# Boost

## Grade 12 Physical Science
## Exam Prep Pack

2020

Compiled By

STEM IN ACTION

@mandelaunistem

STEM in ACTION MandelaUni

+27 71 581 5442

www.amtc.mandela.ac.za

+27 41 504 1396

stemadmin@mandela.ac.za

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# Boost

A Message from STEM in ACTION

Examination Guidelines

Physics Data Sheets

Physics Paper 1 – Practice

Chemistry Data Sheet

Periodic Table

Standard Reduction Potentials

Chemistry Paper 2 – Practice

Physics Paper 1 – Memoranda

Chemistry Paper 2 - Memoranda

## 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!

## How to use your Boost Prep Pack

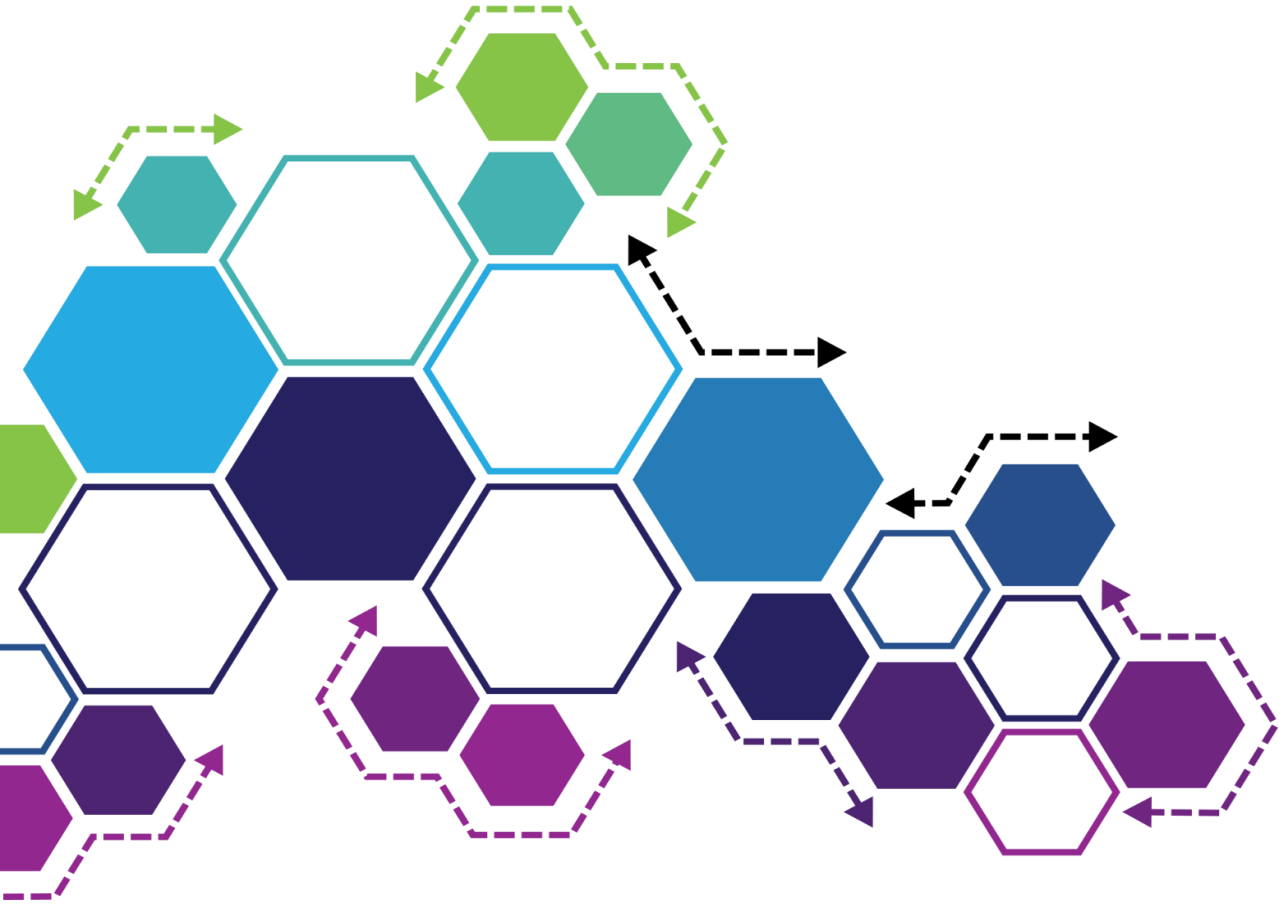
Your prep pack contains the Physical Science examination guidelines and exam papers with memoranda from 2014, 2016 to 2020. Work through the Boost Summary and Experiment Series on the Boost flash drive with your educator in class. This summarises the work according to the exam guidelines and CAPS and gives you handles on how to approach and tackle exam questions. Work through the series in class or in study groups. GATE and SLP learners, since you have your own flash drive, we encourage you to work on your own and gain confidence as you practice and recall your Physical Science knowledge and skills.

## STEM in ACTION…

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.

Due to COVID-19, STEM in ACTION has been unable to give learners and educators the full STEM experience which they are accustomed to at our laboratories on Missionvale Campus. This has resulted in a revised plan of action and the development and delivery of our Grade 12 Physical Science Boost Series. The team at STEM in ACTION has now found a way of reaching their target audience while still adhering to the protocols set by the authorities. The Boost Series will be a means of bringing the STEM in ACTION laboratories into your classroom and assisting you as you prepare for your Grade 12 Physical Science exams this year.

# 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:
  - 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.)
  - 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:
  - Increases in the direction of motion, e.g. 2nd stage rocket engine fires
  - Decreases, e.g. brakes are applied
  - 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:
  - An isolated system (in Physics): An isolated system is one on which the net external force acting on the system is zero.
  - 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, $\Delta x$ the magnitude of the displacement and $\theta$ 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.





**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: $E = \frac{F}{q}$

- 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).





**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.

## 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).

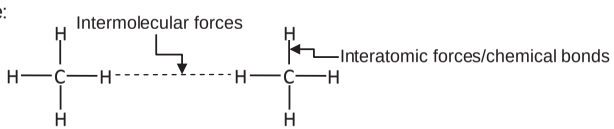
**Volume relationships in gaseous reactions**
- Interpret balanced equations in terms of volume relationships for gases, i.e. under the same conditions of temperature and pressure, equal number of moles of all gases occupy the same volume.

**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.



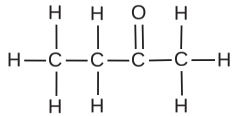


- Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.
  Boiling point:
  The temperature at which the vapour pressure equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
  Melting point:
  The temperature at which 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.

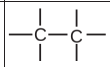
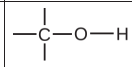
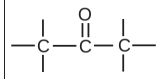
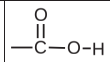
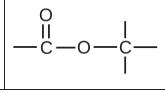


  - o Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.

$CH_3CH_2COCH_3$ OR $CH_3CH_2\overset{\overset{\displaystyle O}{\|}}{C}CH_3$

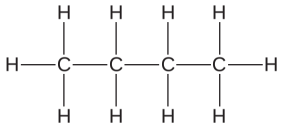
  - o Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.
  - o Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a $CH_2$ group
  - o Saturated compounds: Compounds in which there are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

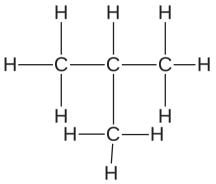
- o Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains
- o Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds

| 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 |  | - |

- o 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.
  - o Chain isomers: Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane

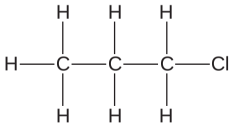

Butane

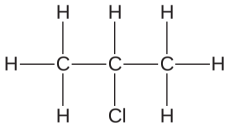

2-methylpropane

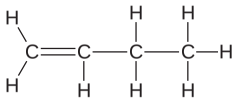


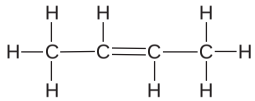


- o Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene

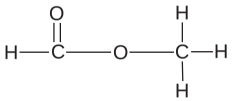

1-chloropropane

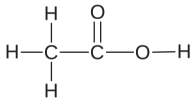

2-chloropropane


but-1-ene


but-2-ene

- o 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:
  - o Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
  - o Type of functional groups
  - o Chain length
  - o 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.
  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.)





**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

**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.





## 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.

## 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 ✓ $\left(\frac{2}{3}\right)$

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.





Example:

| CORRECT | ANSWER (1) | POSSIBLE | ANSWER (2) | POSSIBLE |
|---|---|---|---|---|
| $n = \frac{m}{M}$ ✓<br>$0{,}01$ ✓ $= \frac{m}{52}$ ✓<br>m = 0,52 g ✓<br>(4) | $n = \frac{m}{M}$ ✓<br>$0{,}01$ ✓ $= \frac{52}{m}$ ✗<br>m = 5 200 g ✗<br>(2) | $m = \frac{n}{M}$ ✗<br>$= \frac{0{,}01}{52}$<br>= 0,002 g<br>(0) | $n = \frac{m}{M}$ ✓<br>$m = \frac{M}{n}$ ✗<br>$= \frac{52}{0{,}01}$ ✓<br>= 5 200 g ✗<br>(3) | $n = \frac{m}{M}$ ✓<br>= 0,52 g ✓<br>(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

$H_2S \rightarrow S + 2H^+ + 2e^-$ $(2/2)$

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

$H_2S \rightleftharpoons S + 2H^+ + 2e^-$ $(1/2)$

$H_2S \leftarrow S + 2H^+ + 2e^-$ $(0/2)$

$S + 2H^+ + 2e^- \leftarrow H_2S$ $(2/2)$

$S + 2H^+ + 2e^- \rightleftharpoons H_2S$ $(0/2)$

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).

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 $E^{\theta}_{cell}$ ), 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. ✓ | $^{3}/_{3}$ |
| $N_2 + H_2 \rightarrow$ ✓ | | $^{1}/_{3}$ |
| $\rightarrow NH_3$ ✓ | | $^{1}/_{3}$ |
| $N_2 + H_2$ | | $^{0}/_{3}$ |
| $NH_3$ | | $^{0}/_{3}$ |

## 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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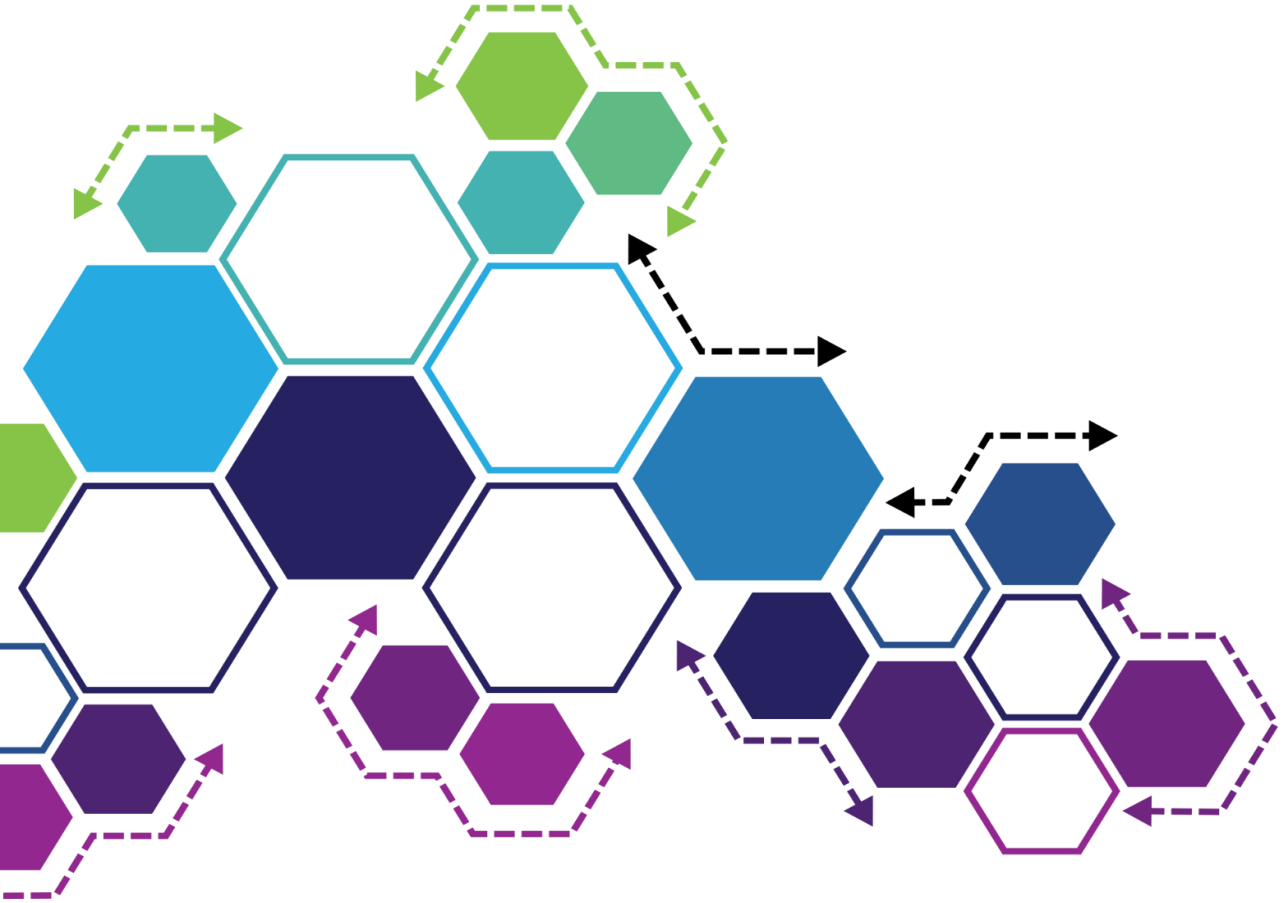
# Physics Data Sheets



**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 | $6,67 \times 10^{-11}\ N \cdot m^2 \cdot kg^{-2}$ |
| Speed of light in a vacuum | c | $3,0 \times 10^{8}\ m \cdot s^{-1}$ |
| Planck's constant | h | $6,63 \times 10^{-34}\ J \cdot s$ |
| Coulomb's constant | k | $9,0 \times 10^{9}\ N \cdot m^2 \cdot C^{-2}$ |
| Charge on electron | e | $-1,6 \times 10^{-19}\ C$ |
| Electron mass | $m_e$ | $9,11 \times 10^{-31}\ kg$ |

### 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 $n = \frac{Q}{q_e}$ | |

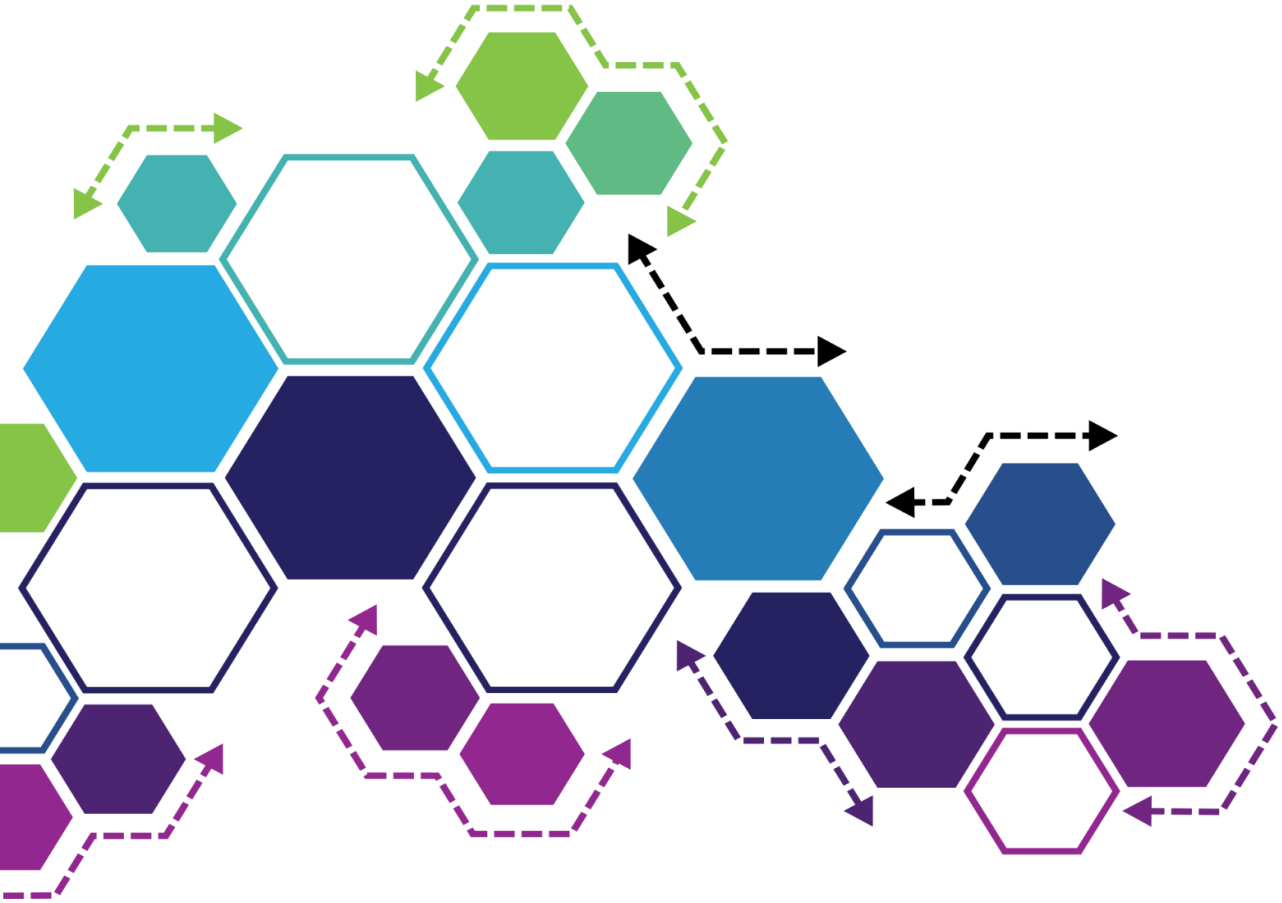
**ELECTRIC CIRCUITS**

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

**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/**
**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.**





**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 …

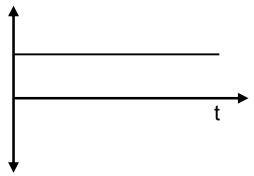
A $\frac{1}{2}g$

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)

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.

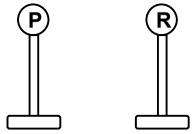
C greater than *f*.

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 …

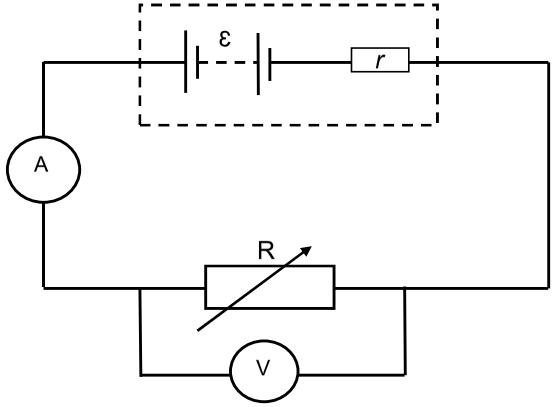
A 25.

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?

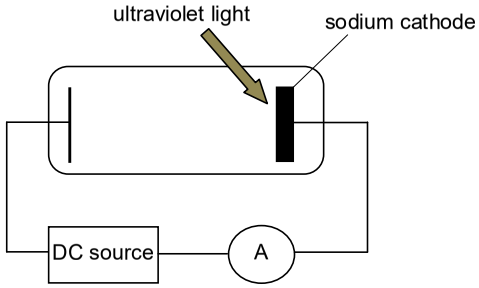
| | AMMETER READING | VOLTMETER READING |
|---|---|---|
| A | Decreases | Increases |
| B | Increases | Increases |
| C | Increases | Decreases |
| D | Decreases | Decreases |

(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.

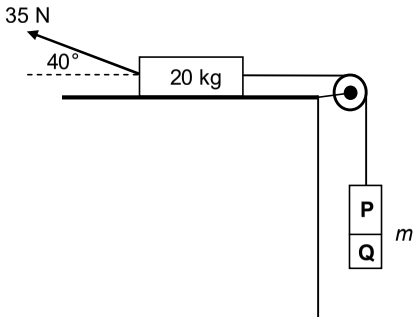
D Replace the sodium cathode with a cathode of lower work function. (2)

**[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]**

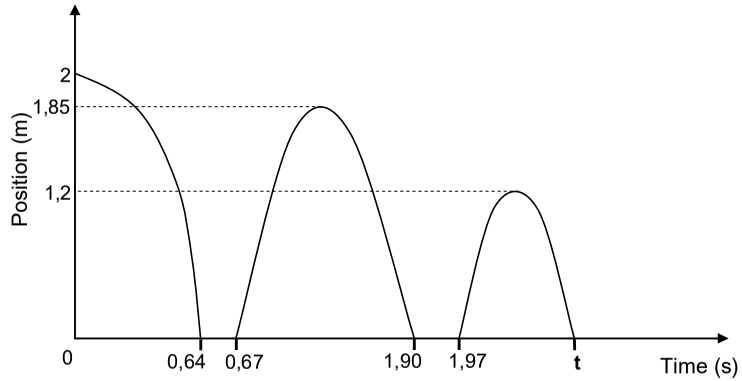




**QUESTION 3 (Start on a new page.)**

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)

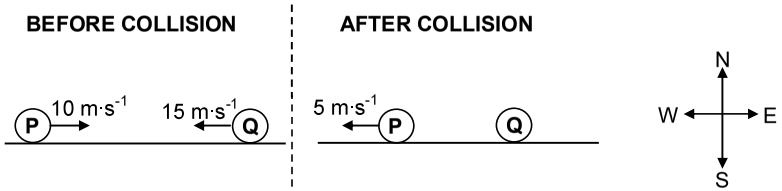
3.2.3 The speed at which the ball leaves the floor at the first bounce (3)

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]**



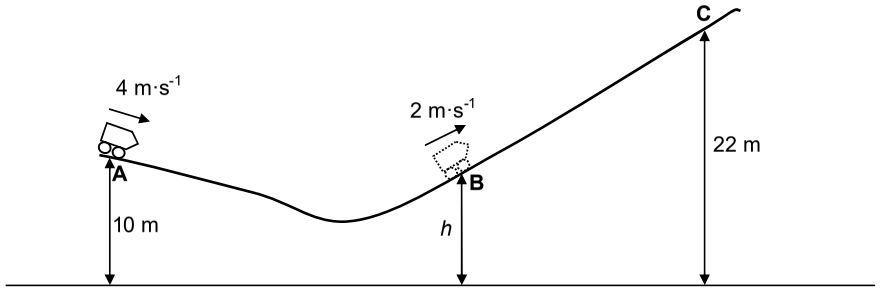


**QUESTION 5 (Start on a new page.)**

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)

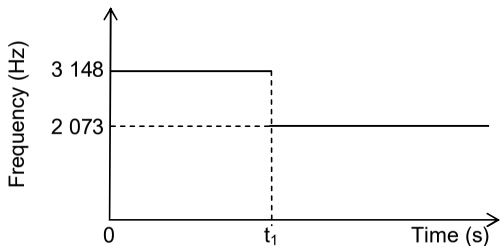
5.3 Use energy principles to calculate the height *h*. (4)

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.

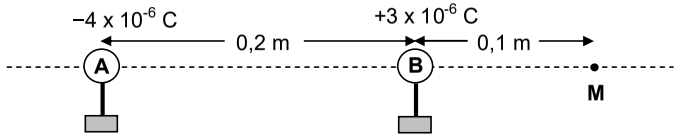
Calculate time $t_1$ indicated on the graph above. (2)
**[11]**





**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 $-4 \times 10^{-6}$ 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**.

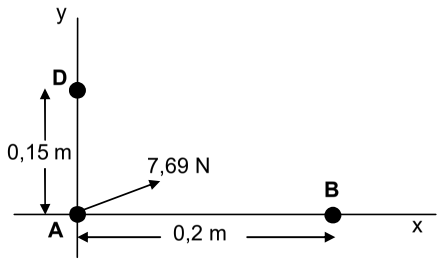
7.1 Calculate the number of electrons in excess on sphere **A**. (3)

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.

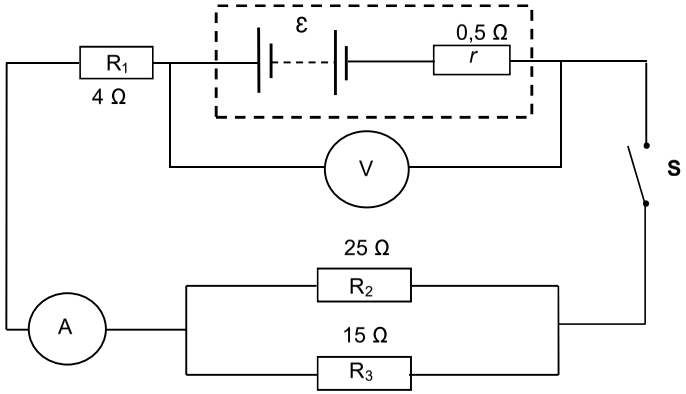
7.5 Is the charge on sphere **D** POSITIVE or NEGATIVE? (1)

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.

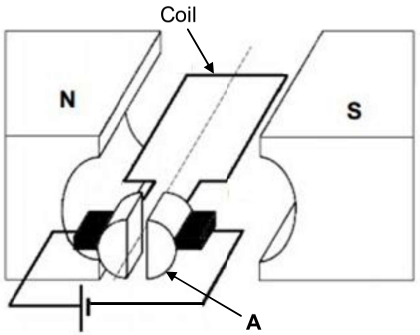
How will this affect the emf of the battery? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
**[18]**





**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)

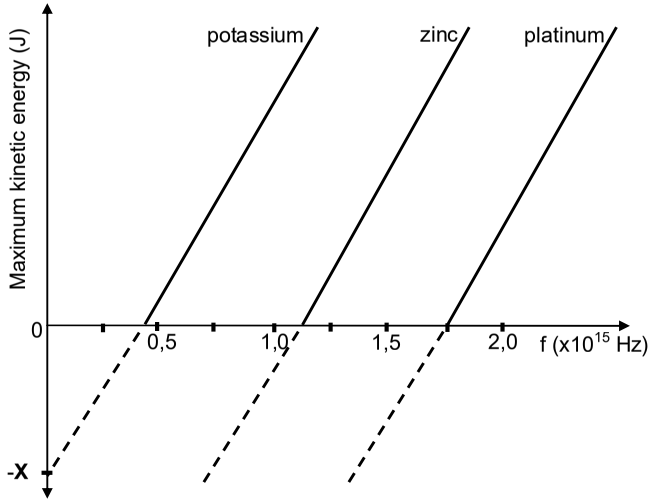
This device is now connected to a 150 V AC source.

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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**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**

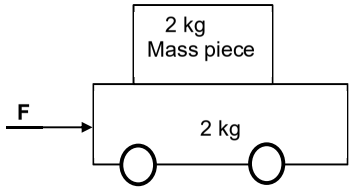
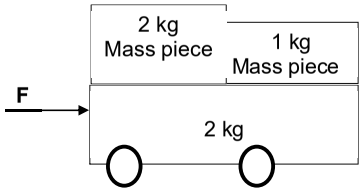



**FIGURE 2**




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

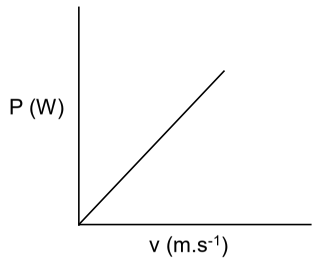
D $\frac{5}{4}$ a (2)

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.

