- ions/hydroxide ions are produced /*(Oormaat)* OH^- *ione / hidroksiedione word geproduseer* ✓✓ (2)

7.3.1 A strong base undergoes complete ionisation ✓✓/disociation

'n Sterk basis ondergaan volledige ionisasie / disosiasie (2)

7.3.2

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***
$K_w = [H_3O^+][OH^-]$ ✓	pOH = -log[OH^-]
$1x10^{-14} = [H_3O^+](0,5)$ ✓	pOH = - log (0,5) ✓
$[H_3O^+] = 2x10^{-14}$ mol·dm^{-3}	pOH = 0,30
pH = -log[H_3O^+] ✓	pH + pOH = 14 ✓
pH = - log($2x10^{-14}$) ✓	pH + 0,30 ✓ = 14 ✓
pH = 13,70 ✓	pH = 13,70 ✓

(5)

7.3.3 **OPTION 1 / *OPSIE 1***

$$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b} \checkmark$$

$$\frac{c_a(25)}{(0,5)(24)} \checkmark = \frac{1}{2} \checkmark$$

c_a = 0,24 mol·dm^{-3}

$$c = \frac{m}{MV}$$

$$0,24 \checkmark = \frac{\checkmark\ 7,56}{(90+18x)(0,25)} \checkmark$$

x = 2 ✓

OPTION 2 / *OPSIE 2*:

Marking guideline / *Nasienriglyne*
- Substitution of / *Vervang* 0,5 and / *en* 24/100 in n = cV
- Use of mole ratio / *Gebruik van mol in* Acid/*Suur*: Base/*Basis* 1:2
- Calculating number of moles of acid in original solution / *Bereken die aantal mol in suur in oorspronklike oplossing*
- Use of / *Gebruik van* 90 in m = nM
- Calculation of mass of water of crystallization in original solution / *Berekening van die massa kristalwater in die oorspronklike oplossing*
- Calculating ration of n_{Water}/n_{Acid} *Berekening van die verhouding van n_{Water} / n_{suur}*
- Final answer / *Finale antwoord*

$n_{NaOH\ reacting\ /\ reageer}$ = cV= 0.5 x 24/1000✓ = 0.012 mol

$n_{oxalic\ acid\ reacting\ /\ reaksie\ van\ oksaalsuur}$= ½ x 0.012 mol✓ = 0,006 mol

$n_{oxalic\ acid\ in\ original\ solution\ /\ oksaalsuur\ in\ oorspronklike\ oplossing}$ = 250/25✓ x 0,006
= 0,06 mol ✓

$m_{\text{oxalic acid in original solution / oksaalsuur in oorspronklike oplossing}}$ = nM = 0,06 x 90 ✓
= 5,4 g

$m_{\text{H2O of crystallisation in original solution / } \textit{kristallisasie in oorspronklike oplossing}}$ = 7,56 - 5,4 ✓
= 2.16 g

n H_2O crystalllisation / *kristallisasie* = 2,16 /18 = 0,12 mol

x = 0,12/0,06 = 2✓ (7)
[28]

TOTAL / *TOTAAL* 150

Kopiereg voorbehou

Thank you to our STEM in ACTION partners

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Principals and School Management Teams
Physical Science CoP
STEM in ACTION learners and the rest of our Science Communities in our Nelson Mandela Metro

Get in touch with us

+27 41 504 1396
stemadmin@mandela.ac.za
www.steminaction.mandela.ac.za
NMU, Missionvale Campus
@STEMinACTION MandelaUni