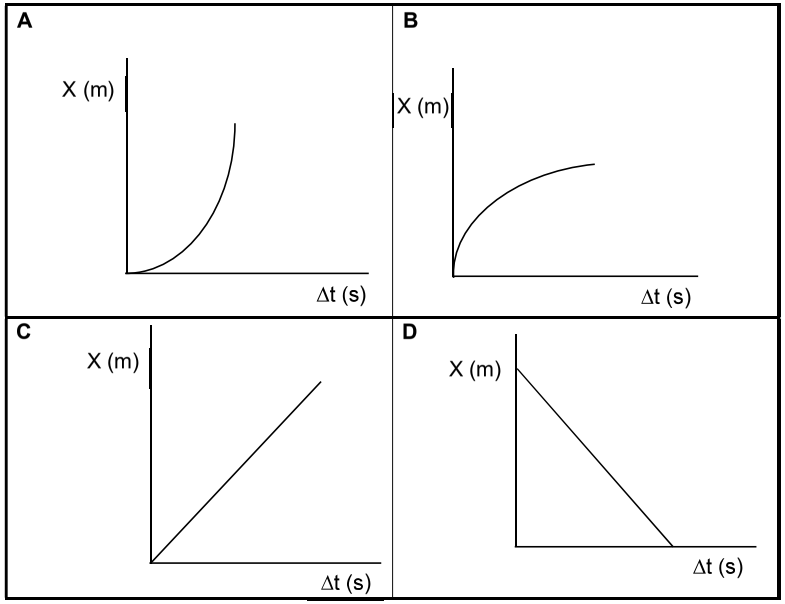
C kinetic energy of the car.

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.

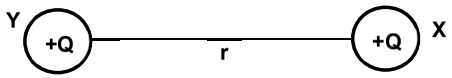
A Photoelectric effect

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**?

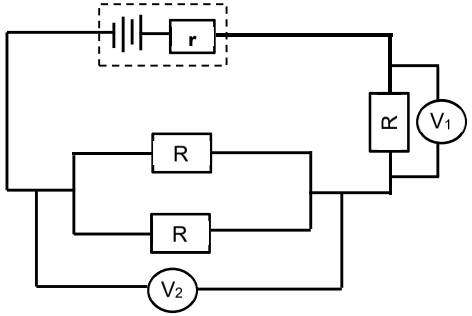
A 8 **r**

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

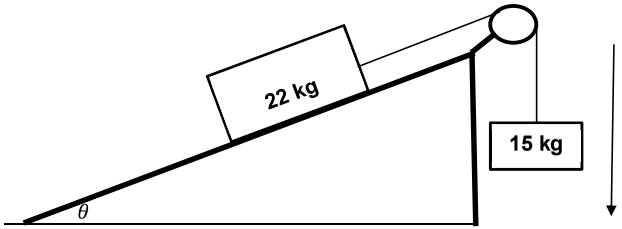
C (ii), (iii) and (iv) only

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 $\theta$ to the horizontal, the 15 kg block moves downwards *(as shown by the arrow alongside the diagram)* at a CONSTANT VELOCITY.

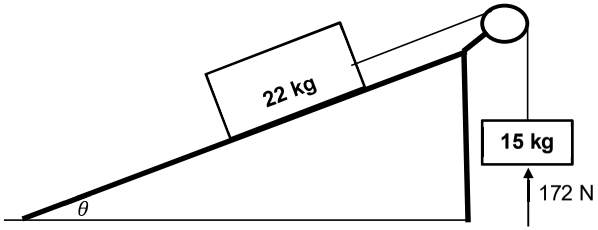



2.1 State Newton's Second Law of motion in words. (2)

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 $\theta$ 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)

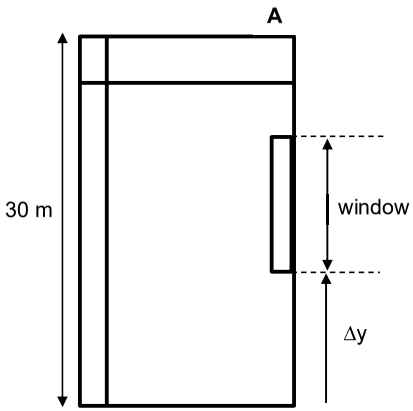
**[18]**





## 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 $\Delta y$, 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)

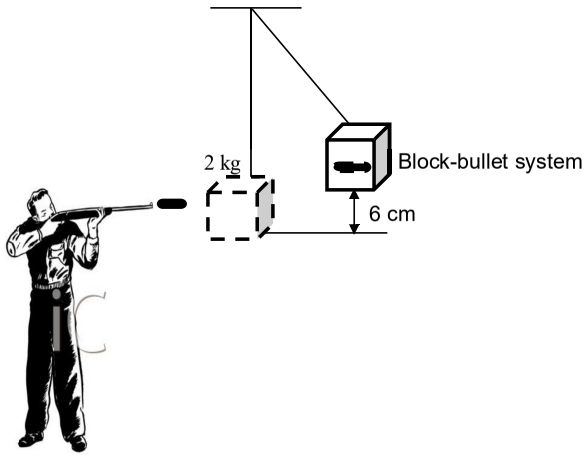
3.4 Velocity with which the ball bounced off the ground (4)

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)

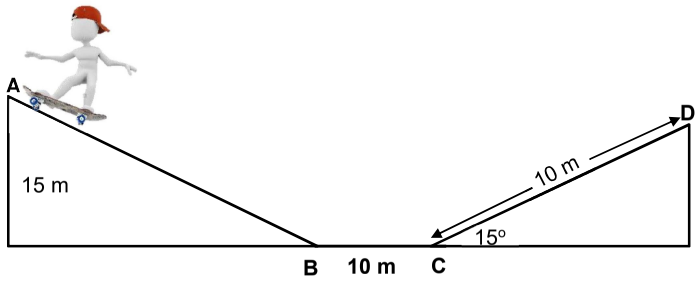
4.2.2 Recoil velocity of the gun (3)
**[10]**





## 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)

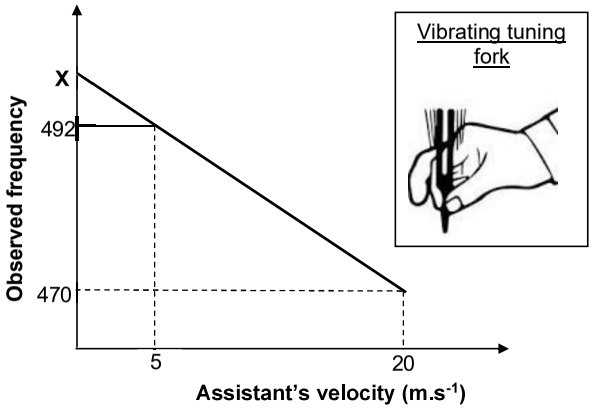
5.4 Use energy principles to calculate the:

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)

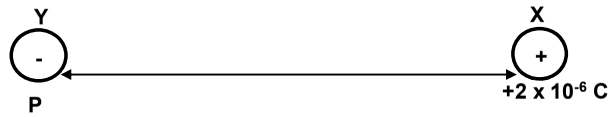
**[15]**





## 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)

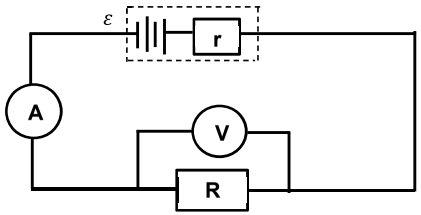
7.3.2 Distance between the charges before sphere **Y** moved (3)

7.3.3 Charge on sphere **Y** (4)

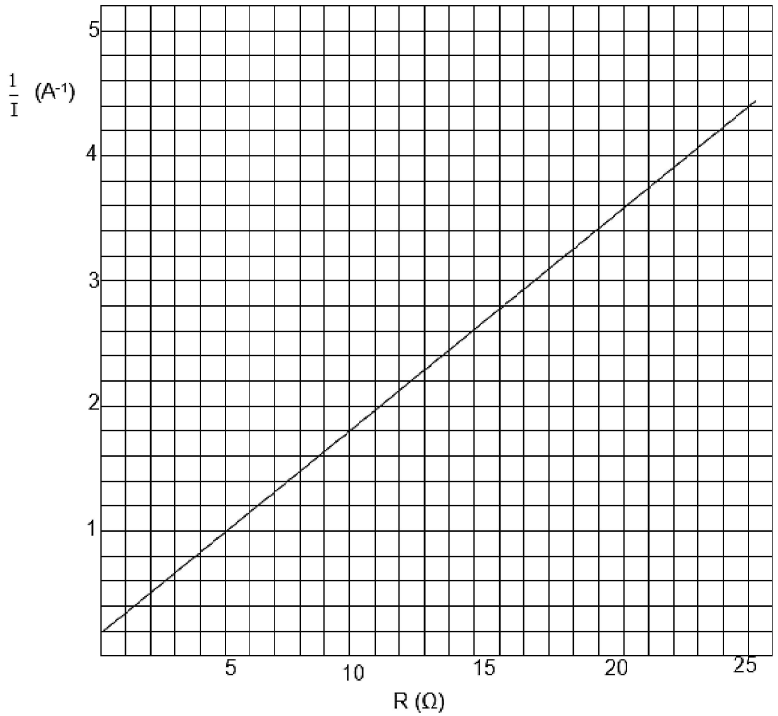
**[19]**

## QUESTION 8

In an experiment to determine the emf ($\varepsilon$) 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.







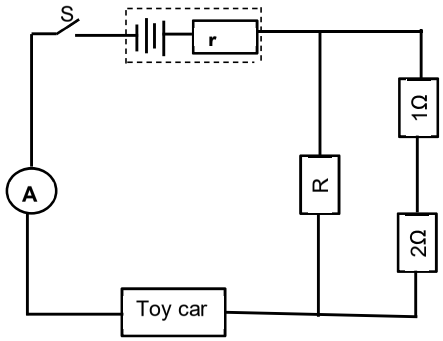

8.1 What is the independent variable for this experiment? (1)

8.2 Using the equation $\frac{1}{I} = \frac{R + r}{emf}$, calculate the:

8.2.1 Emf $\varepsilon$ 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)

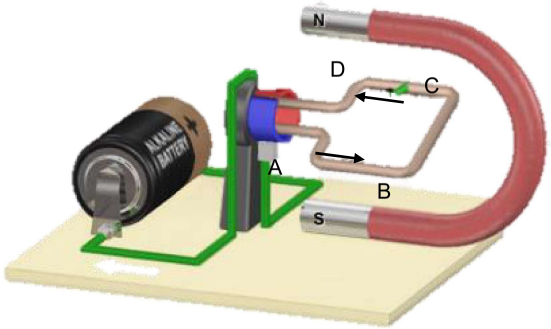
8.3.2 Resistance of resistor R (6)

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**

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2019**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 17 pages and 3 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, e.g. 1.11 E. Each question has only ONE correct answer.

1.1 Which physical quantity is equal to the rate of change of momentum?

A Mass

B Impulse

C Net force

D Acceleration (2)

1.2 The gravitational acceleration on the surface of a planet of radius $R$ is $g$.

The gravitational acceleration at a height of $2R$ above the surface of the same planet is …

A $\frac{g}{9}$

B $\frac{g}{4}$

C $4g$

D $9g$ (2)

1.3 A ball falls from the edge of a table. Ignore the effects of air friction.

Which ONE of the physical quantities associated with the ball during the fall remains constant?

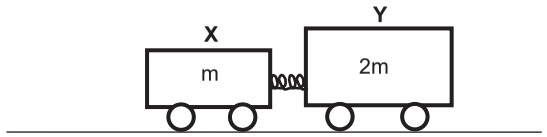
A Weight

B Momentum

C Kinetic energy

D Gravitational potential energy (2)

1.4 Two trolleys, **X** and **Y**, of masses m and 2m respectively, are held together by a compressed spring between them. Initially they are stationary on a horizontal floor, as shown below. Ignore the effects of friction.




The spring is now released and falls to the floor while the trolleys move apart.

The magnitude of the MOMENTUM of trolley **X** while it moves away is …

A zero.

B half the magnitude of the momentum of trolley **Y**.

C twice the magnitude of the momentum of trolley **Y**.

D the same as the magnitude of the momentum of trolley **Y**. (2)

1.5 An object is dropped from rest and after falling a distance $x$, its momentum is $p$. Ignore the effects of air friction.

The momentum of the object, after it has fallen a distance $2x$, is …

A $p$

B $\sqrt{2}p$

C $\frac{p}{2}$

D $2p$ (2)

1.6 A police car, with its siren on, is travelling at a constant speed TOWARDS a stationary sound detector. The siren emits sound waves of frequency $f$ and speed $v$.

Which ONE of the following combinations best describes the frequency and speed of the detected sound waves?

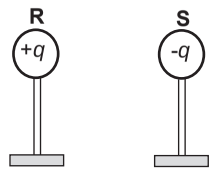
| | FREQUENCY | SPEED |
|---|---|---|
| A | Less than $f$ | $v$ |
| B | Less than $f$ | Less than $v$ |
| C | Greater than $f$ | Less than $v$ |
| D | Greater than $f$ | $v$ |

(2)





1.7 Two identical spheres, **R** and **S**, on insulated stands, carrying charges of $+q$ and $-q$ respectively, are placed a distance apart. Sphere **R** exerts an electrostatic force of magnitude $F$ on sphere **S**.




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

The magnitude of the electrostatic force that sphere **R** exerts on sphere **S** is now …

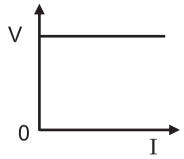
A zero

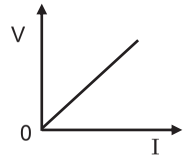
B $\frac{F}{2}$

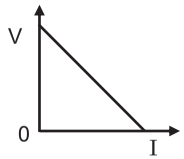
C $F$

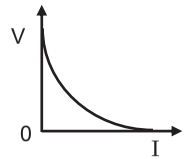
D $2F$ (2)

1.8 Which ONE of the graphs below best represents the relationship between potential difference (V) and current (I) for an ohmic conductor?

A



B



C



D



(2)

1.9 Which ONE of the following combinations regarding the energy conversions in electric motors and electric generators is CORRECT?

| | ENERGY CONVERSION IN MOTORS | ENERGY CONVERSION IN GENERATORS |
|---|---|---|
| A | Mechanical to electrical | Electrical to mechanical |
| B | Mechanical to electrical | Mechanical to electrical |
| C | Electrical to mechanical | Electrical to mechanical |
| D | Electrical to mechanical | Mechanical to electrical |

(2)

1.10 Consider the statements below regarding the photoelectric effect.

The photoelectric effect proves that …

(i) light energy is quantised.

(ii) light has a particle nature.

(iii) light has a wave nature.

Which of the statements above is/are CORRECT?

A (i) only

B (ii) only

C (i) and (ii) only

D (i) and (iii) only (2)
**[20]**



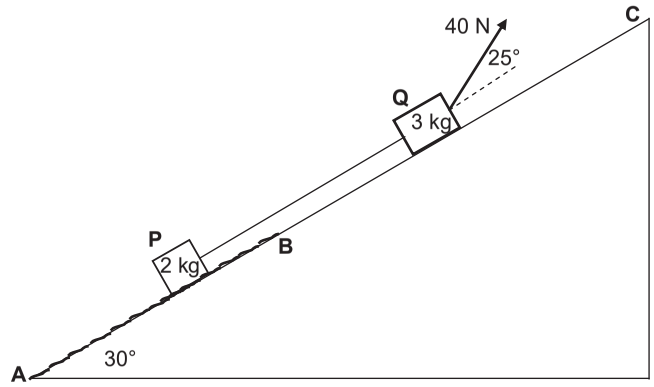


**QUESTION 2 (Start on a new page.)**

Block **P**, of mass 2 kg, is connected to block **Q**, of mass 3 kg, by a light inextensible string. Both blocks are on a plane inclined at an angle of 30° to the horizontal.

Block **Q** is pulled by a constant force of 40 N at an angle of 25° to the incline.

Block **P** moves on a rough section, **AB**, of the incline, while block **Q** moves on a frictionless section, **BC**, of the incline. See diagram below.




An average constant frictional force of 2,5 N acts on block **P** as it moves from **A** to **B** up the incline.

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

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

2.3 Calculate the magnitude of the acceleration of block **P** while block **P** is moving on section **AB**. (8)

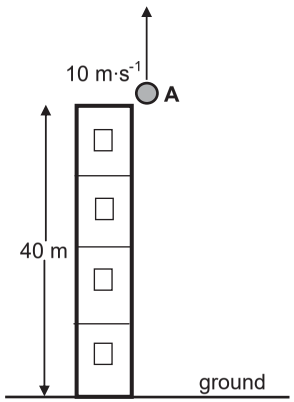
2.4 If block **P** has now passed point **B**, how will its acceleration compare to that calculated in QUESTION 2.3? Choose from GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (2)
**[16]**

**QUESTION 3 (Start on a new page.)**

Stone **A** is thrown vertically upwards with a speed of 10 m·s$^{-1}$ from the edge of the roof of a 40 m high building, as shown in the diagram below.

Ignore the effects of air friction. Take the ground as reference.




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

3.2 Calculate the maximum HEIGHT ABOVE THE GROUND reached by stone **A**. (4)

3.3 Write down the magnitude and direction of the acceleration of stone **A** at this maximum height. (2)

Stone **B** is dropped from rest from the edge of the roof, x seconds after stone **A** was thrown upwards.

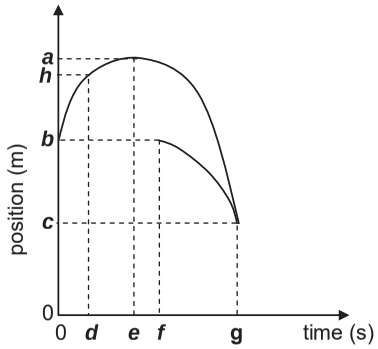
3.4 Stone **A** passes stone **B** when the two stones are 29,74 m *above the ground*.

Calculate the value of x. (6)





3.5 The graphs of position versus time for part of the motion of both stones are shown below.




Which of labels ***a*** to ***h*** on the graphs above represents EACH of the following?

3.5.1 The time at which stone **A** has a positive velocity (1)

3.5.2 The maximum height reached by stone **A** (1)

3.5.3 The time when stone **B** was dropped (1)

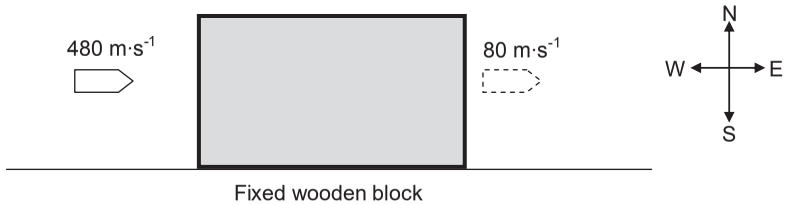
3.5.4 The height at which the stones pass each other (1)
**[18]**

**QUESTION 4 (Start on a new page.)**

A bullet moves east at a velocity of 480 $m \cdot s^{-1}$. It hits a wooden block that is fixed to the floor. The bullet takes 0,01 s to move through the stationary block and emerges from the block at a velocity of 80 $m \cdot s^{-1}$ east. See the diagram below.

Ignore the effects of air resistance.

Consider the block-bullet system as an isolated system.




4.1 Explain what is meant by an *isolated system* as used in Physics. (2)

The magnitude of the momentum of the bullet before it enters the block is 24 $kg \cdot m \cdot s^{-1}$.

4.2 Calculate the:

4.2.1 Mass of the bullet (3)

4.2.2 Average net force exerted by the wooden block on the bullet (5)
**[10]**

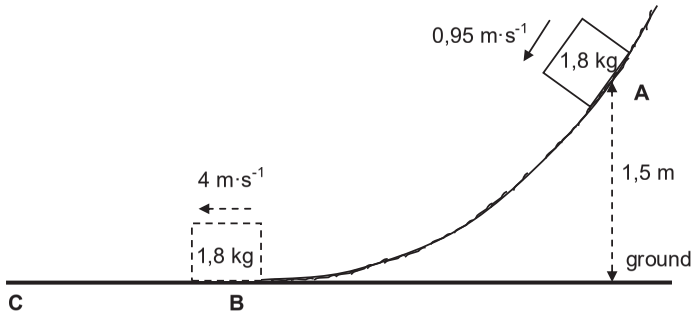




**QUESTION 5 (Start on a new page.)**

An object of mass 1,8 kg slides down a rough curved track and passes point **A**, which is 1,5 m above the ground, at a speed of 0,95 $m \cdot s^{-1}$.

The object reaches point **B** at the bottom of the track at a speed of 4 $m \cdot s^{-1}$.




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

5.2 Name the conservative force acting on the object. (1)

5.3 Is mechanical energy conserved as the object slides from point **A** to point **B**? Choose from YES or NO. Give a reason for the answer. (2)

5.4 Calculate the gravitational potential energy of the object when it was at point **A**. (3)

5.5 Using energy principles, calculate the work done by friction on the object as it slides from point **A** to point **B**. (4)

Surface **BC** in the diagram above is frictionless.

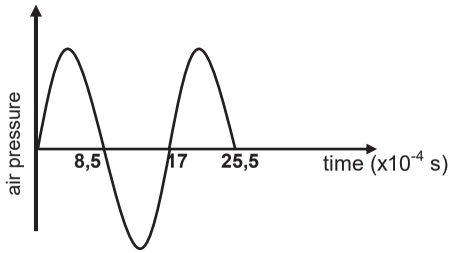
5.6 What is the value of the net work done on the object as it slides from point **B** to point **C**? (1)
**[13]**

**QUESTION 6 (Start on a new page.)**

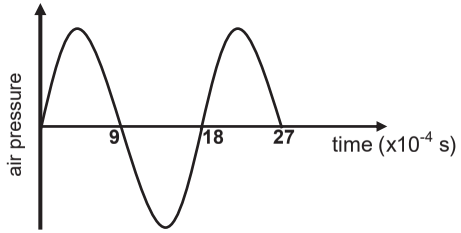
The siren of a police car, which is travelling at a constant speed along a straight horizontal road, emits sound waves of constant frequency. Detector **P** is placed inside the police car and detector **Q** is placed next to the road at a certain distance away from the car. The two detectors record the changes in the air pressure readings caused by the sound waves emitted by the siren as a function of time.

The graphs below were obtained from the recorded results.

**GRAPH A: AIR PRESSURE VS TIME RECORDED BY DETECTOR P IN THE CAR**




**GRAPH B: AIR PRESSURE VS TIME RECORDED BY DETECTOR Q NEXT TO THE ROAD**




6.1 Different patterns are shown above for the same sound wave emitted by the siren. What phenomenon is illustrated by the two detectors showing the different patterns? (1)

The police car is moving AWAY from detector **Q**.

6.2 Use the graphs and give a reason why it can be confirmed that the police car is moving away from detector **Q**. (1)

6.3 Calculate the frequency of the sound waves recorded by detector **P**. (3)

6.4 Use the information in the graphs to calculate the speed of the police car. Take the speed of sound in air as 340 m·s$^{-1}$. (6)
**[11]**

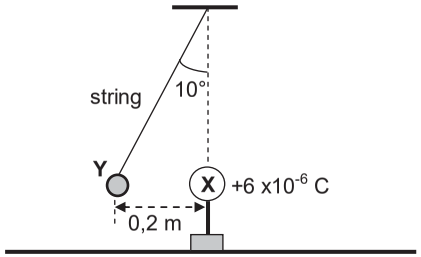




**QUESTION 7 (Start on a new page.)**

7.1 A small sphere, **Y**, carrying an unknown charge, is suspended at the end of a light inextensible string which is attached to a fixed point. Another sphere, **X**, carrying a charge of +6 x10$^{-6}$ C, on an insulated stand is brought close to sphere **Y**.

Sphere **Y** experiences an electrostatic force and comes to rest 0,2 m away from sphere **X**, with the string at an angle of 10° with the vertical, as shown in the diagram below.



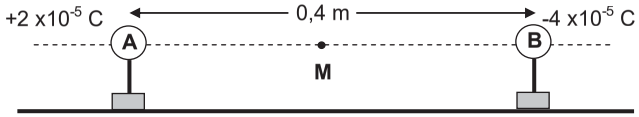

7.1.1 What is the nature of the charge on sphere **Y**? Choose from POSITIVE or NEGATIVE. (1)

7.1.2 Calculate the magnitude of the charge on sphere **Y** if the magnitude of the electrostatic force acting on it is 3,05 N. (3)

7.1.3 Draw a labelled free-body diagram for sphere **Y**. (3)

7.1.4 Calculate the magnitude of the tension in the string. (3)

7.2 Two small charged spheres, **A** and **B**, on insulated stands, with charges +2 x10$^{-5}$ C and -4 x10$^{-5}$ C respectively, are placed 0,4 m apart, as shown in the diagram below. **M** is the midpoint between spheres **A** and **B**.



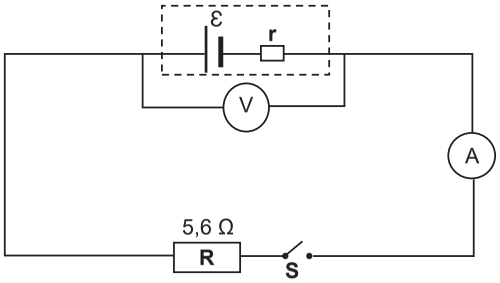

7.2.1 Define the term *electric field at a point*. (2)

7.2.2 Calculate the net electric field at point **M**. (6)
**[18]**

**QUESTION 8 (Start on a new page.)**

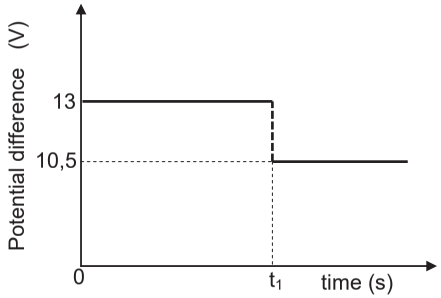
In the circuit diagram below, resistor **R**, with a resistance of 5,6 Ω, is connected, together with a switch, an ammeter and a high-resistance voltmeter, to a battery with an unknown internal resistance, **r**.

The resistance of the connecting wires and the ammeter may be ignored.




The graph below shows the potential difference across the terminals of the battery as a function of time.

At time $t_1$, switch **S** is closed.




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

8.2 Write down the value of the emf of the battery. (1)

8.3 When switch **S** is CLOSED, calculate the:

8.3.1 Current through resistor **R** (3)

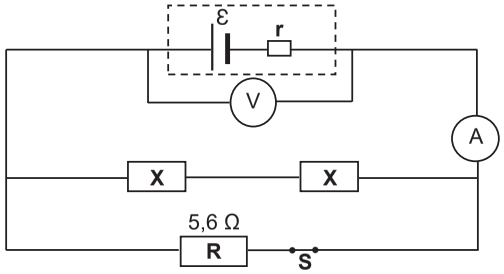
8.3.2 Power dissipated in resistor **R** (3)

8.3.3 Internal resistance, **r**, of the battery (3)





8.4 Two IDENTICAL resistors, each with resistance **X**, are now connected in the same circuit with switch **S** closed, as shown below.




The ammeter reading now increases to 4 A.

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

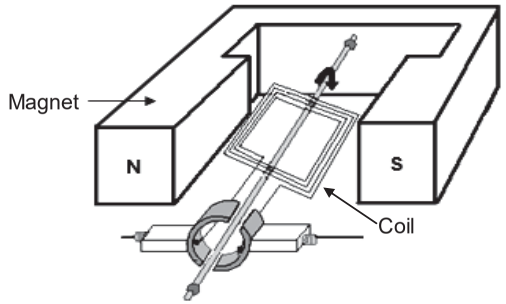
Give a reason for the answer by referring to $V_{\text{internal resistance}}$. (2)

8.4.2 Calculate resistance **X**. (5)

**[19]**

**QUESTION 9 (Start on a new page.)**

9.1 A simplified diagram of an electric generator is shown below. When the coil is rotated with a constant speed, an emf is induced in the coil.




9.1.1 Is this an AC generator or a DC generator? (1)

9.1.2 Briefly explain how an emf is generated in the coil when the coil is rotated by referring to the principle of electromagnetic induction. (2)

9.1.3 Draw a sketch graph of the output voltage versus time for this generator. Show ONE complete cycle. (2)

9.2 A 200 Ω resistor is connected to a DC voltage supply, as shown in diagram **A**. The energy dissipated in the resistor in 10 s is 500 J.

The same resistor is now connected to an AC source (diagram **B**) and 500 J of energy is also dissipated in the resistor in 10 s.

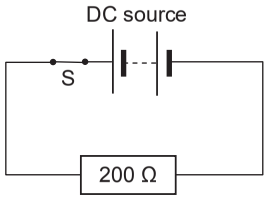



Diagram **A**

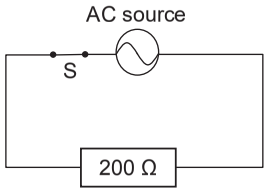



Diagram **B**

9.2.1 Define the term *rms voltage* of an AC source. (2)

9.2.2 Calculate the maximum (peak) voltage of the AC source. (5)
**[12]**



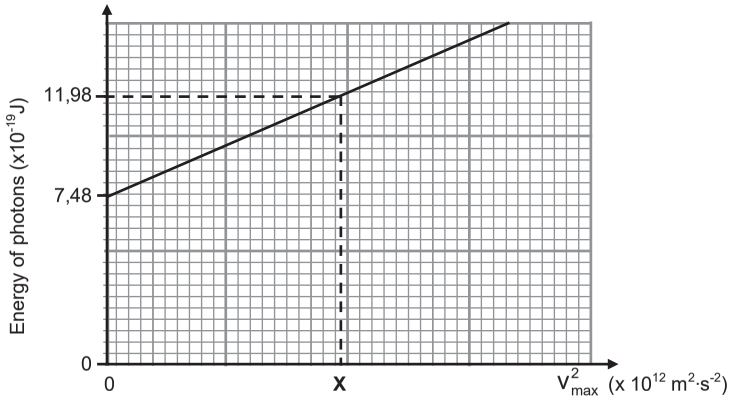


**QUESTION 10 (Start on a new page.)**

During an experiment, light of different frequencies is radiated onto a silver cathode of a photocell and the corresponding maximum speed of the ejected photoelectrons are measured.

A graph of the energy of the incident photons versus the square of the maximum speed of the ejected photoelectrons is shown below.

**Graph of energy of photons versus square of maximum speed of photoelectrons**




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

Use the graph to answer the following questions.

10.2 Write down the value of the work function of silver.

Use a relevant equation to justify the answer. (3)

10.3 Which physical quantity can be determined from the gradient of the graph? (1)

10.4 Calculate the value of **X** as shown on the graph. (5)

The experiment above is now repeated using light of higher intensity.

10.5 How will EACH of the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

10.5.1 The gradient of the graph (1)

10.5.2 The number of photoelectrons emitted per unit time (1)
**[13]**

**TOTAL: 150**

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2018**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 15 pages and 3 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, e.g. 1.11 D.

1.1 Inertia is the tendency of an object to …

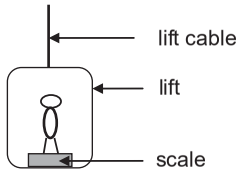
A maintain its mass.

B continue in a state of non-uniform motion.

C remain at rest or in the state of uniform motion.

D maintain its velocity when a non-zero net force is acting on it. (2)

1.2 A person stands on a bathroom scale that is fixed to the floor of a lift, as shown in the diagram below.




The reading on the scale is largest when the lift moves …

A upwards at a constant speed.

B downwards at a constant speed.

C upwards at a increasing speed.

D downwards at a increasing speed. (2)

1.3 An object is projected vertically upwards. Ignore air resistance.

As the object rises, its velocity …

A and acceleration are both directed upwards.

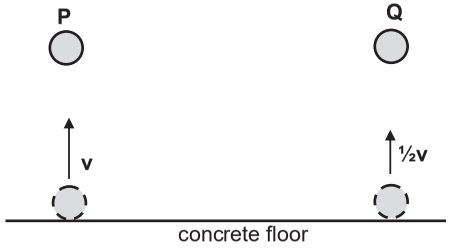
B and acceleration are both directed downwards.

C is directed upwards, but its acceleration is directed downwards.

D is directed downwards, but its acceleration is directed upwards. (2)

1.4 Ball **P** and ball **Q**, of the same mass, are dropped onto a concrete floor. Both balls hit the concrete floor at the same speed, **v**. Ball **P** rebounds with the same vertical speed, **v**, *but ball **Q** rebounds with speed ½**v***.

Refer to the diagram below. Ignore air resistance.




Which ONE of the following statements regarding the collision of EACH ball with the concrete floor is CORRECT?

A Kinetic energy is conserved for both balls **P** and **Q**.

B The change in momentum of ball **P** is greater than that of ball **Q**.

C The contact time with the floor is the same for both balls **P** and **Q**.

D Momentum is conserved for the collision of ball **P**, but not for that of ball **Q**. (2)

1.5 If the net work done on a moving object is POSITIVE, then we can conclude that the kinetic energy of the object …

A is zero.

B has increased.

C has decreased.

D has not changed. (2)

1.6 The spectrum produced by a moving asteroid, as observed from Earth, indicates that the light has shifted towards the blue end of the spectrum.

Which ONE of the following frequency combinations of the observed light and the distance between the asteroid and Earth is CORRECT?

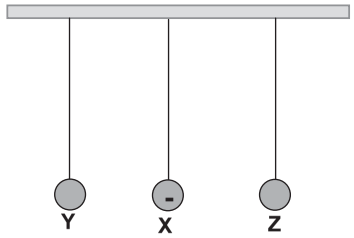
| | FREQUENCY OF OBSERVED LIGHT | DISTANCE BETWEEN ASTEROID AND EARTH |
|---|---|---|
| A | Increased | Decreases |
| B | Increased | Increases |
| C | Decreased | Decreases |
| D | Decreased | Increases |

(2)





1.7 Three charged spheres **X**, **Y** and **Z**, supported by insulating threads of equal length, hang from a beam, as shown in the diagram below.
Sphere **X** is negatively charged.
Sphere **X** attracts sphere **Y**, but repels sphere **Z**.




Which ONE of the following conclusions is CORRECT?

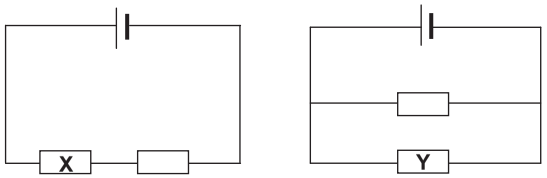
A Sphere **Y** is positively charged and sphere **Z** is negatively charged.

B Sphere **Y** is positively charged and sphere **Z** is positively charged.

C Sphere **Y** is negatively charged and sphere **Z** is negatively charged.

D Sphere **Y** is negatively charged and sphere **Z** is positively charged. (2)

1.8 In the circuit diagrams below, the cells and resistors are identical. The cells have negligible internal resistances.




The power dissipated in resistor **X** is **P**. The power dissipated in resistor **Y** is …

A ¼**P**.

B ½**P**.

C 2**P**.

D 4**P**. (2)

1.9 Which ONE of the following actions will NOT cause an **increase** in the induced emf in a coil if the coil is rotated in a uniform magnetic field?

A Rotating the coil faster

B Increasing the strength of the magnetic field

C Increasing the number of turns of the coil

D Replacing the coil with a coil of lower resistance (2)

1.10 A learner writes the following statements about the emission spectrum of light in a notebook:

(i) An emission spectrum is formed when certain frequencies of electromagnetic radiation pass through a cold gas.

(ii) The lines in the emission spectrum of an atom have the same frequency as the corresponding lines in the atom's absorption spectrum.

(iii) An emission spectrum is formed when the atom makes transitions from a high-energy state to a lower energy state.

Which ONE of the following combinations of the statements above is CORRECT?

A (i) only

B (ii) only

C (ii) and (iii) only

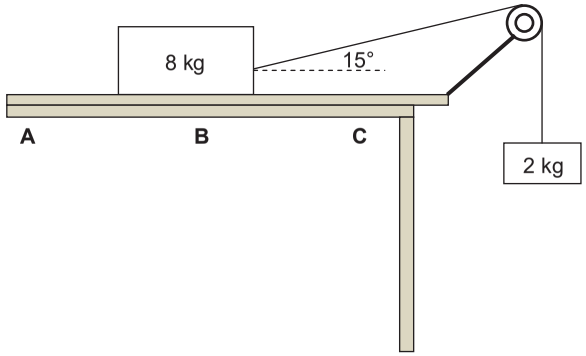
D (i) and (iii) only (2)
**[20]**





**QUESTION 2 (Start on a new page.)**

A block, of mass 8 kg, is placed on a rough horizontal surface. The 8 kg block, which is connected to a 2 kg block by means of a light inextensible string passing over a light frictionless pulley, starts sliding from point **A**, as shown below.




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

2.2 Draw a labelled free-body diagram for the 8 kg block. (4)

2.3 When the 8 kg block reaches point **B**, the angle between the string and the horizontal is 15° and the acceleration of the system is 1,32 $m \cdot s^{-2}$.

2.3.1 Give a reason why the system is NOT in equilibrium. (1)

2.3.2 Use the 2 kg mass to calculate the tension in the string. (3)

2.3.3 Calculate the kinetic frictional force between the 8 kg block and the horizontal surface. (4)

2.4 As the 8 kg block moves from **B** to **C**, the kinetic frictional force between the 8 kg block and the horizontal surface is not constant.

Give a reason for this statement. (1)

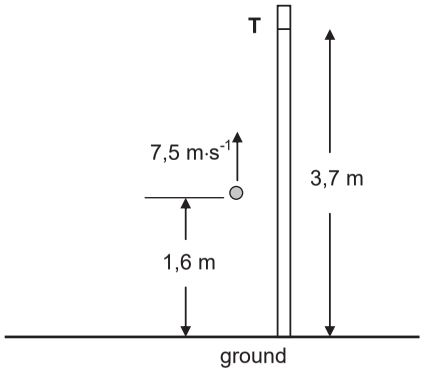
The horizontal surface on which the 8 kg block is moving, is replaced by another horizontal surface made from a different material.

2.5 Will the kinetic frictional force, calculated in QUESTION 2.3.3 above, change? Choose from: YES or NO. Give a reason for the answer. (2)
**[17]**

**QUESTION 3 (Start on a new page.)**

In a competition, participants must attempt to throw a ball vertically upwards past point **T**, marked on a tall vertical pole. Point **T** is 3,7 m above the ground. Point **T** may, or may not, be the highest point during the motion of the ball.

One participant throws the ball vertically upwards at a velocity of 7,5 $m \cdot s^{-1}$ from a point that is 1,6 m above the ground, as shown in the diagram below. Ignore the effects of air resistance.




3.1 In which direction is the net force acting on the ball while it moves towards point **T**?
Choose from: UPWARDS or DOWNWARDS. Give a reason for the answer. (2)

3.2 Calculate the time taken by the ball to reach its highest point. (3)

3.3 Determine, by means of a calculation, whether the ball will pass point **T** or not. (6)

3.4 Draw a velocity-time graph for the motion of the ball from the instant it is thrown upwards until it reaches its highest point.

Indicate the following on the graph:

- The initial velocity and final velocity
- Time taken to reach the highest point (2)

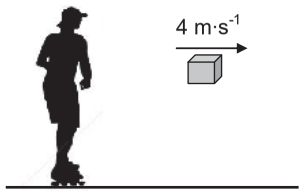
**[13]**





**QUESTION 4 (Start on a new page.)**

Initially a girl on roller skates is at rest on a smooth horizontal pavement. The girl throws a parcel, of mass 8 kg, horizontally to the right at a speed of 4 $m \cdot s^{-1}$. Immediately after the parcel has been thrown, the girl-roller-skate combination moves at a speed of 0,6 $m \cdot s^{-1}$. Ignore the effects of friction and rotation.




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

4.2 Will the girl-roller-skate combination move TO THE RIGHT or TO THE LEFT after the parcel is thrown?
NAME the law in physics that can be used to explain your choice of direction. (2)

The total mass of the roller skates is 2 kg.

4.3 Calculate the mass of the girl. (5)

4.4 Calculate the magnitude of the impulse that the girl-roller-skate combination is experiencing while the parcel is being thrown. (3)

4.5 Without any further calculation, write down the change in momentum experienced by the parcel while it is being thrown. (2)

**[14]**

**QUESTION 5 (Start on a new page.)**

The diagram below, not drawn to scale, shows a vehicle with a mass of 1 500 kg starting from rest at point **A** at the bottom of a rough incline. Point **B** is 200 m vertically above the horizontal.

The total work done by force **F** that moves the vehicle from point **A** to point **B** in 90 s is 4,80 x $10^6$ J.

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

5.2 Is force **F** a conservative force? Choose from: YES or NO. (1)

5.3 Calculate the average power generated by force **F**. (3)

The speed of the vehicle when it reaches point **B** is 25 m·$s^{-1}$.

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

5.5 Use **energy principles** to calculate the total work done on the vehicle by the frictional forces. (5)
**[13]**

**QUESTION 6 (Start on a new page.)**

The alarm of a vehicle parked next to a straight horizontal road goes off, emitting sound with a wavelength of 0,34 m. A patrol car is moving at a constant speed on the same road. The driver of the patrol car hears a sound with a frequency of 50 Hz **lower than** the sound emitted by the alarm. Take the speed of sound in air as 340 m·$s^{-1}$.

6.1 State the Doppler effect in words. (2)

6.2 Is the patrol car driving TOWARDS or AWAY FROM the parked vehicle? Give a reason for the answer. (2)

6.3 Calculate the frequency of the sound emitted by the alarm. (3)

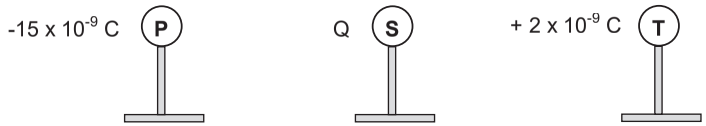
6.4 The patrol car moves a distance of *x* metres in 10 seconds. Calculate the distance *x*. (6)
**[13]**





**QUESTION 7 (Start on a new page.)**

Three small identical metal spheres, **P**, **S** and **T**, on insulated stands, are **initially neutral**. They are then charged to carry charges of -15 x $10^{-9}$ C, Q and +2 x $10^{-9}$ C respectively, as shown below.

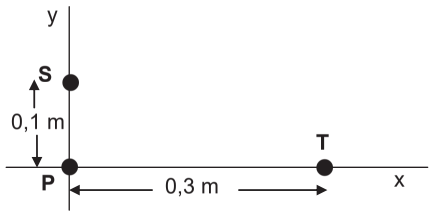



The charged spheres are brought together so that all three spheres touch each other at the same time, and are then separated. The charge on each sphere, after separation, is -3 x $10^{-9}$ C.

7.1 Determine the value of charge Q. (2)

7.2 Draw the electric field pattern associated with the charged spheres, **S** and **T**, **after they are separated** and returned to their original positions. (3)

The spheres, each with the **new charge** of -3 x $10^{-9}$ C, are now placed at points on the *x*-axis and the *y*-axis, as shown in the diagram below, with sphere **P** at the origin.




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

Calculate the magnitude of the:

7.4 Net electrostatic force acting on sphere **P** (5)

7.5 Net electric field at the origin due to charges **S** and **T** (3)

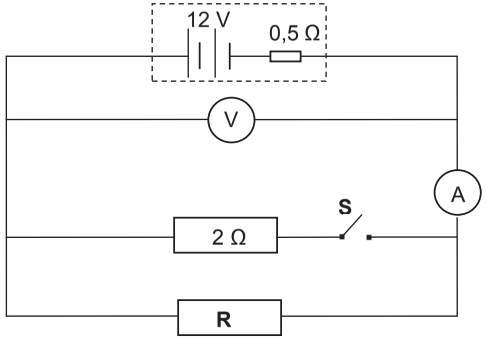
7.6 ONE of the charged spheres, **P** and **T**, experienced a very small increase in mass **after it was charged initially**.

7.6.1 Which sphere, **P** or **T**, experienced this very small increase in mass? (1)

7.6.2 Calculate the increase in mass by the sphere in QUESTION 7.6.1. (3)
**[19]**

**QUESTION 8 (Start on a new page.)**

The battery in the circuit diagram below has an emf of 12 V and an internal resistance of 0,5 Ω. Resistor **R** has an unknown resistance.




8.1 What is the meaning of the following statement?

The emf of the battery is 12 V. (2)

The reading on the ammeter is 2 A when switch **S** is OPEN.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

8.2.2 Resistance of resistor **R** (2)

Switch **S** is now CLOSED.

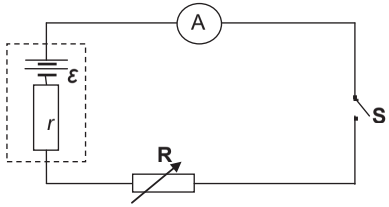
8.3 How does this change affect the reading on the voltmeter? Choose from: INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (4)
**[11]**



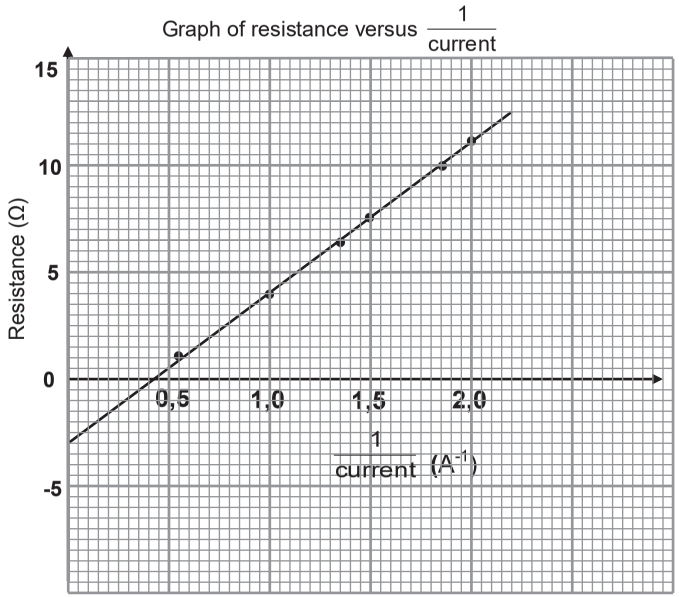


**QUESTION 9 (Start on a new page.)**

Learners perform an experiment to determine the emf (ε) and the internal resistance (*r*) of a battery using the circuit below.




The learners use their recorded readings of current and resistance, together with the equation $R = \frac{\varepsilon}{I} - r$, to obtain the graph below.




9.1 Which variable has to be kept constant in the experiment? (1)

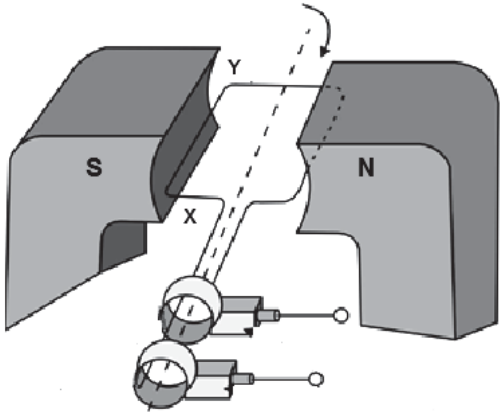
9.2 Refer to the **graph**.

9.2.1 Write down the value of the internal resistance of the cell. (2)

9.2.2 Calculate the emf of the battery. (3)
**[6]**

**QUESTION 10 (Start on a new page.)**

10.1 In the simplified AC generator below, the coil is rotated clockwise.



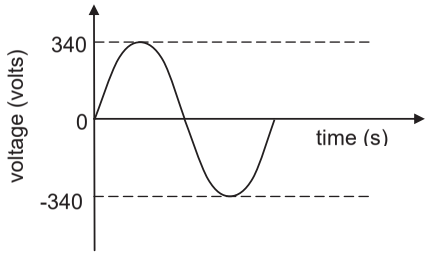

10.1.1 In which direction does the induced current flow in the coil?

Choose from: **X to Y** or **Y to X**. (1)

10.1.2 On which principle or law is the working of the generator based? (1)

10.1.3 State the energy conversion that takes place while the generator is in operation. (2)

10.2 The voltage output for an AC generator is shown below.




10.2.1 Write down the maximum (peak) output voltage of the generator. (1)

A stove is connected to the generator above, and delivers an average power of 1 600 W.

10.2.2 Calculate the rms voltage delivered to the stove. (3)

10.2.3 Calculate the resistance of the stove. (3)
**[11]**





**QUESTION 11 (Start on a new page.)**

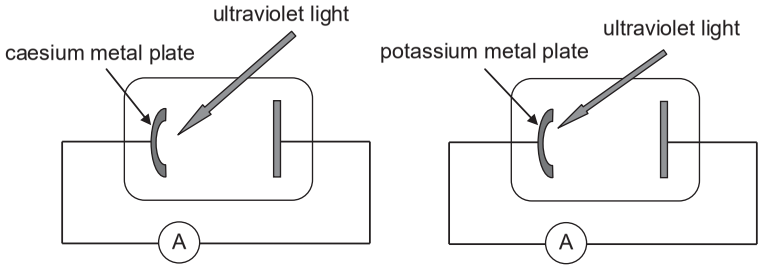
The threshold frequencies of caesium and potassium metals are given in the table below.

| METAL | THRESHOLD FREQUENCY |
|---|---|
| Caesium | $5{,}07 \times 10^{14}$ Hz |
| Potassium | $5{,}55 \times 10^{14}$ Hz |

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

11.2 Which ONE of the two metals in the table has the higher work function? Give a reason for the answer by referring to the information in the table. (2)

The simplified diagrams below show two circuits, **A** and **B**, containing photocells. The photocell in circuit **A** contains a caesium metal plate, while the photocell in circuit **B** contains a potassium metal plate.




Circuit **A** Circuit **B**

Ultraviolet light with the same intensity and wavelength of $5{,}5 \times 10^{-7}$ m is incident on the metal plate in EACH of the photocells and the ammeter in circuit **A** registers a current.

11.3 By means of a calculation, determine whether the ammeter in circuit **B** will also register a current. (3)

11.4 Calculate the maximum kinetic energy of an ejected electron in circuit **A**. (5)

11.5 How will the maximum kinetic energy of the ejected electron, calculated in QUESTION 11.4, change when the intensity of the incident light increases?

Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)
**[13]**

**TOTAL: 150**

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**GRADE 12**

**SEPTEMBER 2018**

# PHYSICAL SCIENCES P1

**MARKS:** **150**

**TIME:** **3 hours**

This question paper consists of 18 pages including a 2-page data sheet.



## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the best answer and write down only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 A car travels EAST at constant velocity. The net force on the car is …

A east.
B west.
C zero.
D south. (2)

1.2 A person on planet A, having radius ***R***, experiences a gravitational force **F**. When the person is on planet B having a radius **5*R***, the gravitational force experienced will be:

A $\frac{1}{25}$ **F**
B $\frac{1}{5}$ **F**
C 5 **F**
D 25 **F** (2)

1.3 Three masses *m*, 2*m* and 3*m* are simultaneously dropped form the same height in vacuum. The accelerations of the masses are $a_1$, $a_2$ and $a_3$ respectively.
Which ONE of the options below, regarding their accelerations, is correct?

A $a_1 < a_2 < a_3$
B $a_1 > a_2 < a_3$
C $a_1 < a_2 > a_3$
D $a_1 = a_2 = a_3$ (2)

1.4 The kinetic energy of an object having a mass *m,* velocity v and momentum p is $\mathbf{E_k}$. Which ONE of the following will represent the kinetic energy of the *same* object when its momentum changes to 2p?

A $4E_k$
B $2E_k$
C ¼ $E_k$
D ½ $E_k$ (2)

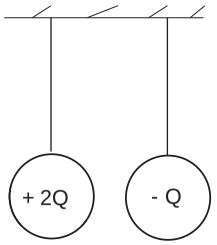
1.5 A block is sliding across a rough horizontal surface. The work done by friction changes only the:

A Kinetic energy
B Potential energy
C Internal energy
D Kinetic and internal energies (2)

1.6 The Doppler effect is used in medicine to …

A detect cancer.
B determine the length of an artery.
C monitor the heartbeat of a foetus.
D monitor the growth rate of a foetus. (2)

1.7 Two small, identical oppositely charged spheres suspended from light inextensible strings, are held in fixed positions and prevented from touching. Refer to the diagram below.



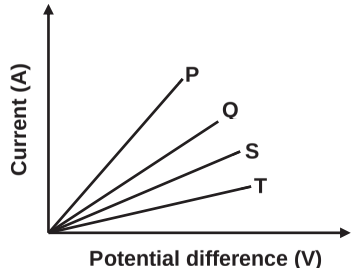

Which ONE of the following statements best describes the behaviour of the spheres when they are released?

A They will move towards each other, touch each other momentarily and then separate.
B They will move towards each other, touch each other momentarily and remain in contact.
C They will remain at their original positions and then vibrate.
D They move away from each other momentarily and then move towards each other. (2)





1.8 The graphs of current versus potential difference obtained for four different resistors **P, Q, S** and **T** are shown below.



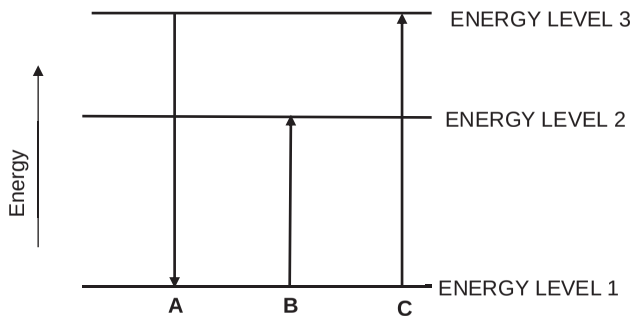

The resistor with the largest resistance is …

A P.
B Q.
C S.
D T. (2)

1.9 An electrical device that uses electrical energy to produce mechanical energy is called a(n) …

A dynamo.
B alternator.
C electric motor.
D generator. (2)

1.10 In the diagram below **A, B** and **C** represent transitions made by an electron in an atom.




Which of the transition(s) represent energy absorption?

A A only
B B only
C A and C only
D B and C only (2)

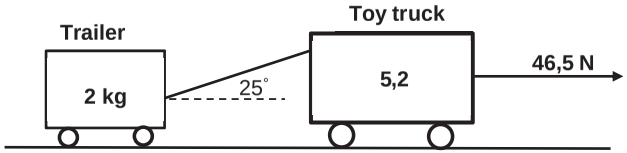
**[20]**





**QUESTION 2 (Start on a NEW page.)**

2.1 A toy truck of mass 5,2 kg is towing a trailer of mass 2 kg. The trailer is attached to the truck by means of a massless, inextensible rope, inclined at 25° to the horizontal, as shown on the diagram below. The pulling force on the truck is 46,5 N. The kinetic frictional force experienced by the truck is 12 N. The kinetic frictional force experienced by the trailer is 5,1 N.




2.1.1 Draw a labelled free-body diagram showing all forces acting on the TRUCK. (5)

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

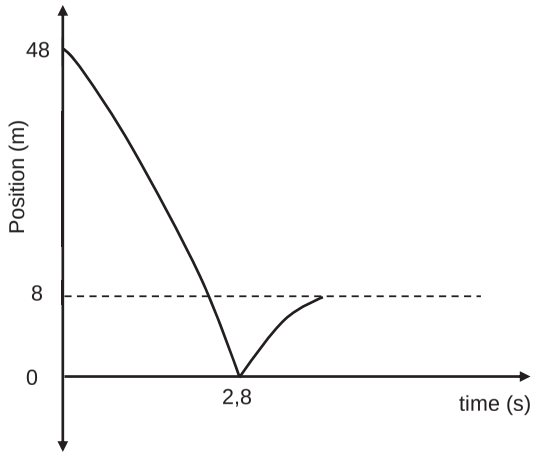
2.1.3 Calculate the tension in the rope. (6)

2.2 The mass and radius of the planet Mars are approximately $6,39 \times 10^{23}$ kg and $3,39 \times 10^{6}$ m respectively.
Calculate the gravitational acceleration on the surface of Mars. (3)

**[16]**

**QUESTION 3 (Start on a NEW page.)**

The position-time graph for a ball thrown vertically downwards from the top of a 48 m tall building is shown below. The graph is not drawn to scale. The ball bounces off the ground, reaching a maximum height of 8 m.
Ignore the effect of air resistance.




3.1 Calculate the speed at which the ball:

3.1.1 Is thrown downwards (4)

3.1.2 Hits the ground (3)

3.1.3 Bounces off the ground (3)

3.2 Draw a velocity-time graph (not to scale) for the entire motion of the ball.

Indicate the following on your graph:

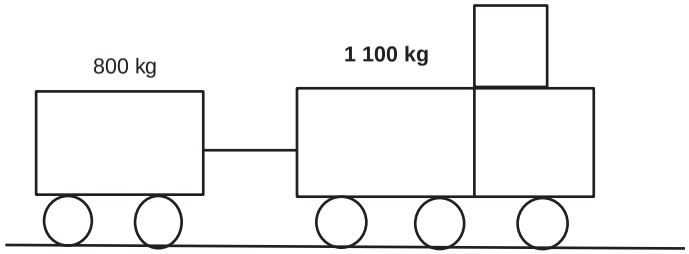
(i) Initial velocity with which the ball was thrown
(ii) Velocity with which the ball hit the ground
(iii) Time taken to attain this velocity
(iv) The velocity with which the ball bounces off the ground (4)
**[14]**





**QUESTION 4 (Start on a NEW page.)**

A 1 100 kg truck is pulling an 800 kg trailer by means of a massless rope at a constant speed of 45 km.h$^{-1}$ to the right as shown in the diagram below.
The rope snaps and the trailer continues to move to the right with an initial velocity of 9,06 m.s$^{-1}$. Ignore all effects of friction.




4.1 Calculate the speed of the truck after the rope snapped. (4)

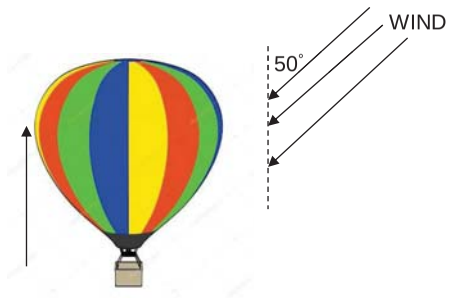
4.2 The truck collides with a wall and is brought to rest in 0,2 seconds.

4.2.1 Define the term *impulse*. (2)

4.2.2 Calculate the average net force exerted by the wall on the truck. (4)
**[10]**

**QUESTION 5 (Start on a NEW page.)**

A hot air balloon of mass 245 kg rises from the ground on a windy day. The wind blows in the direction as shown in the diagram, with a force of 1870 N. The hot air in the balloon provides an upward force of 3 000 N, causing the balloon to rise 12 m vertically upwards with a speed of 15 $ms^{-1}$.




5.1 Draw a labelled free-body diagram showing all forces acting on the balloon. (3)

5.2 Calculate the:

5.2.1 Work done by gravitational force (3)

5.2.2 Net work done on the balloon (4)

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

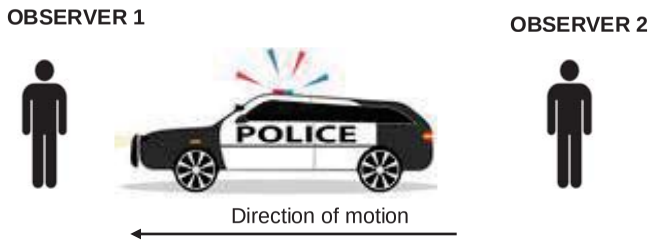
5.4 Use the work-energy theorem to calculate the velocity of the balloon after it has risen 12 m. (3)
**[15]**





**QUESTION 6 (Start on a NEW page.)**

6.1 In the diagram below, a police car with its siren blaring, stationed between two stationary observers.




6.1.1 How does the frequency detected by observer 1 compare to the frequency detected by observer 2 while the car is stationary? Choose from, GREATER THAN, LESS THAN or EQUAL TO. Give a reason for the answer. (2)

6.1.2 The police car starts to move in the direction indicated by the arrow in the diagram. How does the frequency detected by observer 1 compare to the frequency detected by observer 2? Choose from: GREATER THAN, LESS THAN or EQUAL TO. (1)

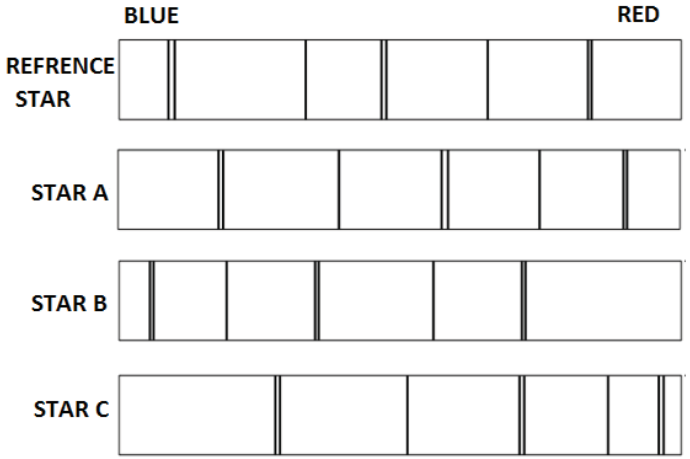
6.1.3 Draw a diagram to support the answer in QUESTION 6.1.2. (3)

6.1.4 NAME the phenomenon described in QUESTIONS 6.1.1 and 6.1.2 above. (1)

Observer 1 registers a frequency of 1 730 Hz as the police car approaches at a constant velocity of 25 $m.s^{-1}$. Take the velocity of sound in air as 340 $m.s^{-1}$.

6.1.5 Calculate the frequency of the siren. (5)

6.2 The spectral lines in the diagram below represent the hydrogen spectrum on different stars. Which of the stars is moving away fastest from the Reference star? Explain your answer.




(2)
**[14]**





**QUESTION 7 (Start on a NEW page.)**

In FIGURE 1 below two identical point charges, placed a distance **X** apart, exert a force of 1 920 N on each other.

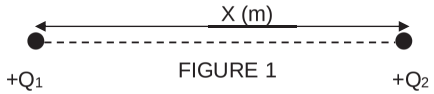



FIGURE 1

In FIGURE 2, the charges are separated a further 6 m. The force exerted by one charge on the other is 120 N.

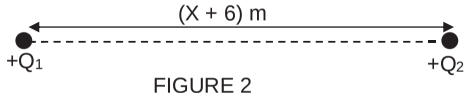



FIGURE 2

(2)

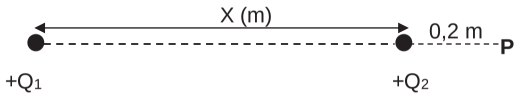
7.1 State Coulomb's law in words.

7.2 Calculate the:

7.2.1 Distance **X** in metres (5)

7.2.2 Magnitude of the charges (4)

7.3 The charges are returned to their original positions as in FIGURE 1. An electron is located at point **P,** a distance of 0,2 m to the right of charge $Q_2$.




Calculate the net:

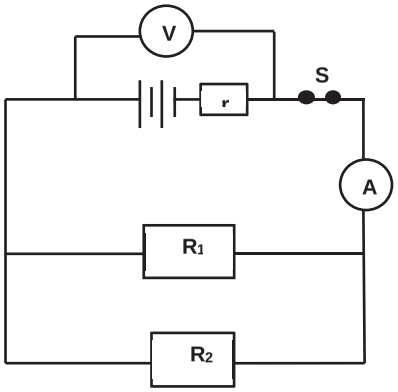
7.3.1 Electric field at point **P** due to the two charges (5)

7.3.2 Force experienced by the electron at point P due to the two charges (3)
**[19]**

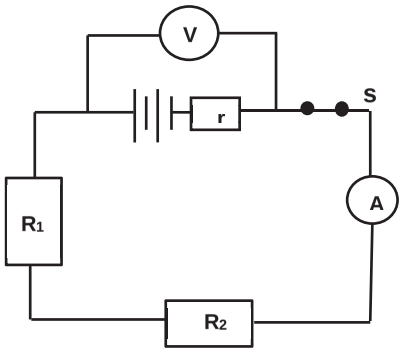
**QUESTION 8 (Start on a NEW page.)**

8.1 A group of learners conduct experiments to determine the emf (ℰ) and internal resistance (r) of a battery. They build the circuits labelled **A** and **B** below and record their readings. The SAME BATTERY and the SAME RESISTORS are used in each experiment.

**CIRCUIT A**




**CIRCUIT B**




| Experiment | $V_{load}$ (V) | $I_{circuit}$ (A) |
|---|---|---|
| **1** | 20,58 | 1,71 |
| **2** | 14,4 | 4,8 |

8.1.1 Which experiment is represented by circuit **A**? (1)

Calculate the:

8.1.2 Internal resistance of the battery (4)

8.1.3 Emf of the battery (2)

8.1.4 Resistance of each resistor (4)

8.1.5 Resistor $R_2$ is now disconnected from circuit **A**. How will this change affect the electrical energy transferred per second by the battery? Write down INCREASE, DECREASE or REMAIN THE SAME. Explain your answer. (3)

8.2 The cost of electricity at a certain municipality is R1,20 per kWh. A bakery operates an electric oven which has a coil of resistance 52 Ω. The current that passes through the coil is 16 A. Calculate how much the bakery pays for electricity per day if the electric oven is used for 6 hours per day. (4)

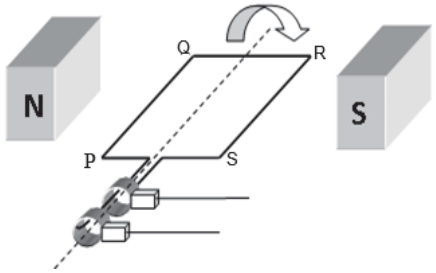
**[18]**





**QUESTION 9 (Start on a NEW page.)**

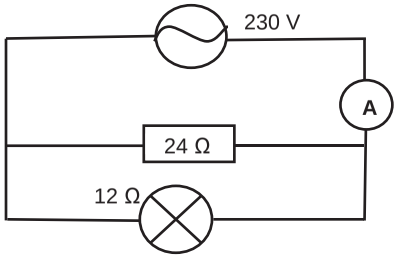
9.1 The simplified diagram below represents a generator rotated in the direction shown on the diagram.




9.1.1 State the energy conversion that takes place in this generator. (2)

9.1.2 The generator is rotated clockwise as indicated in the diagram. What is the direction of the current in the section **PQ** of the device? Write down only **P** to **Q** or **Q** to **P**. (1)

9.2 The diagram below shows a simplified version for part of a household wiring circuit.
The voltage supply in a certain house is 230 V. A light bulb having a resistance of 12 Ω and a kettle having a resistance of 24 Ω are used at a certain time as shown in the diagram below.




Calculate the:

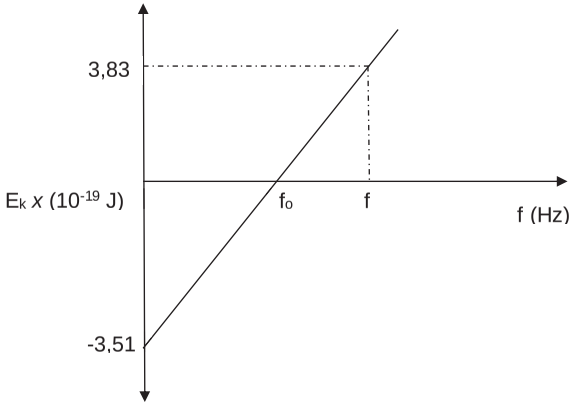
9.2.1 Peak (maximum) voltage of the domestic supply (3)

9.2.2 Average power dissipated if the ~~two light~~ bulb~~s~~ and kettle are used at the same time (5)

**[11]**

**QUESTION 10 (Start on a NEW page.)**

Different frequencies of light are shone onto a sodium metal plate and the maximum kinetic energy of ejected electrons is determined each time.
A graph of maximum kinetic energy versus frequency for the metal is shown below.




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

10.2 Write down the value of the work function of sodium metal. (1)

10.3 The same light photons are incident on zinc metal. How will the gradient of the graph for zinc metal compare to the gradient of the graph for the sodium metal? Write only LESS THAN, GREATER THAN or EQUAL TO.
Give a reason for your answer. (2)

10.4 Calculate the:

10.4.1 Frequency $f_o$ indicated on the graph (3)

10.4.2 Wavelength of the incident photons that correspond to the frequency *f* indicated on the graph above (5)
**[13]**

**TOTAL: 150**

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**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**FEBRUARY/MARCH 2018**

**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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 A constant horizontal force **F** is applied to a box resting on a horizontal, frictionless surface.

Which ONE of the following statements regarding force **F** is CORRECT?

Force **F** will cause the box to move with …

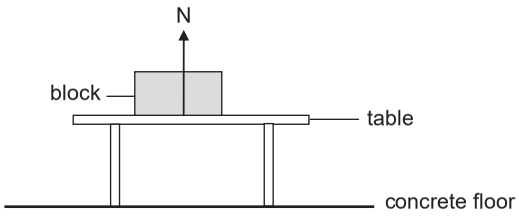
A constant acceleration.

B constant velocity.

C constant kinetic energy.

D constant momentum. (2)

1.2 A block rests on a table. The table stands on a concrete floor. The normal force is represented by N, as shown in the diagram below.




Which ONE of the following forces will form an action-reaction pair with the normal force (N)?

A Force of the block on the Earth

B Force of the block on the table

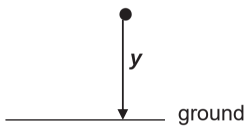
C Force of the table surface on the block

D Force of the block on the concrete floor (2)



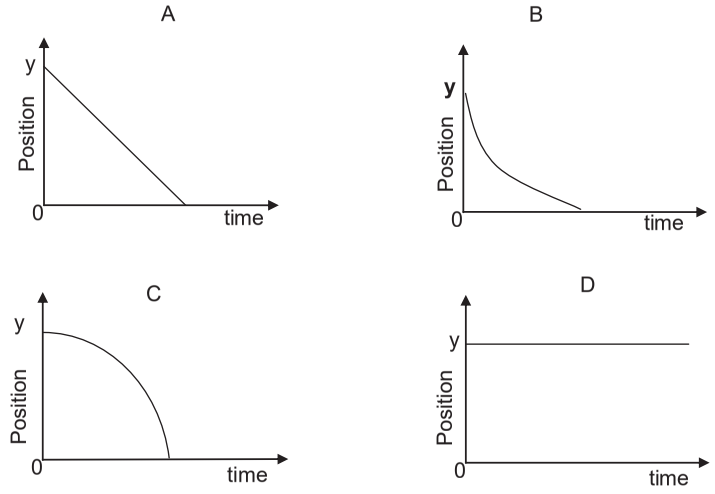


1.3 A small stone is dropped from a height ***y*** above the ground. It strikes the ground after time t, as shown in the diagram below.



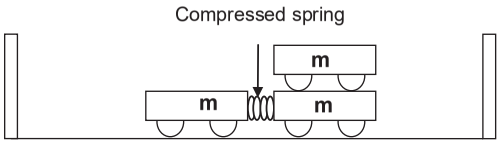

Take upwards as the positive direction and the ground as zero reference. Ignore the effects of air resistance.

Which ONE of the following diagrams shows a correct position-time graph for the motion of the stone?




(2)

1.4 Learners perform an experiment using identical trolleys, each of mass **m**. The trolleys are arranged, as shown in the diagram below. They are initially at rest on a frictionless surface and are connected with a compressed, massless spring.




When the spring is released it falls vertically down and the single trolley moves with momentum **p** to the left.
The magnitude of the momentum of the two trolleys moving to the right will be:

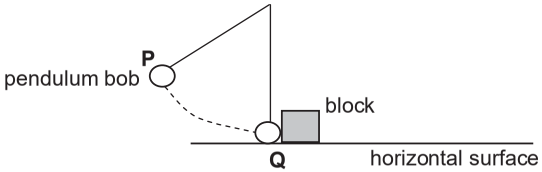
A 2**p**

B **p**

C $\frac{1}{2}$**p**

D $\frac{1}{4}$**p** (2)

1.5 A pendulum bob is released from point **P** above a horizontal surface. At the lowest point, **Q**, of its swing, it collides with a stationary block situated on a frictionless horizontal surface, as shown below. Ignore air friction.




Which ONE of the following combinations of **conservation laws** can be used to calculate the speed of the bob at **Q** immediately before and after colliding with the block?

| | SPEED AT Q | SPEED AFTER COLLISION |
|---|---|---|
| A | Conservation of mechanical energy | Conservation of linear momentum |
| B | Conservation of linear momentum | Conservation of mechanical energy |
| C | Conservation of mechanical energy | Conservation of mechanical energy |
| D | Conservation of linear momentum | Conservation of linear momentum |

(2)





1.6 Which ONE of the statements below about the Doppler effect is CORRECT?

A The Doppler effect is only applicable to sound waves.

B The Doppler effect can be used to explain the expanding universe.

C Electrons are ejected from a metal surface by means of the Doppler effect.

D A stationary listener hears a lower pitch of the sound from a siren of an approaching vehicle because of the Doppler effect. (2)

1.7 The magnitude of the electrostatic force on a charge $\mathbf{Q_1}$ due to another charge $\mathbf{Q_2}$ is **F**. Both charges are now doubled without changing the distance between them.

The magnitude of the new electrostatic force on $\mathbf{Q_1}$ will be:

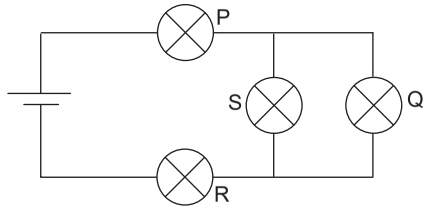
A $\frac{\mathbf{F}}{2}$

B 2**F**

C 4**F**

D 6**F** (2)

1.8 Four identical bulbs, **P**, **Q**, **R** and **S**, are connected to a cell in a circuit, as shown below. The cell has negligible internal resistance.




Which ONE of the following statements about the brightness of bulbs **P**, **Q**, **R** and **S** is CORRECT?

A **P** burns brighter than **R**.

B **S** and **Q** burn brighter than **P** and **R**.

C **P** and **R** burn brighter than **S** and **Q**.

D ALL the bulbs burn with the same brightness. (2)

1.9 Which ONE of the energy conversions below takes place when a **DC** motor is in operation?

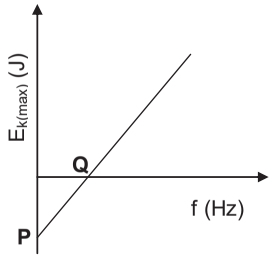
A Kinetic to electrical

B Heat to mechanical

C Mechanical to electrical

D Electrical to mechanical (2)

1.10 In an investigation on the photoelectric effect, the graph of maximum kinetic energy ($E_{k(max)}$) versus frequency (f) was obtained for a certain metal, as shown below.




The intercepts, **P** and **Q** respectively, represent …

A Planck's constant and threshold frequency.

B work function and threshold frequency.

C threshold frequency and work function.

D threshold frequency and Planck's constant. (2)
**[20]**

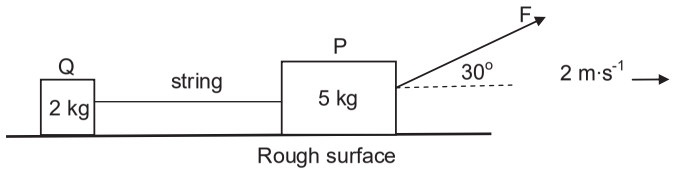




**QUESTION 2 (Start on a new page.)**

Two boxes, **P** and **Q**, resting on a rough horizontal surface, are connected by a light inextensible string. The boxes have masses 5 kg and 2 kg respectively. A constant force **F**, acting at an angle of 30° to the horizontal, is applied to the 5 kg box, as shown below.

The two boxes now move to the right at a **constant speed** of 2 m·s$^{-1}$.




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

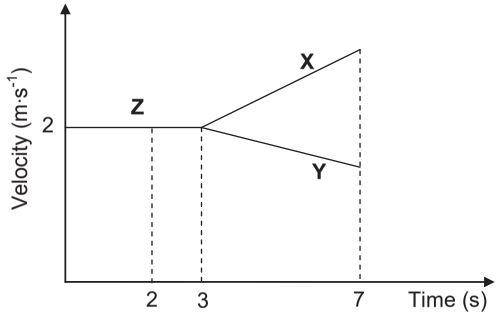
2.2 Draw a labelled free-body diagram for box **Q**. (4)

Box **P** experiences a constant frictional force of 5 N and box **Q** a constant frictional force of 3 N.

2.3 Calculate the magnitude of force **F**. (6)

The string connecting **P** and **Q** suddenly breaks after 3 s while force **F** is still being applied.

Learners draw the velocity-time graph for the motion of **P** and **Q** before and after the string breaks, as shown below.



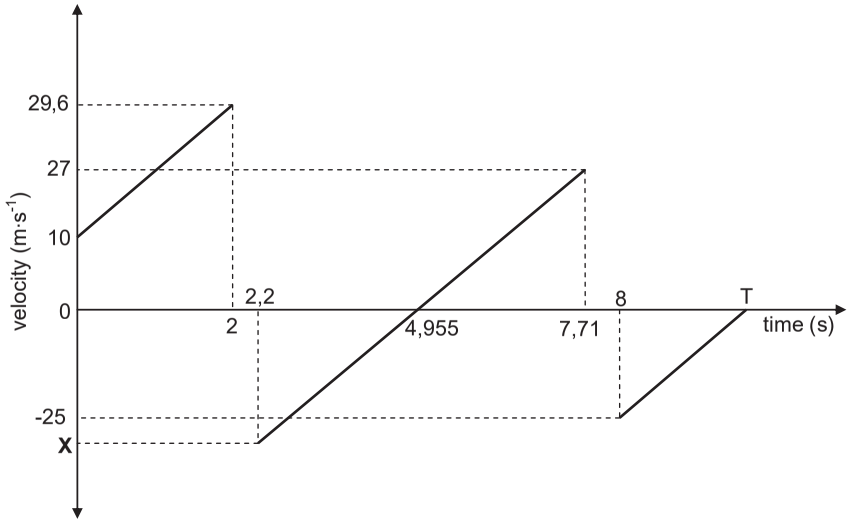

2.4 Write down the time at which the string breaks. (1)

2.5 Which portion (**X**, **Y** or **Z**) of the graph represents the motion of box **Q**, after the string breaks? Use the information in the graph to fully support the answer. (4)
**[17]**

**QUESTION 3 (Start on a new page.)**

A ball is thrown **vertically downwards** from the top of a building and bounces a few times as it hits the ground. The velocity-time graph below describes the motion of the ball from the time it is thrown, up to a certain time **T**.

Take downwards as the positive direction and the ground as zero reference. The graph is NOT drawn to scale. The effects of air friction are ignored.




3.1 Write down the speed with which the ball is thrown downwards. (1)

3.2 ALL parts of the graph have the same gradient. Give a reason for this. (2)

3.3 Calculate the:

3.3.1 Height from which the ball is thrown (3)

3.3.2 Time (T) shown on the graph (4)

3.4 Write down the:

3.4.1 Time that the ball is in contact with the ground at the first bounce (1)

3.4.2 Time at which the ball reaches its maximum height after the first bounce (2)

3.4.3 Value of **X** (1)

3.5 Is the collision of the ball with the ground *elastic* or *inelastic?* Give a reason for the answer using information in the graph. (2)
**[16]**





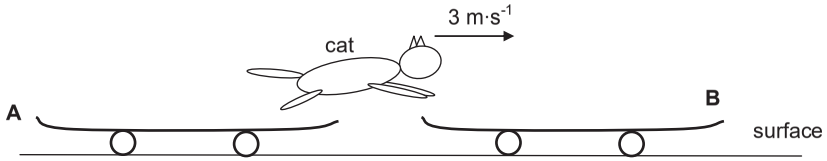
**QUESTION 4 (Start on a new page.)**

The diagram below shows two skateboards, **A** and **B**, initially at rest, with a cat standing on skateboard **A**. The skateboards are in a straight line, one in front of the other and a short distance apart. The surface is flat, frictionless and horizontal.

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

EACH skateboard has a mass of 3,5 kg. The cat, of mass 2,6 kg, jumps from skateboard **A** with a horizontal velocity of 3 $m \cdot s^{-1}$ and lands on skateboard **B** with the same velocity of 3 $m \cdot s^{-1}$.

Refer to the diagram below.




4.2 Calculate the velocity of skateboard **A** just after the cat has jumped from it. (5)

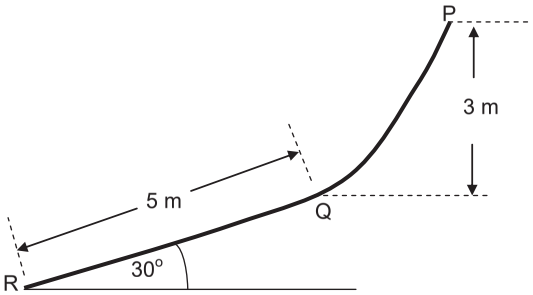
Immediately after the cat has landed, the cat and skateboard **B** move horizontally to the right at 1,28 $m \cdot s^{-1}$.

4.3 Calculate the magnitude of the impulse on skateboard **B** as a result of the cat's landing. (3)
**[10]**

**QUESTION 5 (Start on a new page.)**

A slide, **PQR**, at an amusement park consists of a curved *frictionless* section, **PQ**, and a section, **QR**, which is rough, straight and inclined at 30° to the horizontal. The starting point, **P**, is 3 m above point **Q**. The straight section, **QR**, is 5 m long.

A learner, with mass 50 kg, starting from rest at **P**, slides down section **PQ**, then continues down the straight section, **QR**.




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

5.2 Calculate the speed of the learner at **Q**. (4)

5.3 Draw a labelled free-body diagram for the learner while he/she is on section **QR**. (3)

The coefficient of kinetic friction ($\mu_k$) between the learner and the surface of section **QR** is 0,08.

5.4 Calculate the magnitude of the kinetic frictional force acting on the learner when the learner is on section **QR**. (3)

5.5 Use energy principles to calculate the speed of the learner at point **R**. (5)
**[17]**

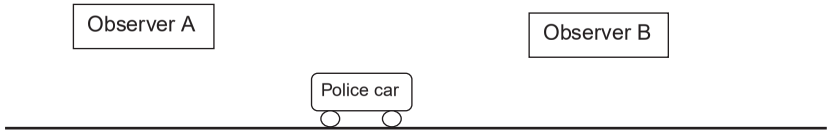




**QUESTION 6 (Start on a new page.)**

A police car is moving at a constant speed on a straight horizontal road. The siren of the car emits sound of constant frequency.
EACH of two observers, **A** and **B**, standing some distance apart on the same side of the road, records the frequency of the detected sound.

Observer **A** records a frequency of 690 Hz and observer **B** records a frequency of 610 Hz.




6.1 State the Doppler Effect in words. (2)

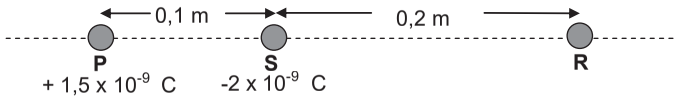
6.2 In which direction is the car moving? Choose from TOWARDS A or AWAY FROM A. Give a reason for the answer. (2)

6.3 Determine the speed of the police car. Take the speed of sound in air as 340 $m.s^{-1}$. (6)

6.4 Name ONE application of the Doppler effect. (1)
**[11]**

**QUESTION 7 (Start on a new page.)**

Two point charges, **P** and **S**, are placed a distance 0,1 m apart. The charge on **P** is $+1,5 \times 10^{-9}$ C and that on **S** is $-2 \times 10^{-9}$ C.
A third point charge, **R**, with an unknown positive charge, is placed 0,2 m to the right of point charge **S**, as shown in the diagram below.




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

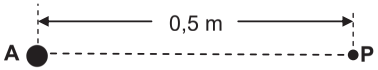
7.2 Draw a labelled force diagram showing the electrostatic forces acting on **R** due to **P** and **S**. (2)

7.3 Calculate the magnitude of the charge on **R**, if it experiences a net electrostatic force of $1,27 \times 10^{-6}$ N to the left.

Take forces directed to the right as positive. (7)
**[11]**

**QUESTION 8 (Start on a new page.)**

**P** is a point 0,5 m from charged sphere **A**. The electric field at **P** is $3 \times 10^{7}$ N·C$^{-1}$ directed towards **A**. Refer to the diagram below.




8.1 Draw the electric field pattern due to charged sphere **A**. Indicate the sign of the charge on the sphere in your diagram. (2)

8.2 Calculate the magnitude of the charge on sphere **A**. (3)

Another charged sphere, **B**, having an excess of $10^{5}$ electrons, is now placed at point **P**.

8.3 Calculate the electrostatic force experienced by sphere **B**. (6)
**[11]**

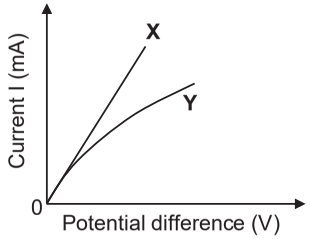




**QUESTION 9 (Start on a new page.)**

9.1 The two graphs below show the relationship between current and potential difference for two different conductors, **X** and **Y**.

Graphs of I versus V for two different conductors, **X** and **Y**

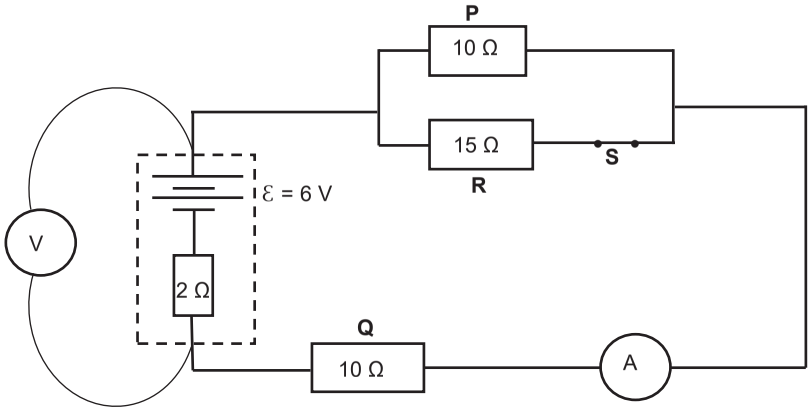



9.1.1 State Ohm's law in words. (2)

9.1.2 Which ONE of the two conductors, **X** or **Y**, is ohmic?

Refer to the graph and give a reason for the answer. (2)

9.2 In the diagram below, a battery with an emf of 6 V and an internal resistance of 2 Ω, is connected to three resistors **P**, **Q** and **R**. A voltmeter **V** is connected across the battery. The ammeter **A** has a negligible resistance.




9.2.1 Calculate the ammeter reading when switch **S** is closed. (5)

The switch **S** is now open.

9.2.2 Will the ammeter reading in QUESTION 9.2.1 INCREASE, DECREASE or REMAIN THE SAME? Give a reason for the answer. (2)

9.2.3 How will the voltmeter reading now compare with the voltmeter reading when the switch is closed? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

9.2.4 Explain the answer to QUESTION 9.2.3. (3)
**[15]**

**QUESTION 10 (Start on a new page.)**

10.1 Learners want to build a small **DC** motor as a project.

Write down THREE essential components that are needed for the building of the motor. (3)

10.2 An electrical device with a resistance of 11 Ω is connected to an **AC** source with an rms voltage of 240 V.

10.2.1 Define the term *rms voltage*. (2)

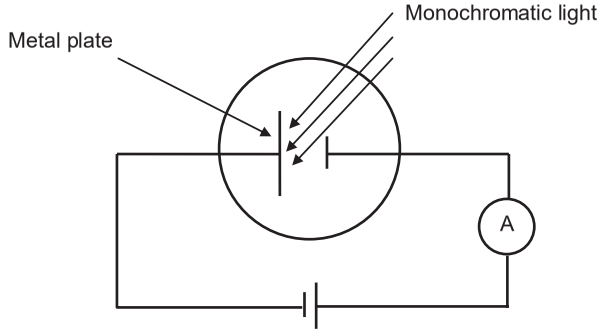
10.2.2 Calculate the maximum (peak) current passing through the device. (4)
**[9]**





**QUESTION 11 (Start on a new page.)**

11.1 In the diagram below, monochromatic light is incident on the metal plate of a photocell. A sensitive ammeter shows a reading.




11.1.1 How does the energy of the photons of the incident light compare to the work function of the metal plate?
Choose from GREATER THAN, LESS THAN or EQUAL TO.

Give a reason for the answer. (2)

11.1.2 When a change is made to the monochromatic light, the reading on the ammeter increases.

A learner makes the following statement with regard to this change:

The increase in the ammeter reading is due to an increase in the energy of the incident photons.

Give a reason why this statement is INCORRECT. (2)

11.1.3 What does the photoelectric effect tell us about the nature of light? (1)

11.2 Ultraviolet radiation is incident on the surface of sodium metal. The threshold frequency ($f_0$) for sodium is $5{,}73 \times 10^{14}$ Hz. The maximum speed of an electron emitted from the metal surface is $4{,}19 \times 10^{5}$ m·s$^{-1}$.

11.2.1 Define or explain the term *threshold frequency*. (2)

Calculate the:

11.2.2 Work function of sodium (3)

11.2.3 Frequency of the incident photon (3)
**[13]**

**TOTAL: 150**

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2017**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 19 pages and 3 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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The acceleration due to gravity on Earth is greater than that on the moon.

Which ONE of the following statements is CORRECT?

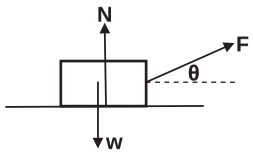
A The weight of an object on Earth is the same as that on the moon.

B The mass of an object on Earth is the same as that on the moon.

C The mass of an object on Earth is greater than that on the moon.

D The weight of an object on Earth is less than that on the moon. (2)

1.2 The force diagram below shows the forces acting on a box.




Which ONE of the following equations for the magnitude of the normal force (N) is CORRECT?

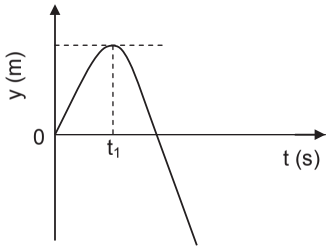
A $N = w + F\cos\theta$

B $N = w + F\sin\theta$

C $N = w - F\cos\theta$

D $N = w - F\sin\theta$ (2)

1.3 A stone is projected vertically upwards from the top of a building at a speed of $v$ m·s$^{-1}$. The position-time graph below represents the motion of the stone. Ignore the effects of air resistance.




Which ONE of the combinations below regarding the magnitudes of the stone's velocity and acceleration, at time $t_1$, is CORRECT?

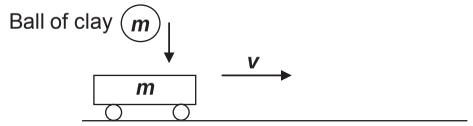
| | MAGNITUDE OF VELOCITY (m·s$^{-1}$) | MAGNITUDE OF ACCELERATION (m·s$^{-2}$) |
|---|---|---|
| A | 0 | 9,8 |
| B | 0 | 0 |
| C | $v$ | 0 |
| D | $v$ | 9,8 |

(2)



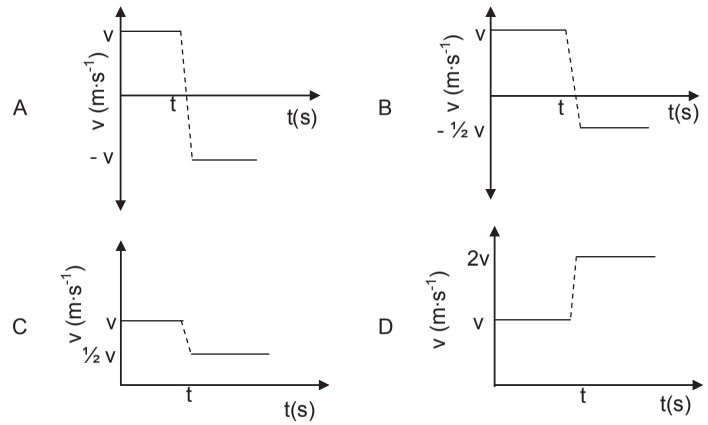


1.4 A trolley of mass ***m*** is moving at constant velocity ***v*** to the right on a frictionless horizontal surface. A ball of clay, also of mass ***m***, dropped vertically, falls onto the trolley at time t, as shown in the diagram below.




The ball of clay sticks to the trolley.

Which ONE of the velocity-time graphs below CORRECTLY represents the velocity of the trolley *before* and *after* time t?




(2)

1.5 A person lifts a crate vertically upwards at constant velocity through a distance *h*. The person does work *x* on the crate in time *t*.

The person now lifts the same crate vertically upwards at constant velocity through the same distance, but in time 2*t*.

The work done by the person on the crate will now be …

A ½*x*

B *x*

C 2*x*

D 4*x* (2)

1.6 The wavelengths of light emitted by a distant star appear shorter when observed from Earth. From this we can conclude that the star is …

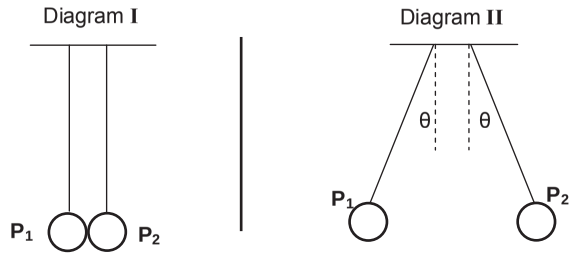
A moving towards Earth and the light is blue shifted.

B moving towards Earth and the light is red shifted.

C moving away from Earth and the light is red shifted.

D moving away from Earth and the light is blue shifted. (2)

1.7 Two identical light graphite-coated spheres, $P_1$ and $P_2$, are suspended using identical thin insulated threads. $P_1$ is charged, but $P_2$ is neutral. The spheres are then brought into contact with each other, as shown in diagram **I**. Thereafter the spheres assume the positions, as shown in diagram **II**.




Which ONE of the following statements concerning the charges on the spheres possibly explains why the spheres move apart after touching, as shown in diagram **II**?

| | SIGN OF CHARGE ON $P_1$ | SIGN OF CHARGE ON $P_2$ | MAGNITUDE OF CHARGES ON $P_1$ AND $P_2$ |
|---|---|---|---|
| A | + | + | Unequal |
| B | - | - | Unequal |
| C | + | - | Equal |
| D | + | + | Equal |

(2)





1.8 When a resistor of resistance R is connected to a battery of emf Ɛ and negligible internal resistance, the power dissipated in the resistor is P.

If the resistor is replaced with a resistor of resistance 2R, without changing the battery, the power dissipated will be …

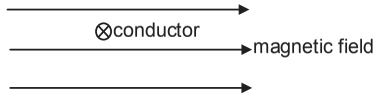
A ¼P

B ½P

C 2P

D 4P (2)

1.9 The diagram below shows a current-carrying conductor lying in a uniform magnetic field directed to the right. The current flows into the page.




Which ONE of the following arrows shows the direction of the force experienced by the conductor due to the magnetic field?

(2)

1.10 Light of a certain frequency is shone onto a metal **M** and electrons are ejected from the surface. The same source of light is shone onto another metal **N**.

The electrons ejected from the surface of metal **N** have a much higher kinetic energy than that from metal **M**.

This means that …

A metal **N** has the same work function as metal **M**.

B metal **N** has a larger work function than metal **M**.

C the threshold frequency of metal **N** is higher than that of metal **M**.

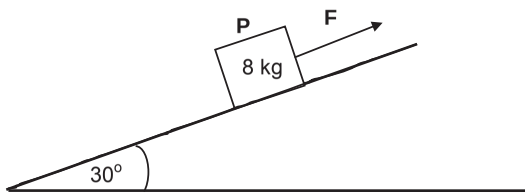
D the threshold frequency of metal **N** is lower than that of metal **M**. (2)

**[20]**

**QUESTION 2 (Start on a new page.)**

2.1 An 8 kg block, **P**, is being pulled by constant force **F** up a rough inclined plane at an angle of 30° to the horizontal, at CONSTANT SPEED.

Force **F** is parallel to the inclined plane, as shown in the diagram below.




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

2.1.2 Draw a labelled free-body diagram for block **P**. (4)

The kinetic frictional force between the block and the surface of the inclined plane is 20,37 N.

2.1.3 Calculate the magnitude of force **F**. (5)

Force **F** is now removed and the block ACCELERATES down the plane. The kinetic frictional force remains 20,37 N.

2.1.4 Calculate the magnitude of the acceleration of the block. (4)

2.2 A 200 kg rock lies on the surface of a planet. The acceleration due to gravity on the surface of the planet is 6,0 $m \cdot s^{-2}$.

2.2.1 State Newton's Law of Universal Gravitation in words. (2)

2.2.2 Calculate the mass of the planet if its radius is 700 km. (4)
**[21]**



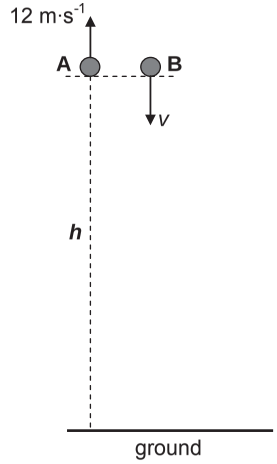


**QUESTION 3 (Start on a new page.)**

Stone **A** is projected vertically upwards at a speed of 12 $m \cdot s^{-1}$ from a height ***h*** *above the ground*. Ignore the effects of air resistance.

3.1 Calculate the time taken for stone **A** to reach its maximum height. (3)

At the same instant that stone **A** is projected upwards, stone **B** is thrown vertically downwards from the same height at an *unknown speed*, *v*. Refer to the diagram below.




When stone **A** reaches its maximum height, the speed of stone **B** is 3*v*.

3.2 Calculate the speed, *v*, with which stone **B** is thrown downwards. (4)

At the instant stone **A** passes its initial position on its way down, stone **B** hits the ground.

3.3 Calculate the height ***h***. (3)

3.4 Sketch velocity-time graphs for the complete motions of stones **A** and **B** on the same set of axes. Label your graphs for stones **A** and **B** clearly.

Show the following on the graphs:

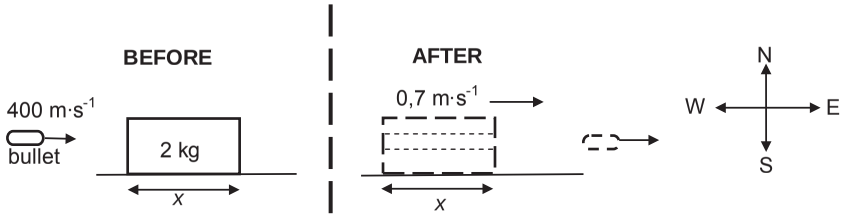
- The time taken for stone **A** to reach its maximum height
- The velocity with which stone **B** is thrown downwards (4)

**[14]**

**QUESTION 4 (Start on a new page.)**

A 2 kg block is at rest on a smooth, frictionless, horizontal table. The length of the block is *x*.

A bullet of mass 0,015 kg, travelling east at 400 m·s$^{-1}$, strikes the block and passes straight through it with constant acceleration. Refer to the diagram below. Ignore any loss of mass of the bullet and the block.




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

The block moves eastwards at 0,7 m·s$^{-1}$ after the bullet has emerged from it.

4.2 Calculate the magnitude of the velocity of the bullet immediately after it emerges from the block. (4)

4.3 If the bullet takes 0,002 s to travel through the block, calculate the length, *x*, of the block. (5)
**[11]**

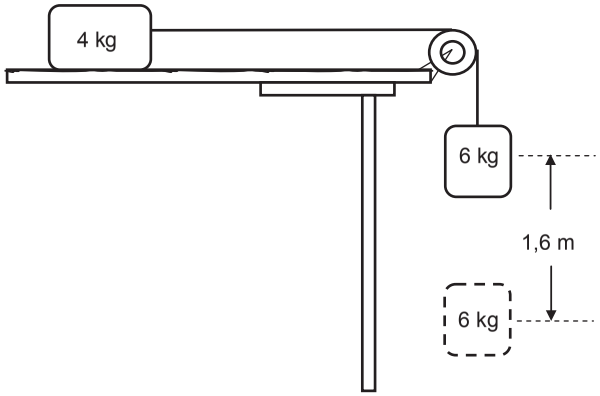




**QUESTION 5 (Start on a new page.)**

In the diagram below, a 4 kg block lying on a rough horizontal surface is connected to a 6 kg block by a light inextensible string passing over a light frictionless pulley.

Initially the blocks are HELD AT REST.




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

When the blocks are released, the 6 kg block falls through a vertical distance of 1,6 m.

5.2 Draw a labelled free-body diagram for the 6 kg block. (2)

5.3 Calculate the work done by the gravitational force on the 6 kg block. (3)

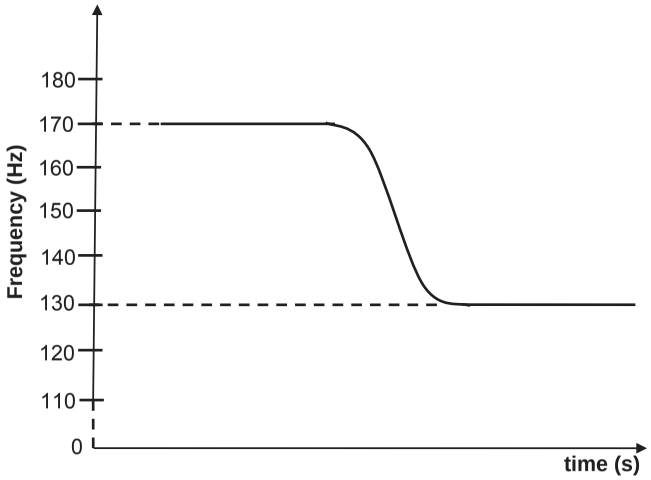
The coefficient of kinetic friction between the 4 kg block and the horizontal surface is 0,4. Ignore the effects of air resistance.

5.4 Use **energy principles** to calculate the speed of the 6 kg block when it falls through 1,6 m while still attached to the 4 kg block. (5)
**[12]**

**QUESTION 6 (Start on a new page.)**

A police car moving at a constant velocity with its siren on, passes a stationary listener.

The graph below shows the changes in the frequency of the sound of the siren detected by the listener.




6.1 State the Doppler Effect in words. (2)

6.2 Write down the frequency of the sound detected by the listener as the police car:

6.2.1 Approaches the listener (1)

6.2.2 Moves away from the listener (1)

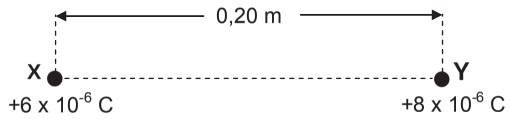
6.3 Calculate the speed of the police car. Take the speed of sound in air to be 340 $m \cdot s^{-1}$. (6)
**[10]**





**QUESTION 7 (Start on a new page.)**

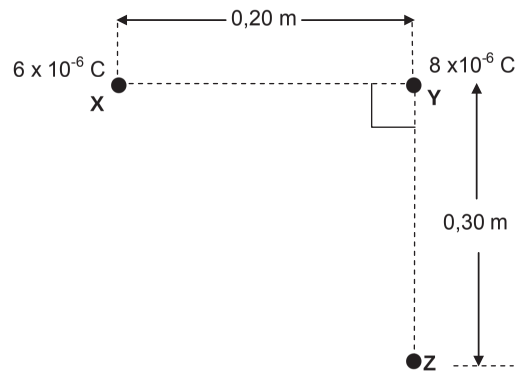
Two small spheres, **X** and **Y**, carrying charges of $+6 \times 10^{-6}$ C and $+8 \times 10^{-6}$ C respectively, are placed 0,20 m apart in air.




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

7.2 Calculate the magnitude of the electrostatic force experienced by charged sphere **X**. (4)

A third sphere, **Z**, of unknown **negative** charge, is now placed at a distance of 0,30 m below sphere **Y**, in such a way that the line joining the charged spheres **X** and **Y** is perpendicular to the line joining the charged spheres **Y** and **Z**, as shown in the diagram below.

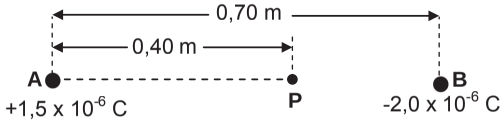



7.3 Draw a vector diagram showing the directions of the electrostatic forces **and** the net force experienced by charged sphere **Y** due to the presence of charged spheres **X** and **Z** respectively. (3)

7.4 The magnitude of the net electrostatic force experienced by charged sphere **Y** is 15,20 N. Calculate the charge on sphere **Z**. (4)
**[13]**

**QUESTION 8 (Start on a new page.)**

**A** and **B** are two small spheres separated by a distance of 0,70 m. Sphere **A** carries a charge of +1,5 x $10^{-6}$ C and sphere **B** carries a charge of -2,0 x $10^{-6}$ C.




**P** is a point between spheres **A** and **B** and is 0,40 m from sphere **A**, as shown in the diagram above.

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

8.2 Calculate the magnitude of the net electric field at point **P**. (4)

8.3 A point charge of magnitude 3,0 x $10^{-9}$ C is now placed at point **P**.

Calculate the magnitude of the electrostatic force experienced by this charge. (3)
**[9]**



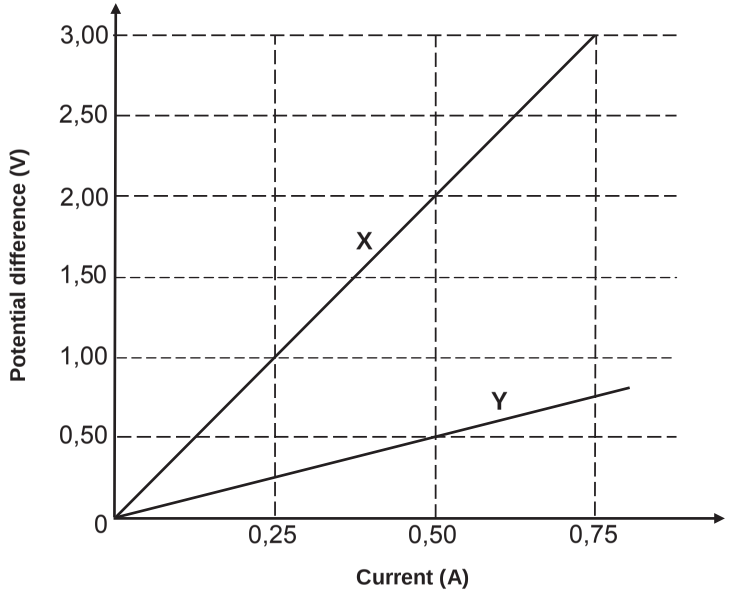


**QUESTION 9 (Start on a new page.)**

9.1 Learners investigated the relationship between potential difference (V) and current (I) for the combination of two resistors, $\mathbf{R_1}$ and $\mathbf{R_2}$. In one experiment, resistors $\mathbf{R_1}$ and $\mathbf{R_2}$ were connected in parallel. In a second experiment, resistors $\mathbf{R_1}$ and $\mathbf{R_2}$ were connected in series.

The learners then plotted graph **X**, the results of one of the experiments, and graph **Y**, the results of the other experiment, as shown below.

**GRAPHS OF POTENTIAL DIFFERENCE VERSUS CURRENT FOR THE COMBINATION OF TWO RESISTORS IN SERIES AND IN PARALLEL**



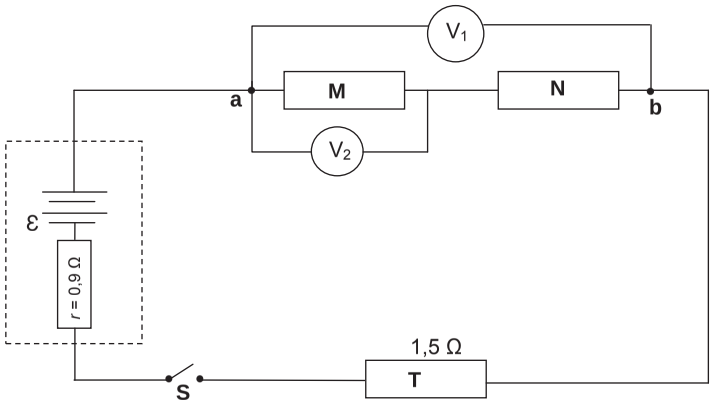

9.1.1 State Ohm's law in words. (2)

9.1.2 What physical quantity does the gradient (slope) of the V-I graph represent? (1)

9.1.3 Calculate the gradient (slope) of graph **X**. (2)

9.1.4 Determine the resistance of resistor $\mathbf{R_1}$. (4)

9.2 The circuit below consists of three resistors, **M**, **N** and **T**, a battery with emf Ɛ and an internal resistance of 0,9 Ω. The effective resistance between points **a** and **b** in the circuit is 6 Ω. The resistance of resistor **T** is 1,5 Ω.




When switch **S** is closed, a high-resistance voltmeter, $V_1$, across **a** and **b** reads 5 V.

Calculate the:

9.2.1 Current delivered by the battery (3)

9.2.2 Emf (Ɛ) of the battery (4)

Voltmeter $V_2$ reads 2,5 V when the switch is closed.

9.2.3 Write down the resistance of **N**. (No calculations required.) Give a reason for the answer. (2)
**[18]**

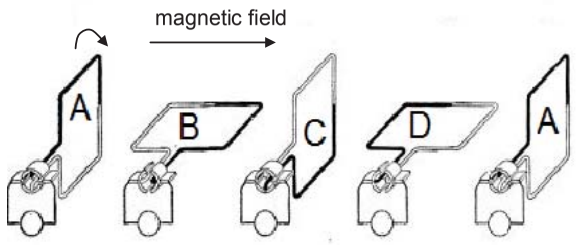




**QUESTION 10 (Start on a new page.)**

10.1 The diagram below shows different positions (**ABCDA**) of the coil in a **DC** generator for a complete revolution. The coil is rotated clockwise at a constant speed in a uniform magnetic field.

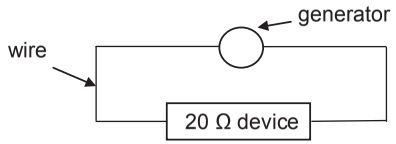
The direction of the magnetic field is shown in the diagram below.




10.1.1 Write down the energy conversion that takes place during the operation of the DC generator. (1)

10.1.2 Sketch a graph to show how the induced emf of the generator varies with time. Clearly indicate positions **A**, **B**, **C**, **D** and **A** on the graph. (2)

10.2 A small AC generator, providing an rms voltage of 25 V, is connected across a device with a resistance of 20 Ω. The wires connecting the generator to the device have a total resistance of 0,5 Ω. Refer to the diagram below.

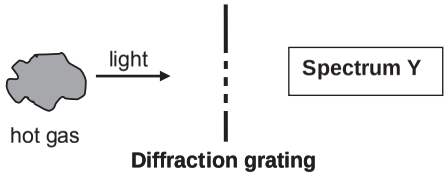


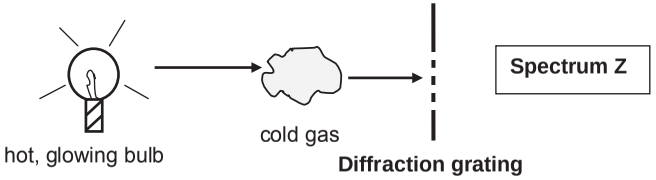

10.2.1 Write down the total resistance of the circuit. (1)

10.2.2 Calculate the average power delivered to the *device*. (5)
**[9]**

**QUESTION 11 (Start on a new page.)**

11.1 A teacher in a science class explains how different types of spectra are obtained. The teacher uses the simplified diagrams shown below for the explanation.




Name the type of spectrum of:

11.1.1 **Y** (1)

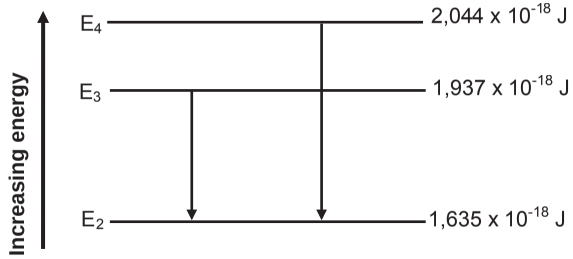
11.1.2 **Z** (1)





11.2 In an excited atom, electrons can 'jump' from lower energy levels to higher energy levels. They can also 'drop' from higher energy levels to lower energy levels.

The diagram below (not drawn to scale) shows some of the transitions for electrons in an excited atom.




11.2.1 Do the transitions indicated in the diagram lead to ABSORPTION or EMISSION spectra? (1)

11.2.2 Calculate the frequency of the photon produced when an electron in an excited atom makes a transition from $\mathbf{E_4}$ to $\mathbf{E_2}$, as shown in the diagram. (4)

The threshold frequency of a metal, Q, is $4,4 \times 10^{14}$ Hz.

11.2.3 Calculate the kinetic energy of the most energetic electron ejected when the photon produced in QUESTION 11.2.2 is incident on the surface of metal Q. (4)

Another metal, R, has a threshhold frequency of $7,5 \times 10^{14}$ Hz.

11.2.4 Will the photon produced in QUESTION 11.2.2 be able to eject electrons from the surface of metal R? Write down only YES or NO.

Give a reason for the answer. (2)
**[13]**

**TOTAL: 150**

basic education

Department:
Basic Education
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**NOVEMBER 2016**

**MARKS: 150**

**TIME: 3 hours**

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





**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions. Write down the question number (1.1–1.10), choose the answer and make a cross (X) over the letter (A–D) of your choice in the ANSWER BOOK.

EXAMPLE:

| | | | | |
|---|---|---|---|---|
| ••••• | A | B | C | ~~D~~ |

1.1 The tendency of an object to remain at rest or to continue in its uniform motion in a straight line is known as …

A inertia.

B acceleration.

C Newton's Third Law.

D Newton's Second Law. (2)

1.2 The mass of an astronaut on Earth is M. At a height equal to twice the radius of the Earth, the **mass** of the astronaut will be …

A $\frac{1}{4}$M

B $\frac{1}{9}$M

C M

D 2M (2)

1.3 An object is thrown vertically upwards from the ground.

Which ONE of the following is CORRECT regarding the direction of the acceleration of the object as it moves upwards and then downwards? Ignore the effects of air resistance.

| | OBJECT MOVING UPWARDS | OBJECT MOVING DOWNWARDS |
|---|---|---|
| A | Downwards | Upwards |
| B | Upwards | Downwards |
| C | Downwards | Downwards |
| D | Upwards | Upwards |

(2)

1.4 A person drops a glass bottle onto a concrete floor from a certain height and the bottle breaks. The person then drops a second, identical glass bottle from the same height onto a thick, woollen carpet, but the bottle does not break.

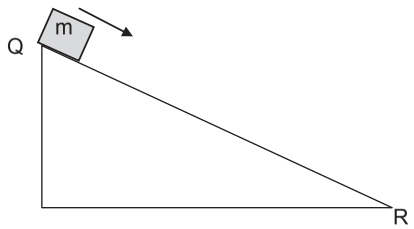
Which ONE of the following is CORRECT for the second bottle compared to the first bottle for the same momentum change?

| | AVERAGE FORCE ON SECOND BOTTLE | TIME OF CONTACT WITH CARPET |
|---|---|---|
| A | Larger | Smaller |
| B | Smaller | Smaller |
| C | Larger | Larger |
| D | Smaller | Larger |

(2)

1.5 A block of mass m is released from rest from the top of a frictionless inclined plane **QR**, as shown below.

The total mechanical energy of the block is $E_Q$ at point **Q** and $E_R$ at point **R**. The kinetic energy of the block at points **Q** and **R** is $K_Q$ and $K_R$ respectively.




Which ONE of the statements regarding the total mechanical energy and the kinetic energy of the block at points **Q** and **R** respectively is CORRECT?

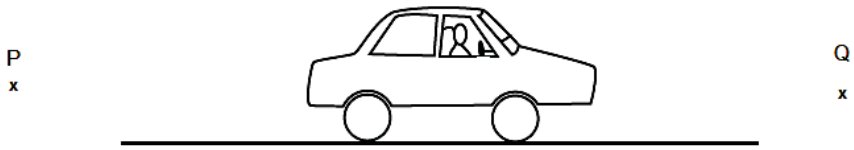
| | TOTAL MECHANICAL ENERGY E | KINETIC ENERGY K |
|---|---|---|
| A | $E_Q > E_R$ | $K_Q = K_R$ |
| B | $E_Q = E_R$ | $K_Q < K_R$ |
| C | $E_Q = E_R$ | $K_Q = K_R$ |
| D | $E_Q < E_R$ | $K_Q > K_R$ |

(2)





1.6 The diagram below shows the positions of two stationary listeners, **P** and **Q**, relative to a car moving at a constant velocity towards listener **Q**. The hooter on the car emits sound. Listeners **P** and **Q** and the driver all hear the sound of the hooter.

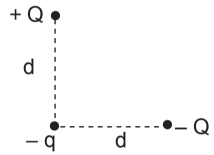



Which ONE of the following CORRECTLY describes the frequency of the sound heard by **P** and **Q**, *compared to that heard by the driver*?

| | FREQUENCY OF THE SOUND HEARD BY P | FREQUENCY OF THE SOUND HEARD BY Q |
|---|---|---|
| A | Lower | Higher |
| B | Higher | Higher |
| C | Lower | Lower |
| D | Higher | Lower |

(2)

1.7 Two charges, + Q and – Q, are placed a distance d from a negative charge – q. The charges, + Q and – Q, are located along lines that are perpendicular to each other as shown in the diagram below.



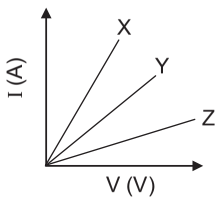

Which ONE of the following arrows CORRECTLY shows the direction of the net force acting on charge – q due to the presence of charges + Q and – Q?

| | |
|---|---|
| A | → |
| B | ↗ |
| C | ↖ |
| D | ← |

(2)

1.8 Learners investigate the relationship between current (I) and potential difference (V) at a constant temperature for three different resistors, **X**, **Y** and **Z**.

They obtain the graphs shown below.




The resistances of **X**, **Y** and **Z** are $R_X$, $R_Y$ and $R_Z$ respectively.

Which ONE of the following conclusions regarding the resistances of the resistors is CORRECT?

A $R_z > R_Y > R_x$

B $R_X = R_Y = R_Z$

C $R_X > R_Y > R_Z$

D $R_X > R_Y$ and $R_Y < R_Z$ (2)

1.9 Which ONE of the following changes may lead to an increase in the emf of an AC generator without changing its frequency?

A Decrease the resistance of the coil.

B Increase the area of the coil.

C Increase the resistance of the coil.

D Decrease the speed of rotation. (2)

1.10 The wavelength of a monochromatic light source **P** is twice that of a monochromatic light source **Q**. The energy of a photon from source **P** will be … of a photon from source **Q**.

A a quarter of the energy

B half the energy

C equal to the energy

D twice the energy (2)
**[20]**

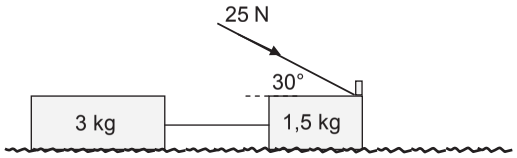




**QUESTION 2 (Start on a new page.)**

A learner constructs a push toy using two blocks with masses 1,5 kg and 3 kg respectively. The blocks are connected by a massless, inextensible cord.

The learner then applies a force of 25 N at an angle of 30° to the 1,5 kg block by means of a light rigid rod, causing the toy to move across a flat, rough, horizontal surface, as shown in the diagram below.




The coefficient of kinetic friction ($\mu_k$) between the surface and each block is 0,15.

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

2.2 Calculate the magnitude of the kinetic frictional force acting on the 3 kg block. (3)

2.3 Draw a labelled free-body diagram showing ALL the forces acting on the 1,5 kg block. (5)

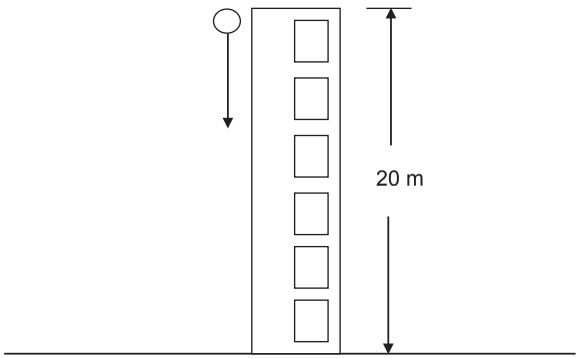
2.4 Calculate the magnitude of the:

2.4.1 Kinetic frictional force acting on the 1,5 kg block (3)

2.4.2 Tension in the cord connecting the two blocks (5)
**[18]**

**QUESTION 3 (Start on a new page.)**

A ball is dropped from the top of a building 20 m high. Ignore the effects of air resistance.




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

3.2 Calculate the:

3.2.1 Speed at which the ball hits the ground (4)

3.2.2 Time it takes the ball to reach the ground (3)

3.3 Sketch a velocity-time graph for the motion of the ball (no values required). (2)
**[11]**

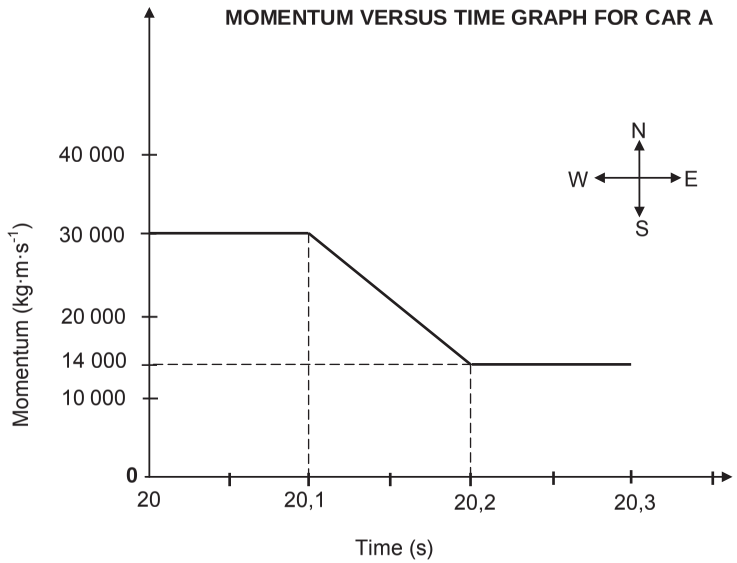




**QUESTION 4 (Start on a new page.)**

The graph below shows how the momentum of car **A** changes with time *just before* and *just after* a head-on collision with car **B**.

Car **A** has a mass of 1 500 kg, while the mass of car **B** is 900 kg.
Car **B** was travelling at a constant velocity of 15 $m \cdot s^{-1}$ west before the collision.
Take east as positive and consider the system as isolated.




4.1 What do you understand by the term *isolated system* as used in physics? (1)

Use the information in the graph to answer the following questions.

4.2 Calculate the:

4.2.1 Magnitude of the velocity of car **A** just before the collision (3)

4.2.2 Velocity of car **B** just after the collision (5)

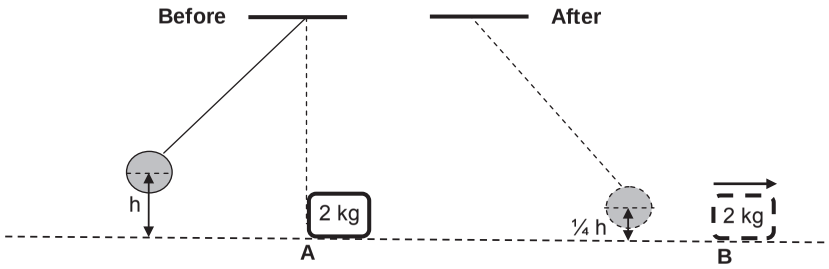
4.2.3 Magnitude of the net average force acting on car **A** during the collision (4)
**[13]**

**QUESTION 5 (Start on a new page.)**

A pendulum with a bob of mass 5 kg is held stationary at a height h metres above the ground. When released, it collides with a block of mass 2 kg which is stationary at point **A**.

The bob swings past **A** and comes to rest momentarily at a position ¼ h above the ground.

The diagrams below are NOT drawn to scale.



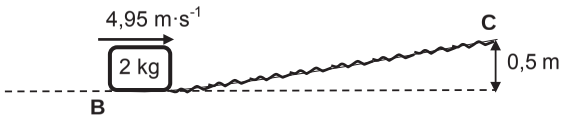

Immediately after the collision the 2 kg block begins to move from **A** to **B** at a constant speed of 4,95 $m \cdot s^{-1}$.
Ignore frictional effects and assume that no loss of mechanical energy occurs during the collision.

5.1 Calculate the:

5.1.1 Kinetic energy of the block immediately after the collision (3)

5.1.2 Height h (4)

The block moves from point **B** at a velocity of 4,95 $m \cdot s^{-1}$ up a rough inclined plane to point **C**. The speed of the block at point **C** is 2 $m \cdot s^{-1}$. Point **C** is 0,5 m above the horizontal, as shown in the diagram below.
During its motion from **B** to **C** a uniform frictional force acts on the block.




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

5.3 Use energy principles to calculate the work done by the frictional force when the 2 kg block moves from point **B** to point **C**. (4)
**[13]**





**QUESTION 6 (Start on a new page.)**

6.1 An ambulance is moving towards a stationary listener at a constant speed of 30 $m \cdot s^{-1}$. The siren of the ambulance emits sound waves having a wavelength of 0,28 m. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1.1 State the Doppler effect in words. (2)

6.1.2 Calculate the frequency of the sound waves emitted by the siren as heard by the ambulance driver. (3)

6.1.3 Calculate the frequency of the sound waves emitted by the siren as heard by the listener. (5)

6.1.4 How would the answer to QUESTION 6.1.3 change if the speed of the ambulance were LESS THAN 30 $m \cdot s^{-1}$? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

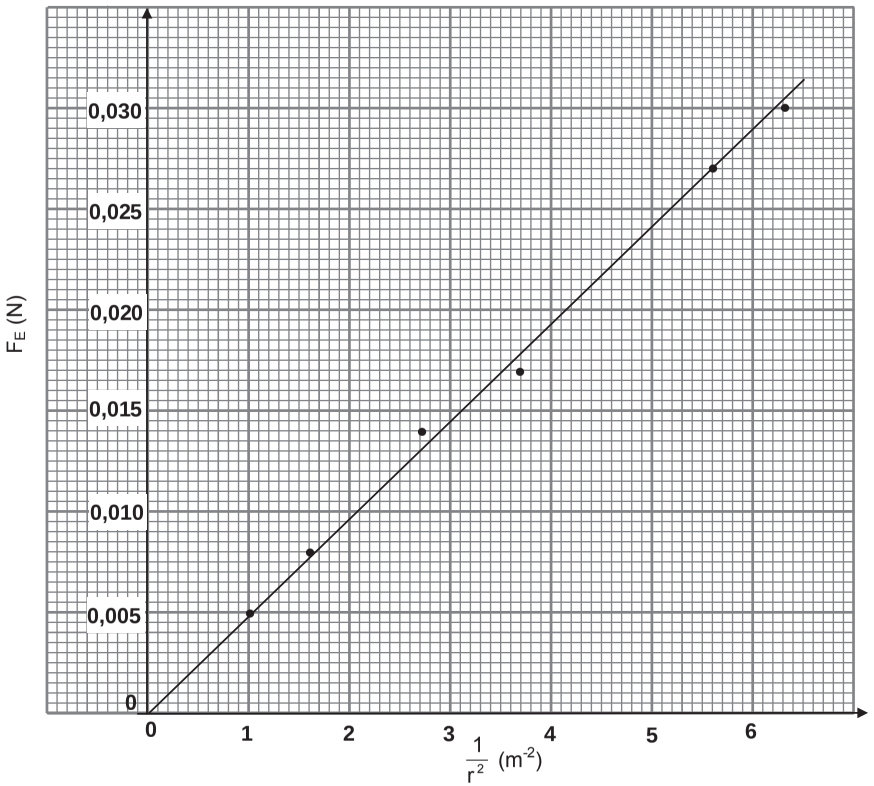
6.2 An observation of the spectrum of a distant star shows that it is moving away from the Earth.

Explain, in terms of the frequencies of the spectral lines, how it is possible to conclude that the star is moving away from the Earth. (2)
**[13]**

**QUESTION 7 (Start on a new page.)**

7.1 In an experiment to verify the relationship between the electrostatic force, $F_E$, and distance, r, between two **identical**, positively charged spheres, the graph below was obtained.

**GRAPH OF $F_E$ VERSUS $\frac{1}{r^2}$**




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

7.1.2 Write down the dependent variable of the experiment. (1)

7.1.3 What relationship between the electrostatic force $F_E$ and the square of the distance, $r^2$, between the charged spheres can be deduced from the graph? (1)

7.1.4 Use the information in the graph to calculate the charge on each sphere. (6)

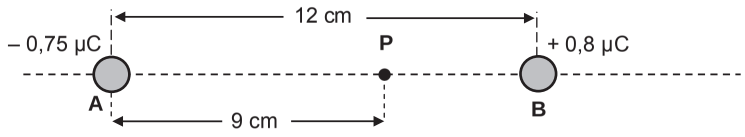




7.2 A charged sphere, **A**, carries a charge of – 0,75 μC.

7.2.1 Draw a diagram showing the electric field lines surrounding sphere **A**. (2)

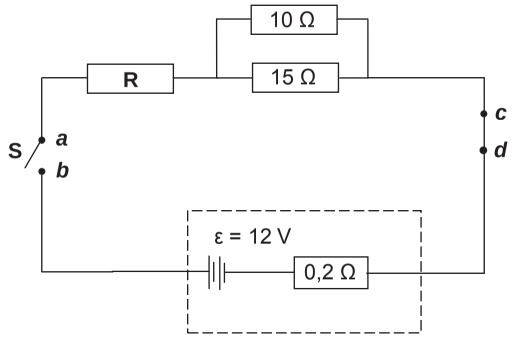
Sphere **A** is placed 12 cm away from another charged sphere, **B**, along a straight line in a vacuum, as shown below. Sphere **B** carries a charge of +0,8 μC. Point **P** is located 9 cm to the right of sphere **A**.




7.2.2 Calculate the magnitude of the net electric field at point **P**. (5)
**[17]**

**QUESTION 8 (Start on a new page.)**

8.1 In the circuit below the battery has an emf (ε) of 12 V and an internal resistance of 0,2 Ω. The resistances of the connecting wires are negligible.




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

8.1.2 Switch **S** is open. A high-resistance voltmeter is connected across points ***a*** and ***b***.
What will the reading on the voltmeter be? (1)

8.1.3 Switch **S** is now closed. The same voltmeter is now connected across points ***c*** and ***d***.
What will the reading on the voltmeter be? (1)

When switch **S** is closed, the potential difference across the terminals of the battery is 11,7 V.

Calculate the:

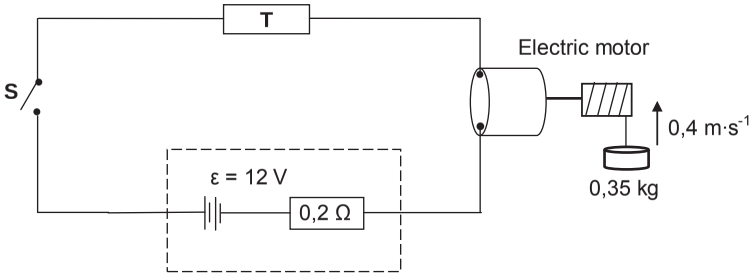
8.1.4 Current in the battery (3)

8.1.5 Effective resistance of the **parallel** branch (2)

8.1.6 Resistance of resistor **R** (4)

8.2 A battery with an emf of 12 V and an internal resistance of 0,2 Ω are connected in series to a very small electric motor and a resistor, **T**, of unknown resistance, as shown in the circuit below.

The motor is rated **X** watts, 3 volts, and operates at optimal conditions.




When switch **S** is closed, the motor lifts a 0,35 kg mass vertically upwards at a constant speed of 0,4 $m \cdot s^{-1}$. Assume that there is no energy conversion into heat and sound.

Calculate the value of:

8.2.1 **X** (3)

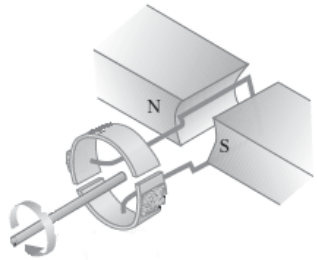
8.2.2 The resistance of resistor **T** (5)
**[21]**





**QUESTION 9 (Start on a new page.)**

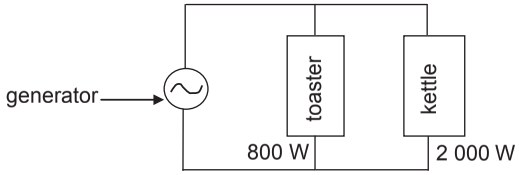
9.1 A generator is shown below. Assume that the coil is in a vertical position.




9.1.1 Is the generator above AC or DC? Give a reason for the answer. (2)

9.1.2 Sketch an induced emf versus time graph for ONE complete rotation of the coil. (The coil starts turning from the vertical position.) (2)

9.2 An AC generator is operating at a maximum emf of 340 V. It is connected across a toaster and a kettle, as shown in the diagram below.




The toaster is rated at 800 W, while the kettle is rated at 2 000 W. Both are working under optimal conditions.

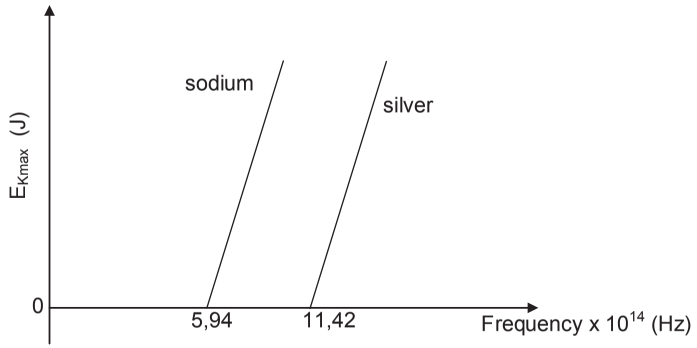
Calculate the:

9.2.1 rms current passing through the toaster (3)

9.2.2 Total rms current delivered by the generator (4)
**[11]**

**QUESTION 10 (Start on a new page.)**

10.1 A learner is investigating the photoelectric effect for two different metals, silver and sodium, using light of different frequencies. The maximum kinetic energy of the emitted photoelectrons is plotted against the frequency of the light for each of the metals, as shown in the graphs below.




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

10.1.2 Which metal, sodium or silver, has the larger work function? Explain the answer. (3)

10.1.3 Name the physical constant represented by the slopes of the graphs. (1)

10.1.4 If light of the same frequency is shone on each of the metals, in which metal will the ejected photoelectrons have a larger maximum kinetic energy? (1)

10.2 In a different photoelectric experiment blue light obtained from a light bulb is shone onto a metal plate and electrons are released.

The wavelength of the blue light is 470 x $10^{-9}$ m and the bulb is rated at 60 mW. The bulb is only 5% efficient.

10.2.1 Calculate the number of photons that will be incident on the metal plate per second, assuming all the light from the bulb is incident on the metal plate. (5)

10.2.2 **Without any further calculation**, write down the number of electrons emitted per second from the metal. (1)
**[13]**

**TOTAL: 150**

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**GRADE 12**

**SEPTEMBER 2014**

# PHYSICAL SCIENCES P1

**MARKS:** **150**

**TIME:** **3 hours**

This question paper consists of 17 pages including a 3 page data sheet.

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the best answer and write down **A**, **B**, **C** or **D** next to the question number (1.1–1.10) on your ANSWER BOOK.

1.1 A builder throws a brick vertically upwards with an initial velocity of 7,35 $m \bullet s^{-1}$. When the brick reaches its maximum height, then the …

A acceleration of the brick is 7,35 $m \bullet s^{-2}$ and its potential energy is a maximum.

B velocity of the brick is 0 $m \bullet s^{-1}$ and its potential energy is a minimum.

C velocity of the brick is 9,8 $m \bullet s^{-1}$ and its potential energy is a maximum.

D acceleration of the brick is 9,8 $m \bullet s^{-2}$ and its kinetic energy is a minimum. (2)

1.2 A vehicle with mass *m* is moving horizontally at a constant velocity on a frictionless path. The kinetic energy of the vehicle is K and the momentum is p. The velocity of the vehicle can be given as:

A $\frac{K}{2p}$

B $\frac{2K}{p}$

C $\frac{K}{P}$

D $\frac{p}{K}$ (2)

1.3 When an airbag inflates in a car during a collision, the chances of serious injury to a passenger is reduced because the …

A passenger is brought to rest in a shorter period of time.

B net force acting on the passenger is reduced.

C passenger's change in momentum is reduced.

D passenger's change in momentum is increased. (2)





1.4 A spaceship experiences a weight of X on earth. It is sent into space and lands on a planet which has a mass twice that of the earth and a radius ½ that of the earth. The weight of the spaceship will be ...

A 8X

B ½X

C X

D ¼X (2)

1.5 Astronomers observe that the emitted light of a star shifts to the red part of the visible spectrum. The observation confirms that the ...

A star is moving closer towards earth.

B earth is moving towards the star.

C temperature of earth is increasing.

D universe is expanding. (2)

1.6 A girl stands next to the road as a fire engine approaches her with its sirens blaring and the red flashlights on. She makes the following observations:

| | Frequency of sound heard | Colour of flashlight |
|---|---|---|
| A | Higher | Red |
| B | Lower | Red |
| C | Higher | Orange |
| D | Lower | Orange |

(2)

1.7 Which statement below is CORRECT for resistors connected in parallel in a circuit?

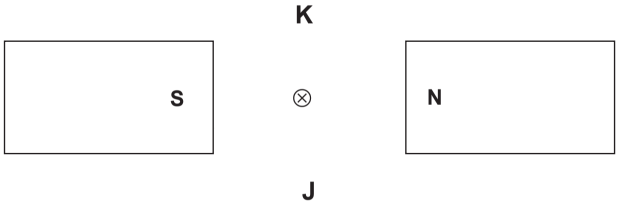
A The voltage (V) across the combination is divided but the resistors each have the same current (I).

B The current (I) across the combination is divided but the resistors each have the same voltage (V).

C The current (I) and the voltage (V) across the combination is divided.

D The current (I) and the voltage (V) across the combination is the same across each resistor. (2)

1.8 Two strong bar magnets are arranged with the north and south poles facing each other as shown in the diagram below. A current-carrying conductor placed between the two magnetic poles carries conventional current into the plane of the page.




The conductor would experience a force towards …

A N.

B S.

C K.

D J. (2)

1.9 If a light is passed through a cold, diluted gas, the atoms of the gas absorb photons at a certain …

A velocity and form an absorption spectrum.

B velocity and form a continuous spectrum.

C frequency and form an absorption spectrum.

D frequency and form a line emission spectrum. (2)

1.10 An atom in the ground state absorbs energy, E, and is excited to a higher energy state. When the atom returns to the ground state, a photon with energy …

A E is absorbed.

B E is released.

C ½E is absorbed.

D ½E is released. (2)

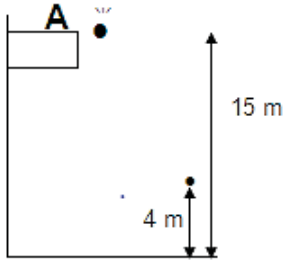
**[20]**





**QUESTION 2 (Start on a new page.)**

A cricket ball, mass 156 g, is dropped from point **A** on a tall building, 15 m high. It strikes the concrete pavement and it then bounces to a maximum height of 4 m.




2.1 Calculate the velocity with which the cricket ball strikes the pavement. (3)

2.2 If the effects of air friction are NOT ignored during the fall of the cricket ball, how would the value you calculated in QUESTION 2.1 change? Write down HIGHER, LOWER or STAYS THE SAME. (1)

2.3 The cricket ball is in contact with the concrete pavement of 0,8 s. Ignore the effects of air friction. Take DOWNWARD motion as POSITIVE.

2.3.1 Calculate the impulse of the cricket ball on the pavement. (8)

2.3.2 Calculate the (net) average force exerted by the pavement on the cricket ball. (4)

2.4 Sketch the **position versus time** graph for the motion of the cricket ball from the moment it is dropped until it reaches its maximum height after the bounce.

USE POINT **A** AS THE ZERO POSITION.

Indicate the following on the graph:

- The height from which the cricket ball is dropped
- The height reached by the cricket ball after the bounce
- Time with which the cricket ball is in contact with the concrete pavement (4)

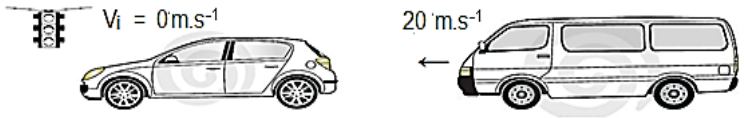
2.5 The cricket ball is now replaced with a softer ball of similar mass. State how the (net) average force exerted by the concrete pavement on the softer ball compares with your answer in QUESTION 2.3.2. (Write down only GREATER, SMALLER or STAYS THE SAME). Use physics principles to explain your answer. (3)

**[23]**

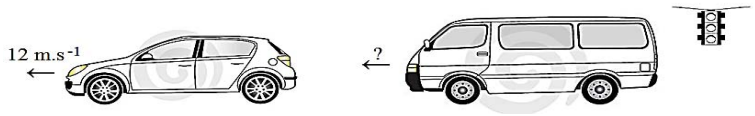
**QUESTION 3 (Start on a new page.)**

A car of mass 1 500 kg is stationary at a traffic light. It is hit from behind by a minibus of mass 2 000 kg travelling at a speed of 20 m•s$^{-1}$. Immediately after the collision the car moves forward at 12 m•s$^{-1}$.

**BEFORE**




**AFTER**




3.1 State the LAW OF CONSERVATION OF LINEAR MOMENTUM in words. (2)

3.2 Calculate the speed of the minibus immediately after the collision. (4)

3.3 The driver of the minibus is NOT wearing a seatbelt.

Describe the motion that the driver undergoes immediately after the collision. (1)

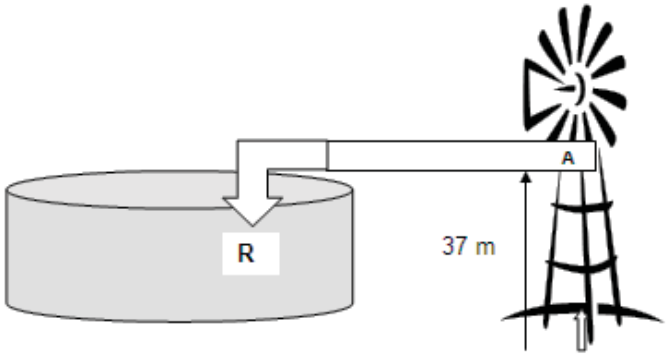
3.4 State the law of physics which can be used to explain your answer about the motion of the driver in QUESTION 3.3. (2)
**[9]**





**QUESTION 4 (Start on a new page.)**

A windmill is used on a farm to pump water out of a well that is 37 m deep. The water flows past point A, 37 m above the well to the dam with a constant velocity of 2 m•s$^{-1}$.




4.1 Calculate how much energy is necessary to pump 90 kg of water out of the well to point **A**. (4)

4.2 It is necessary to pump 90 kg of water per minute. What is the maximum power that the windmill must produce? (3)

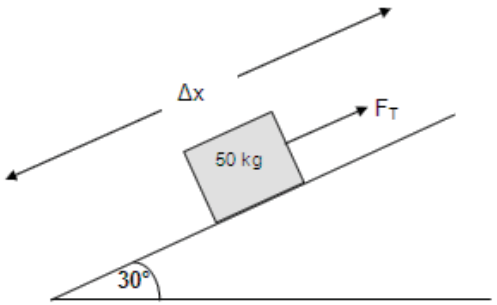
4.3 The farmer wants to modernise the farm. The farmer decides to buy a 0,5 kW petrol water pump.

4.3.1 Will the petrol water pump be able to produce the required power? (YES or NO) (1)

4.3.2 Why would you advise the farmer to rather use a windmill instead of a petrol water pump? (1)
**[9]**

**QUESTION 5 (Start on a new page.)**

The diagram below shows a crate of mass 50 kg sliding down a steep slope. The slope makes an angle of 30° with the horizontal. The motion of the crate as it moves down the slope is controlled by a worker using a rope attached to the crate. The rope is held parallel to the slope. The tension in the rope, $F_T$, is 300 N and a constant frictional force of 50 N acts on the crate as it slides down the slope.




5.1 Draw a **labelled free-body diagram** showing the forces parallel to the slope acting on the crate as it moves down the slope. (3)

5.2 State the WORK-ENERGY THEOREM in words. (2)

5.3 The change in kinetic energy of the crate is 450 J as it slides from the top to the bottom of the slope.

Use the **work-energy theorem** to calculate the length of the slope, Δx. (5)

5.4 Calculate the coefficient of kinetic friction on the crate as it moves down the slope. (4)
**[14]**





**QUESTION 6 (Start on a new page.)**

An ambulance approaches an accident scene at a constant velocity. The siren of the ambulance emits sound waves with a constant, unknown frequency. A detector at the scene measures the frequency as 1,07 times the frequency of the siren.

6.1 State the DOPPLER EFFECT for sound in words. (2)

6.2 Calculate the speed at which the ambulance approaches the accident scene. Use the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.3 Explain, in terms of wave motion, why the frequency detected by the detector is higher than the frequency of the source. (2)

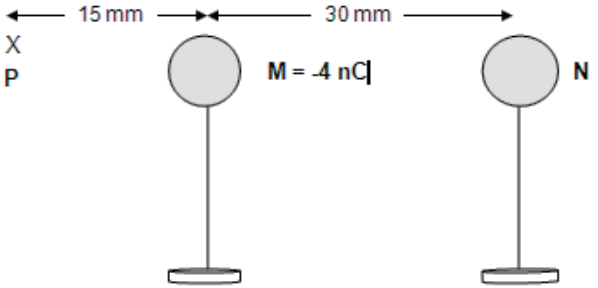
6.4 State TWO uses of the Doppler flow meter in humans. (2)

6.5 A line in a hydrogen spectrum has a frequency of $7,55 \times 10^{14}$ Hz when measured in a laboratory. The same line in the light of a star has a frequency of $7,23 \times 10^{14}$ Hz.

Is this star moving TOWARDS or AWAY from the Earth?
Explain your answer. (2)
**[13]**

**QUESTION 7 (Start on a new page.)**

Two metal spheres, **M** and **N,** are on insulated stands. **M** with charge of -4 nC is placed 30 mm away from **N**. **P** is a point at a distance 15 mm from sphere **M** as shown below. The NET ELECTRIC FIELD STRENGTH at point **P** due to presence of **M** and **N** is 2 x $10^5$ N•$C^{-1}$ eastwards.




7.1 Define the term *ELECTRIC FIELD* at a point. (2)

7.2 Calculate the magnitude and direction of the electric field at point **P** due to the presence of sphere **M**. (5)

7.3 Calculate the magnitude of the charge on sphere **N**. (5)

7.4 Is the charge on sphere **N,** POSITIVE or NEGATIVE? (1)

7.5 Sketch the net electric field pattern due to the two spheres, **M** and **N**. (3)

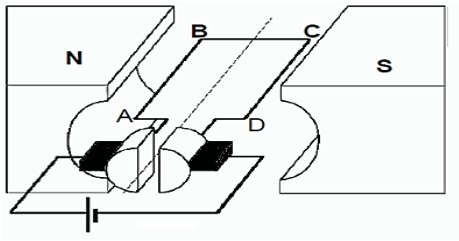
7.6 Calculate the magnitude of the electric force that an electron will experience when placed at point **P**. (3)
**[19]**





**QUESTION 8 (Start on a new page.)**

The simplified sketch below represents a DC motor.




8.1 Name the principle on which the motor operates. (1)

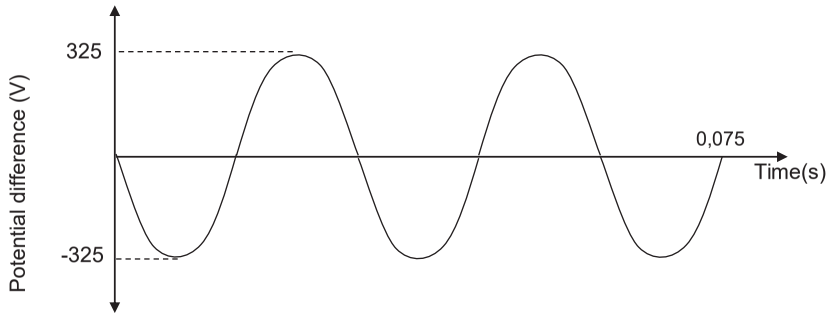
8.2 State the energy conversion which takes place in a DC motor. (1)

8.3 Give a reason why section BC in the above diagram does NOT experience a magnetic force whilst the coil is in the position as shown. (2)

8.4 In which direction will the coil rotate, CLOCKWISE or ANTI-CLOCKWISE? (1)

8.5 Write down ONE way in which the turning effect (torque) can be increased. (1)

8.6 The graph below shows how the alternating voltage, produced by the AC generator, varies with time.



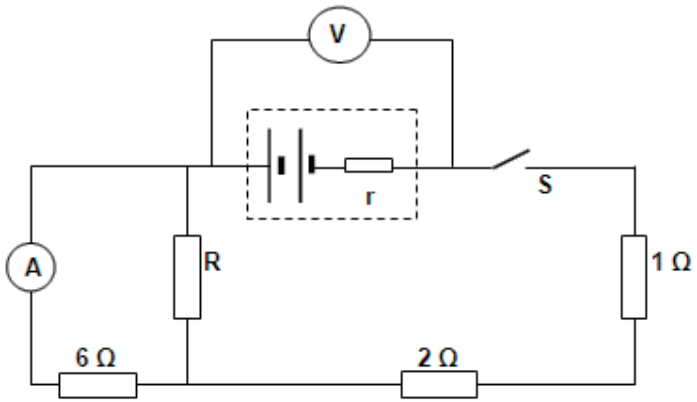

8.6.1 Calculate the frequency of the alternating voltage. (3)

8.6.2 The generator's average power output is 2,7 kW. Calculate the maximum current that the generator produces. (5)
**[14]**

**QUESTION 9 (Start on a new page.)**

A learner wants to use a battery with an emf of 13 V to operate a walking doll. The battery has an unknown internal resistance of **r**. The walking doll has a resistance of 6 Ω. The learner uses the circuit below to obtain the potential difference required for the walking doll to function.

When switch **S** is closed, the reading on the voltmeter drops to 12 V and the walking doll functions at its maximum power of 6 W.




9.1 Explain briefly why the reading on the voltmeter drops when switch **S** is closed. (2)

9.2 Calculate the internal resistance, **r**, of the battery. Show all the steps in your calculations. (9)

9.3 Calculate the magnitude of the unknown resistor, **R**. (3)

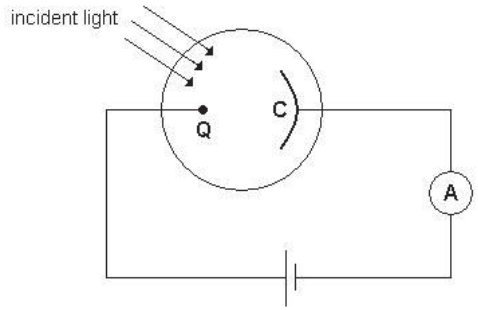
9.4 The resistor **R** is replaced with a conducting wire of negligible resistance. What effect will this have on the "lost volts"? Fully explain your answer. (4)
**[18]**



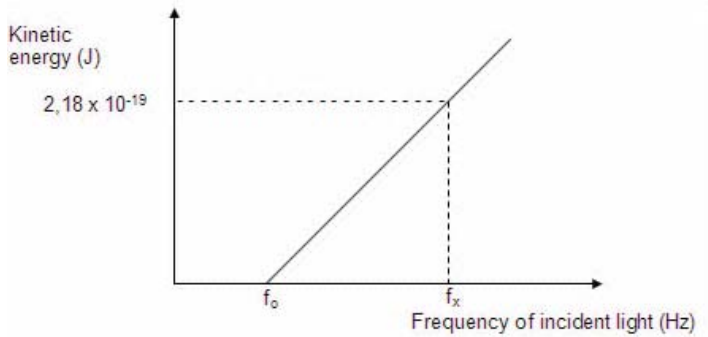


**QUESTION 10 (Start on a new page.)**

Learners in a physics class perform an experiment using a photo cell to investigate the relationship between photo electrons emitted and the frequency of the incident light.




A graph is plotted of the maximum kinetic energy ($E_k$) against the frequency of the incident light. When the straight line graph is extrapolated, it intercepts the x-axis at $f_o = 4{,}29 \times 10^{14}$ Hz.




10.1 Write an investigative question for this investigation. (2)

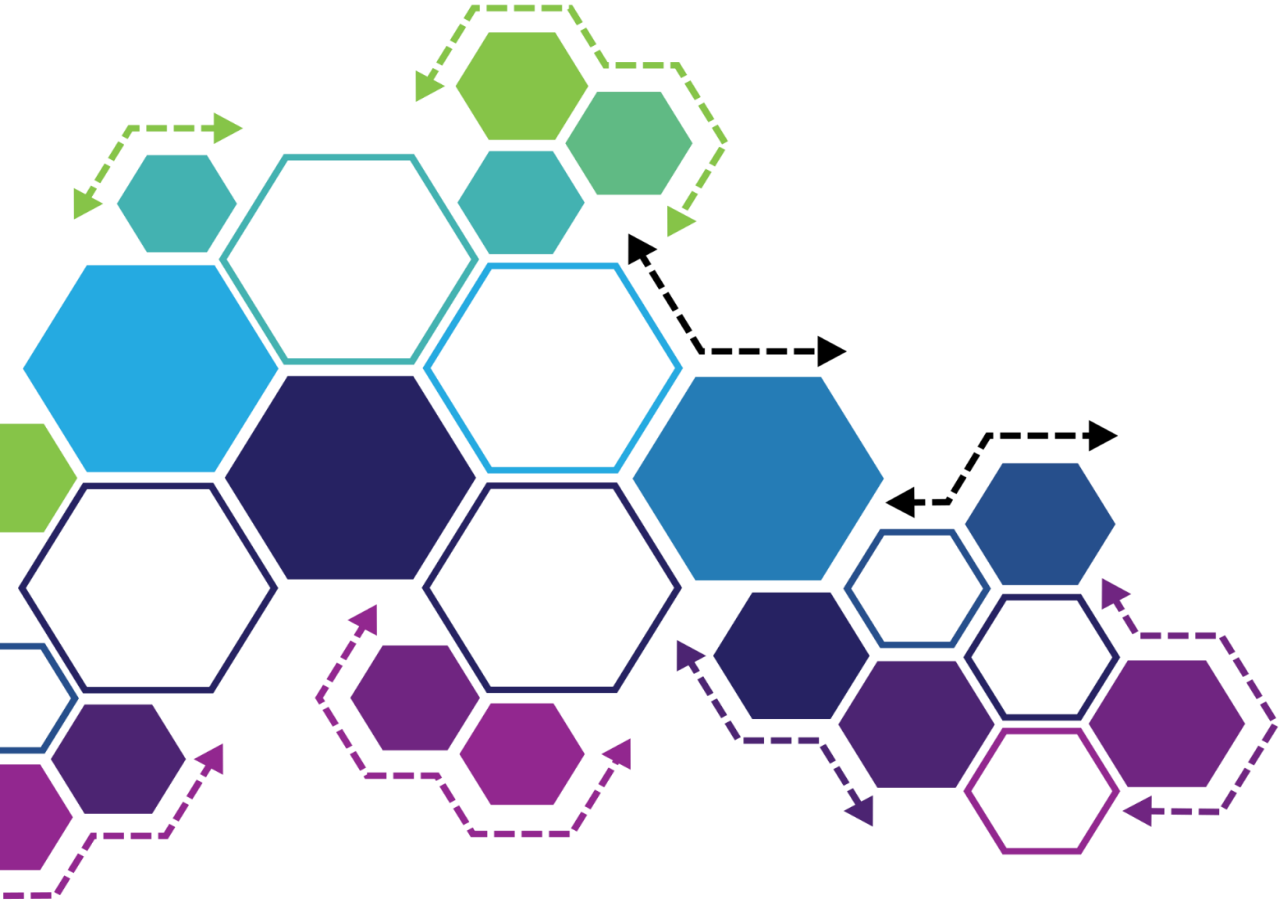
10.2 What is the frequency, f, in the graph called? (1)

10.3 Calculate the frequency, $f_x$, in the graph. (5)

10.4 Draw a sketch-graph of the **kinetic energy** of the photo-electrons (on the y-axis) **versus** the **intensity** of the incident light. (No values needed on the graph.) (3)
**[11]**

**TOTAL: 150**

# Chemistry Data Sheets



## 4.3 INFORMATION SHEETS – PAPER 2 (CHEMISTRY)

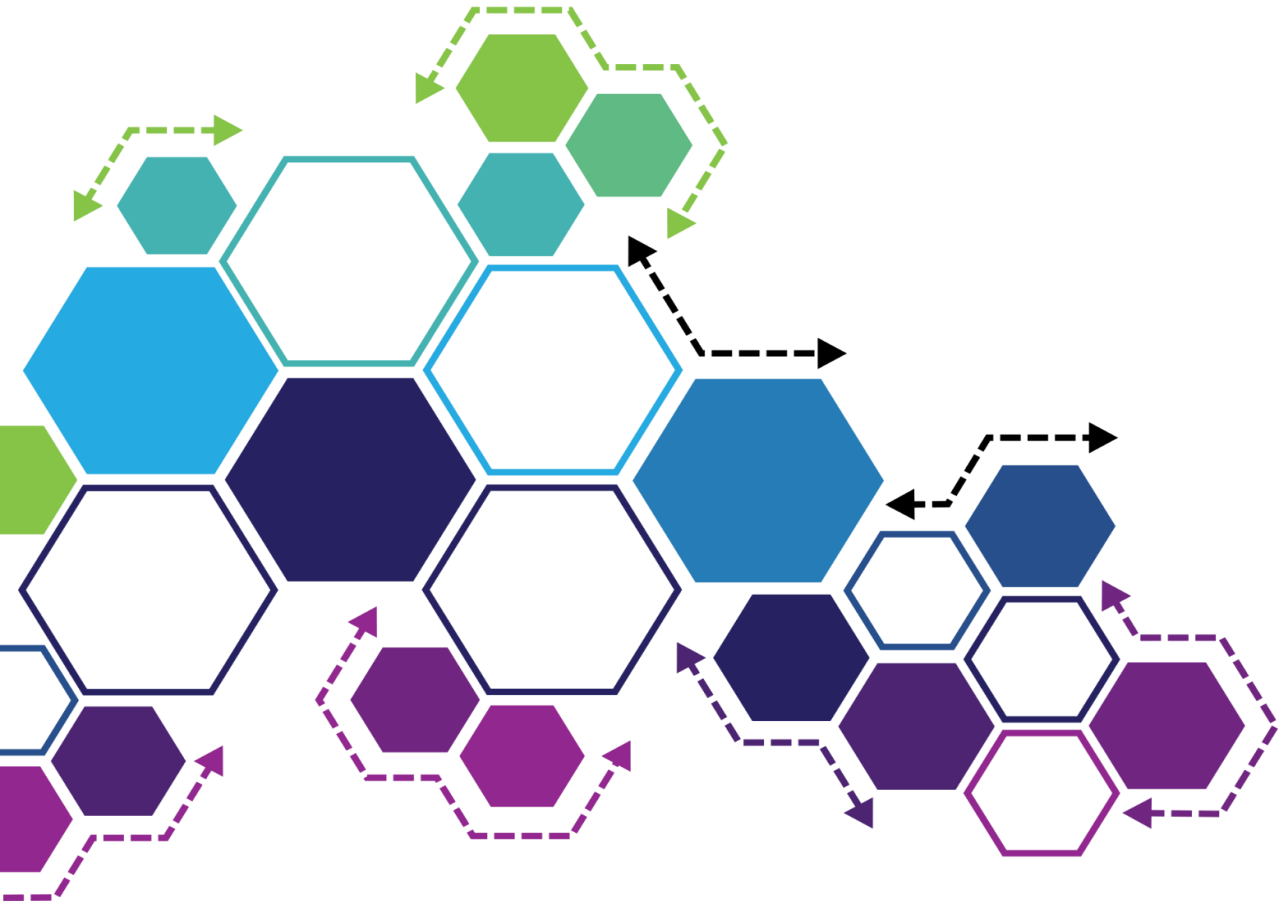
### TABLE 1: PHYSICAL CONSTANTS

| NAME | SYMBOL | VALUE |
|---|---|---|
| Avogadro's constant | $N_A$ | $6,02 \times 10^{23}$ mol$^{-1}$ |
| Standard pressure | $p^{\theta}$ | $1,01 \times 10^{5}$ Pa |
| Molar gas volume at STP | $V_m$ | 22,4 dm$^3$·mol$^{-1}$ |
| Standard temperature | $T^{\theta}$ | 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 | |
| $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$<br>$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$<br>$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ | |

# Periodic Table



## TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*

Electronegativity / *Elektronegatiwiteit* — 1,9

Symbol / *Simbool* — Cu

Approximate relative atomic mass / *Benaderde relatiewe atoommassa* — 63,5

| 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<br>1<br>H<br>1 | | | | | | | | | | | | | | | | | 2<br>He<br>4 |
| 1,0<br>3<br>Li<br>7 | 1,5<br>4<br>Be<br>9 | | | | | | | | | | | 2,0<br>5<br>B<br>11 | 2,5<br>6<br>C<br>12 | 3,0<br>7<br>N<br>14 | 3,5<br>8<br>O<br>16 | 4,0<br>9<br>F<br>19 | 10<br>Ne<br>20 |
| 0,9<br>11<br>Na<br>23 | 1,2<br>12<br>Mg<br>24 | | | | | | | | | | | 1,5<br>13<br>Aℓ<br>27 | 1,8<br>14<br>Si<br>28 | 2,1<br>15<br>P<br>31 | 2,5<br>16<br>S<br>32 | 3,0<br>17<br>Cℓ<br>35,5 | 18<br>Ar<br>40 |
| 0,8<br>19<br>K<br>39 | 1,0<br>20<br>Ca<br>40 | 1,3<br>21<br>Sc<br>45 | 1,5<br>22<br>Ti<br>48 | 1,6<br>23<br>V<br>51 | 1,6<br>24<br>Cr<br>52 | 1,5<br>25<br>Mn<br>55 | 1,8<br>26<br>Fe<br>56 | 1,8<br>27<br>Co<br>59 | 1,8<br>28<br>Ni<br>59 | 1,9<br>29<br>Cu<br>63,5 | 1,6<br>30<br>Zn<br>65 | 1,6<br>31<br>Ga<br>70 | 1,8<br>32<br>Ge<br>73 | 2,0<br>33<br>As<br>75 | 2,4<br>34<br>Se<br>79 | 2,8<br>35<br>Br<br>80 | 36<br>Kr<br>84 |
| 0,8<br>37<br>Rb<br>86 | 1,0<br>38<br>Sr<br>88 | 1,2<br>39<br>Y<br>89 | 1,4<br>40<br>Zr<br>91 | 41<br>Nb<br>92 | 1,8<br>42<br>Mo<br>96 | 1,9<br>43<br>Tc | 2,2<br>44<br>Ru<br>101 | 2,2<br>45<br>Rh<br>103 | 2,2<br>46<br>Pd<br>106 | 1,9<br>47<br>Ag<br>108 | 1,7<br>48<br>Cd<br>112 | 1,7<br>49<br>In<br>115 | 1,8<br>50<br>Sn<br>119 | 1,9<br>51<br>Sb<br>122 | 2,1<br>52<br>Te<br>128 | 2,5<br>53<br>I<br>127 | 54<br>Xe<br>131 |
| 0,7<br>55<br>Cs<br>133 | 0,9<br>56<br>Ba<br>137 | 57<br>La<br>139 | 1,6<br>72<br>Hf<br>179 | 73<br>Ta<br>181 | 74<br>W<br>184 | 75<br>Re<br>186 | 76<br>Os<br>190 | 77<br>Ir<br>192 | 78<br>Pt<br>195 | 79<br>Au<br>197 | 80<br>Hg<br>201 | 1,8<br>81<br>Tℓ<br>204 | 1,8<br>82<br>Pb<br>207 | 1,9<br>83<br>Bi<br>209 | 2,0<br>84<br>Po | 2,5<br>85<br>At | 86<br>Rn |
| 0,7<br>87<br>Fr | 0,9<br>88<br>Ra<br>226 | 89<br>Ac | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58<br>Ce<br>140 | 59<br>Pr<br>141 | 60<br>Nd<br>144 | 61<br>Pm | 62<br>Sm<br>150 | 63<br>Eu<br>152 | 64<br>Gd<br>157 | 65<br>Tb<br>159 | 66<br>Dy<br>163 | 67<br>Ho<br>165 | 68<br>Er<br>167 | 69<br>Tm<br>169 | 70<br>Yb<br>173 | 71<br>Lu<br>175 |
| 90<br>Th<br>232 | 91<br>Pa | 92<br>U<br>238 | 93<br>Np | 94<br>Pu | 95<br>Am | 96<br>Cm | 97<br>Bk | 98<br>Cf | 99<br>Es | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |

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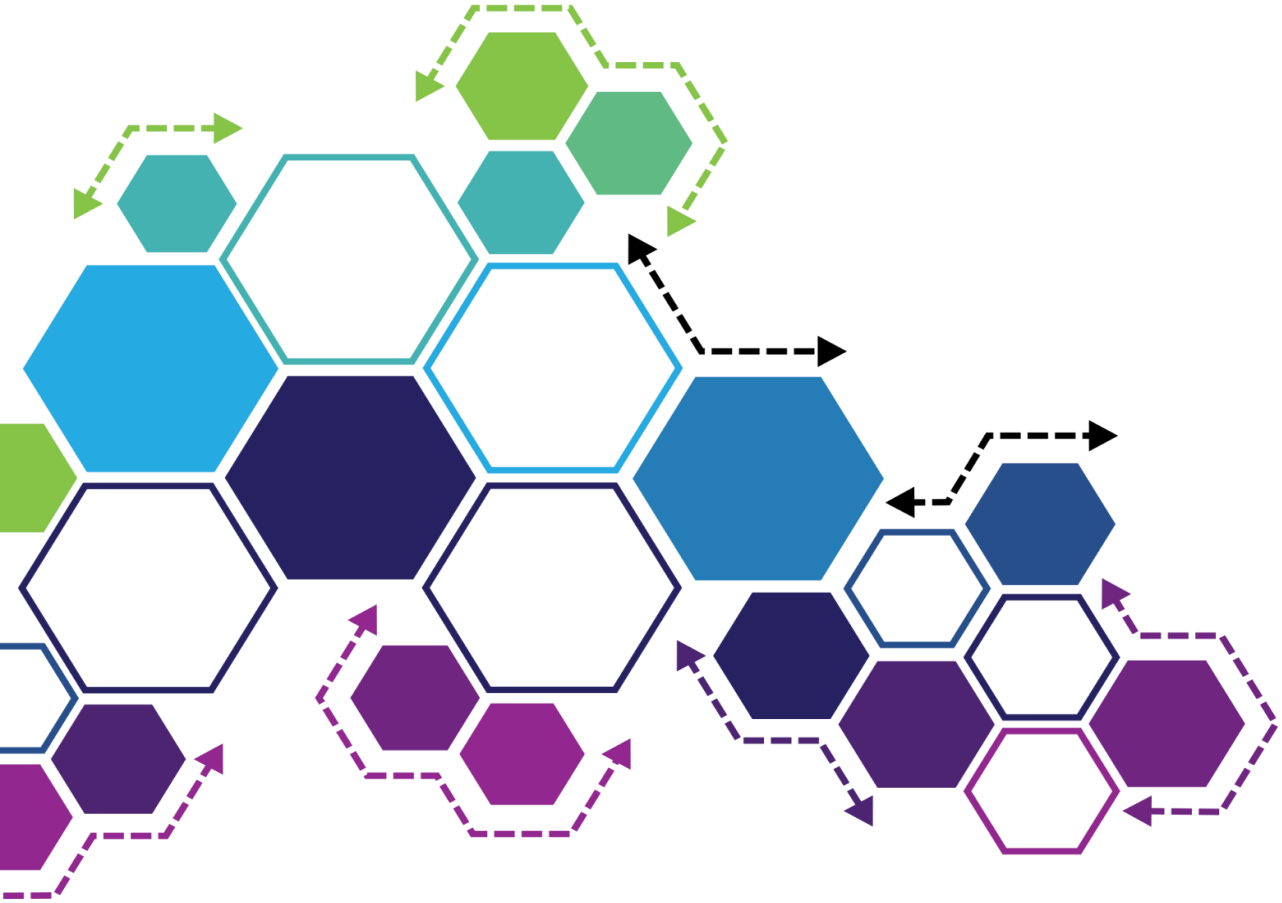
# Standard Reduction Potentials



## 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 |





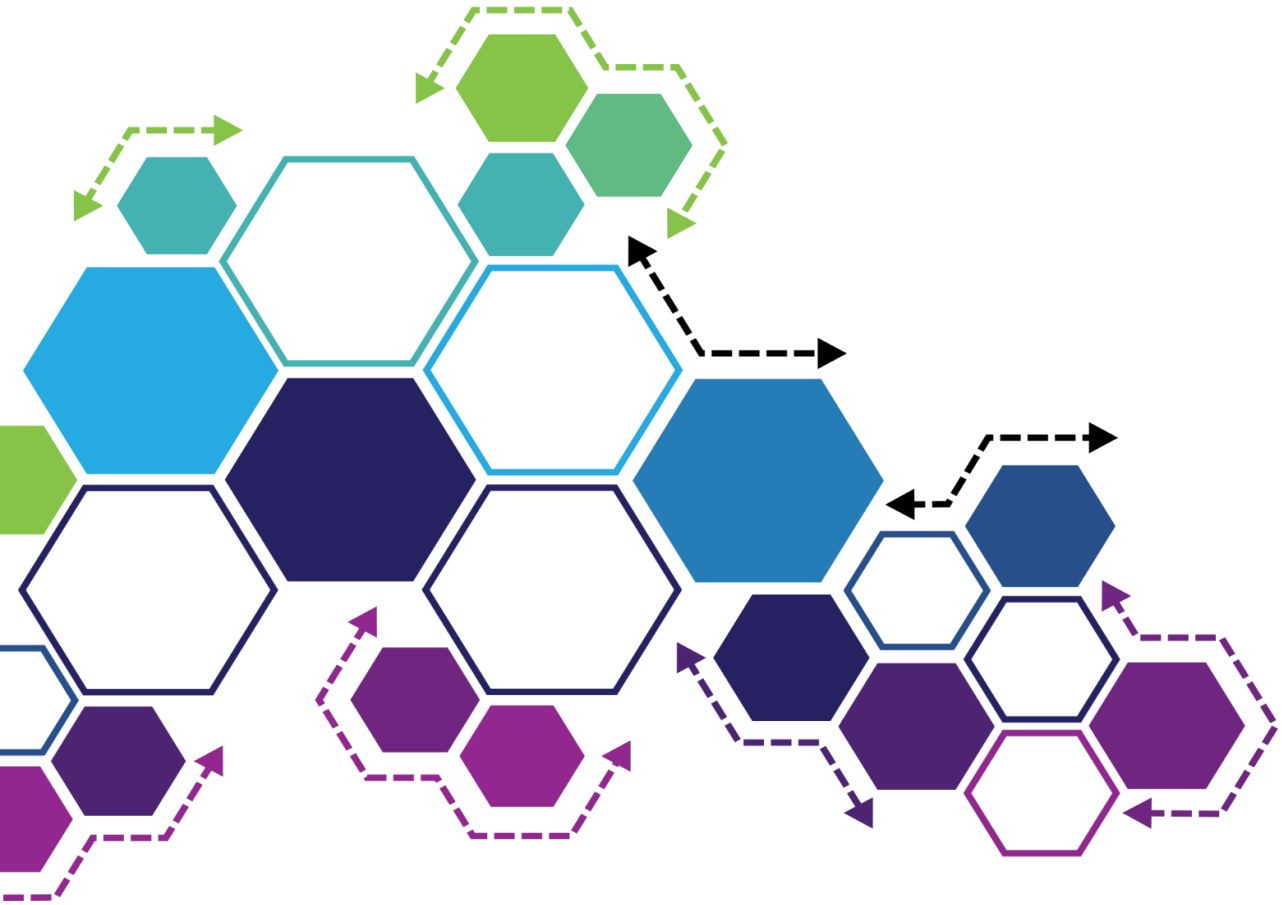
## TABLE 4B: STANDARD REDUCTION POTENTIALS

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/**
**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.**





**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 …

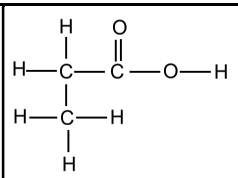
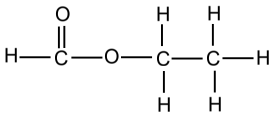
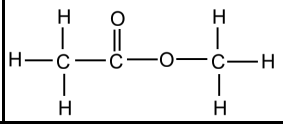
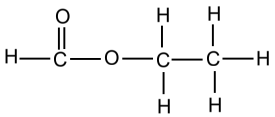
A $C_3H_6O_2$

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)

1.4 Zinc (Zn) granules react as follows with EXCESS hydrochloric acid solution, $HC\ell(aq)$:

$$Zn(s) + HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

Which ONE of the following combinations of volume and concentration of $HC\ell(aq)$ 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 $HC\ell(aq)$ ($cm^3$) | CONCENTRATION $HC\ell(aq)$ ($mol\cdot dm^{-3}$) |
|---|---|---|
| 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?

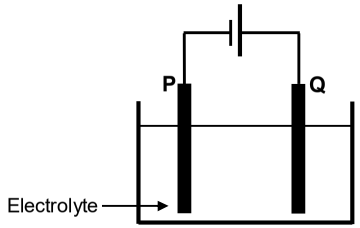
A $Ni^{2+}(aq) + H_2(g) \rightarrow Ni(s) + 2H^+(aq)$

B $Br_2(\ell) + 2C\ell^-(aq) \rightarrow 2Br^-(aq) + C\ell_2(g)$

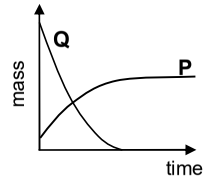
C $2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$

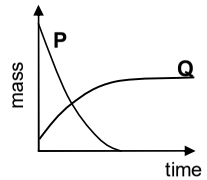
D $2Cu^+(aq) + Pb^{2+}(aq) \rightarrow 2Cu^{2+}(aq) + Pb(s)$ (2)

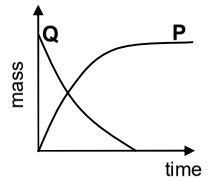
1.9 The simplified diagram below represents an electrochemical cell used for the PURIFICATION of copper.

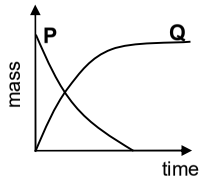



Which ONE of the graphs below represents the CHANGE IN MASS of electrodes **P** and **Q** during the purification process?

A



B



C



D



(2)

1.10 Eutrophication in water is caused by …

A algal bloom.

B bacterial nitrogen fixation.

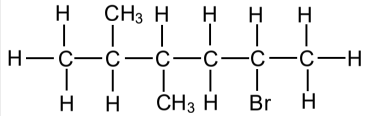
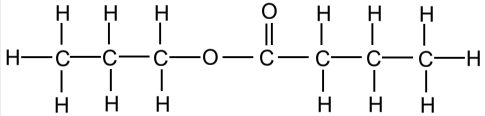
C an increase in plant nutrients.

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)

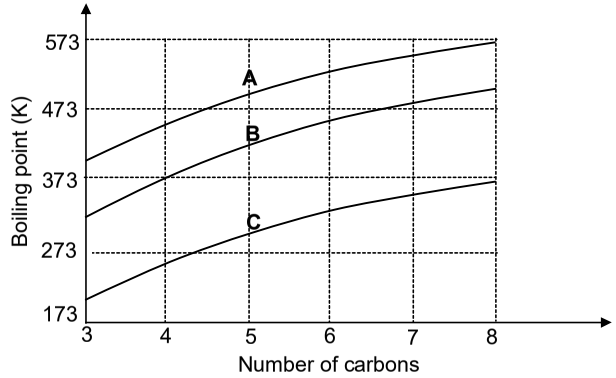
2.3.3 IUPAC name of compound **X** (1)
**[12]**





**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)

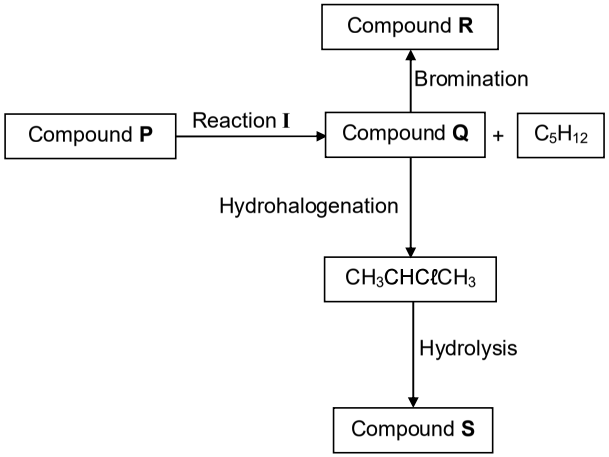
3.4.2 The aldehydes
Explain the answer. (4)

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.

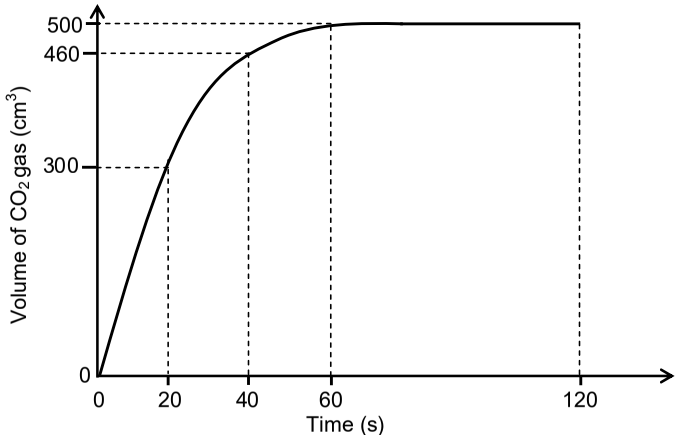
| EXPERIMENT | VOLUME OF $HC\ell(aq)$ ($cm^3$) | CONCENTRATION OF $HC\ell(aq)$ ($mol{\cdot}dm^{-3}$) | STATE OF DIVISION OF $CaCO_3$ |
|---|---|---|---|
| **A** | 500 | 0,1 | granules |
| **B** | 500 | 0,1 | lumps |
| **C** | 500 | 0,1 | powder |

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:

$$CaCO_3(s) + 2CH_3COOH(aq) \rightarrow (CH_3COO)_2Ca(aq) + H_2O + CO_2(g)$$

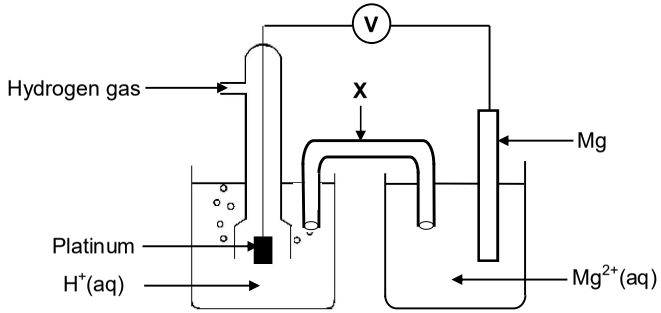
Calculate the percentage calcium carbonate in the impure sample if 1 $cm^3$ of household vinegar has a mass of 1 g. (8)
**[20]**





**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)

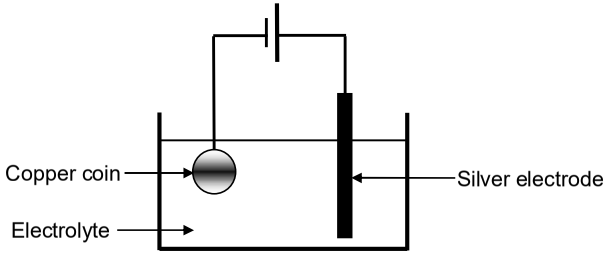
8.5 Calculate the initial voltmeter reading of this cell under standard conditions. (4)

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)

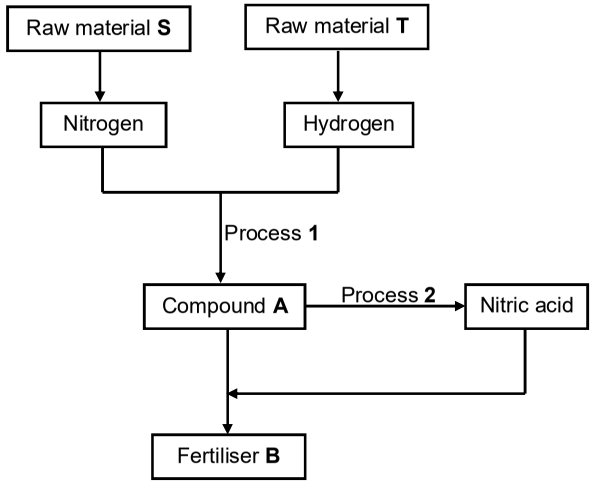
9.5 Write down the balanced equation of the half-reaction that takes place at the silver electrode. (2)
**[8]**





**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?

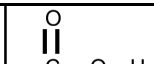
A Pentane

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)

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.

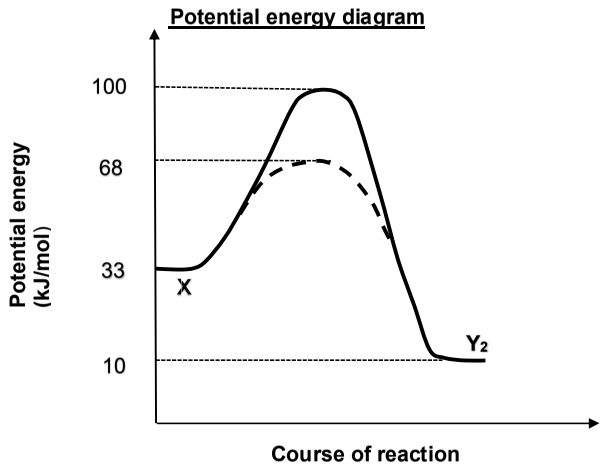
B primary alcohol.

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.

$$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$$

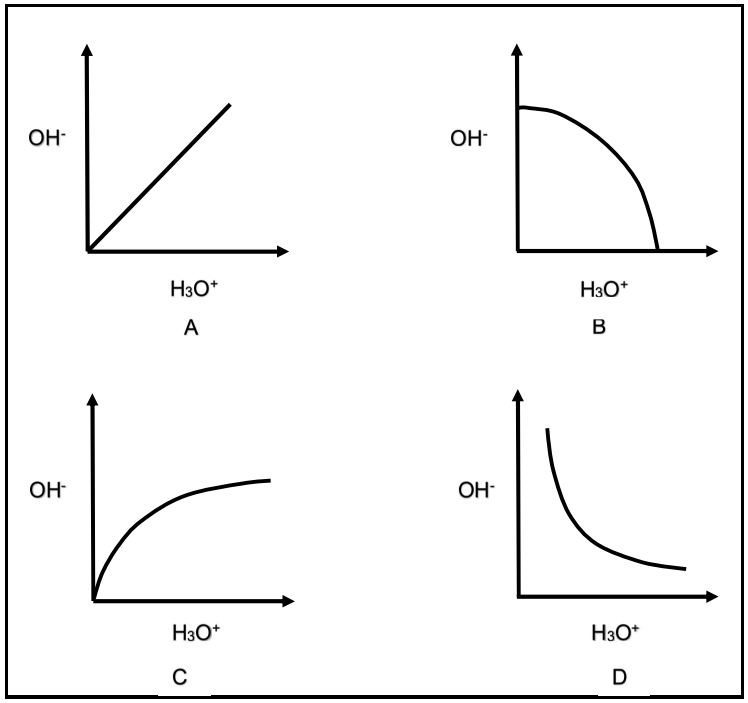
More C(s) and $CO_2(g)$ are added to the container at constant temperature.

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]**

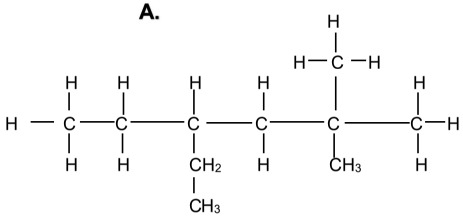




**QUESTION 2 (Start on a new page.)**

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:** $(CH_3)_2CH-\overset{\overset{\large O}{\|}}{C}-H$

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]**

**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 ⟶

**II**: Compound **P** + $H_2$ ⟶ $CH_3CH(CH_3)CH_3$

**III**: $CH_3CH_2CH_2COOH$ + $CH_3CH_2CH_2OH$ ⟶ 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]**

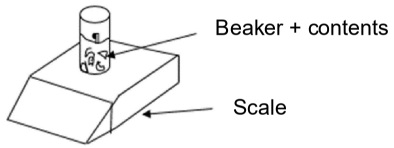
**QUESTION 5 (Start on a new page.)**

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.

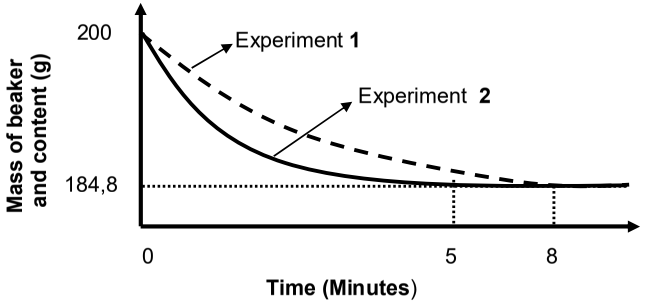
$$CaCO_3\,(s) + 2\,HC\ell\,(aq) \rightarrow CaC\ell_2\,(aq) + H_2O\,(\ell) + CO_2(g)$$

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)

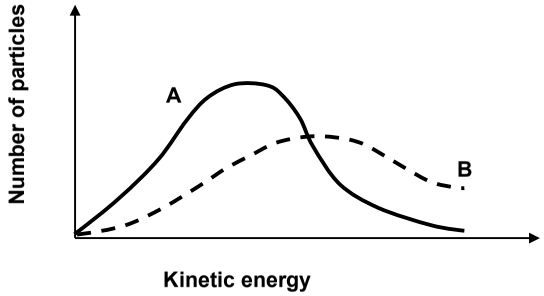
5.4 Calculate the average rate of reaction in $g \cdot min^{-1}$ for experiment **2**. (3)

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.)**

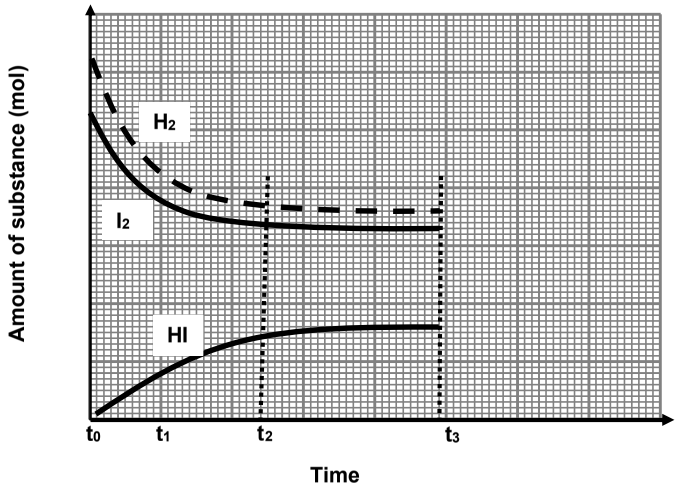
Consider the reversible reaction taking place in a closed container:

$$H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)$$

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)





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]**

**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 ($C_2O_4H_2 \cdot \mathbf{x}\ H_2O$).

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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**GRADE 12**

# PHYSICAL SCIENCES: CHEMISTRY (P2)

**NOVEMBER 2019**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 14 pages and 4 data sheets.**





## 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 compounds has the HIGHEST vapour pressure?

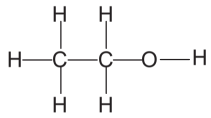
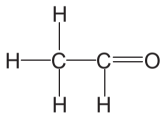
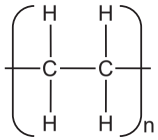
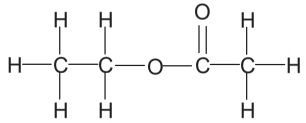
A $HCOOH$

B $CH_3CHO$

C $CH_3CH_2OH$

D $CH_3CH_2CH_3$ (2)

1.2 Which ONE of the formulae below represents the product of a POLYMERISATION reaction?

| | | | |
|---|---|---|---|
| **A** |  | **B** |  |
| **C** |  | **D** |  |

(2)

1.3 Which ONE of the following combinations are BOTH UNSATURATED HYDROCARBONS?

A Ethane and ethene

B Ethene and ethyne

C Ethane and ethanol

D Ethanoic acid and ethene (2)

1.4 Which ONE of the following sets of values for activation energy ($E_a$) and heat of reaction ($\Delta H$) is possible for a reaction?

| | ACTIVATION ENERGY ($E_a$) ($kJ \cdot mol^{-1}$) | HEAT OF REACTION ($\Delta H$) ($kJ \cdot mol^{-1}$) |
|---|---|---|
| A | 100 | +100 |
| B | 50 | +100 |
| C | 50 | +50 |
| D | 100 | -50 |

(2)

1.5 Consider the following balanced equation for a system at equilibrium:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

How will the addition of a catalyst to the equilibrium mixture affect the YIELD and REACTION RATE?

| | YIELD | REACTION RATE |
|---|---|---|
| A | Increases | Increases |
| B | Remains the same | Remains the same |
| C | Remains the same | Increases |
| D | Decreases | Increases |

(2)

1.6 A hypothetical reaction reaches equilibrium at a certain temperature in a closed container according to the following balanced equation:

$$A(g) + 2B(g) \rightleftharpoons 3C(s) \quad \Delta H < 0$$

Which ONE of the following changes to the equilibrium conditions will result in an INCREASE in the equilibrium constant, $K_c$?

A Increase in temperature

B Decrease in temperature

C Increase in pressure at constant temperature

D Decrease in pressure at constant temperature (2)





1.7 A hydrochloric acid solution, $HC\ell(aq)$, and an acetic acid solution, $CH_3COOH(aq)$, of EQUAL CONCENTRATIONS are compared.

How do the $H_3O^+(aq)$ concentration of $HC\ell(aq)$ and the pH of $HC\ell(aq)$ compare to that of $CH_3COOH(aq)$?

| | $[H_3O^+]$ of $HC\ell(aq)$ | pH of $HC\ell(aq)$ |
|---|---|---|
| A | Higher than | Higher than |
| B | Higher than | Lower than |
| C | Equal to | Equal to |
| D | Higher than | Equal to |

(2)

1.8 Two hypothetical half-reactions and their respective reduction potentials are shown below:

$$B^+(aq) + e^- \rightleftharpoons B(s) \qquad E^\theta = -1,5\ V$$
$$A^{2+}(aq) + 2e^- \rightleftharpoons A(s) \qquad E^\theta = 2,5\ V$$

A galvanic cell is set up using the above substances.

Which ONE of the following statements is CORRECT for this galvanic cell?

A B(s) is the reducing agent.

B A(s) is the oxidising agent.

C The mass of B(s) will increase.

D The mass of A(s) will decrease. (2)

1.9 In an electrolytic cell …

A the anode is the positive electrode.

B oxidation takes place at the cathode.

C electrons flow from the cathode to the anode.

D the mass of the anode increases. (2)

1.10 Which ONE of the following is used as a catalyst in the Ostwald process?

A Iron

B Copper

C Platinum

D Vanadium (V) oxide (2)

**[20]**

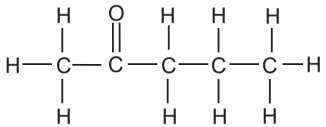
**QUESTION 2 (Start on a new page.)**

2.1 The IUPAC name of an organic compound is 4,4-dimethylpent-2-yne.

2.1.1 Write down the GENERAL FORMULA of the homologous series to which this compound belongs. (1)

2.1.2 Write down the STRUCTURAL formula of this compound. (3)

2.2 The organic compound below has one positional isomer and one functional isomer.



2.2.1 Define the term *positional isomer.* (2)

For this compound, write down the:

2.2.2 IUPAC name of its POSITIONAL isomer (2)

2.2.3 Structural formula of its FUNCTIONAL isomer (2)

2.3 Consider the condensed structural formula of an organic compound below.

$CH_3CH_2C(CH_3)CH_3$
|
OH

2.3.1 Is this a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

2.3.2 Write down the IUPAC name of the above compound. (2)

2.3.3 Write down the IUPAC name of the MAJOR ORGANIC PRODUCT formed when this compound undergoes an elimination reaction. (2)
**[16]**





**QUESTION 3 (Start on a new page.)**

The boiling points of five organic compounds (**P**, **Q**, **R, S** and **T**) are studied.

| COMPOUND | IUPAC NAME |
|---|---|
| **P** | Pentanal |
| **Q** | 2,2-dimethylbutane |
| **R** | 3-methylpentane |
| **S** | Hexane |
| **T** | Pentan-1-ol |

3.1 Define the term *boiling point.* (2)

The boiling points of compounds **Q**, **R** and **S** are compared.

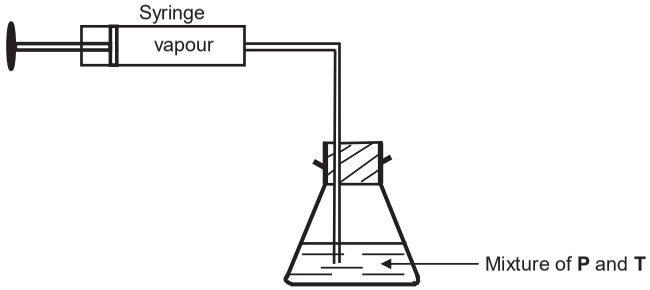
3.2 Give a reason why this is a fair comparison. (1)

The boiling points of **Q**, **R** and **S** are given below (NOT necessarily in the correct order).

| | | |
|---|---|---|
| 55 °C | 49,7 °C | 68 °C |

3.3 Which ONE of the three boiling points is most likely the boiling point of compound **R**? Explain the answer. (4)

3.4 A mixture of equal amounts of **P** and **T** is placed in a flask and heated to a temperature below their boiling points. Assume that no reaction or condensation takes place. The vapour produced is collected in a syringe.

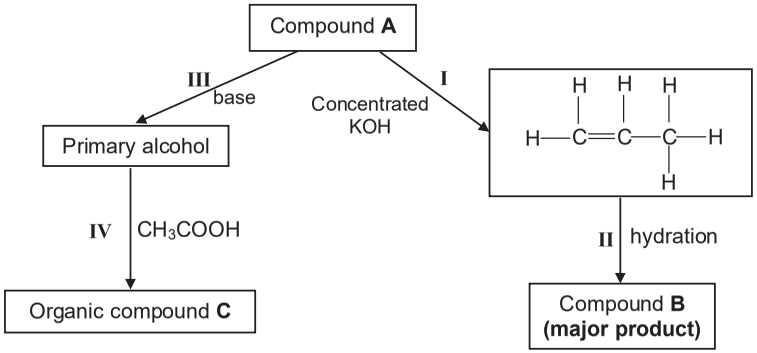



3.4.1 Which compound (**P** or **T**) will be present in a greater amount in the SYRINGE? (2)

3.4.2 Explain the answer to QUESTION 3.4.1 by referring to the TYPES and STRENGTHS of intermolecular forces. (3)
**[12]**

**QUESTION 4 (Start on a new page.)**

The flow diagram below shows how compound **A** can be used to prepare other organic compounds. The numbers **I**, **II**, **III** and **IV** represent different organic reactions.




Use the information in the flow diagram to answer the following questions.

4.1 Name the homologous series to which compound **A** belongs. (1)

4.2 Write down the TYPE of reaction represented by:

4.2.1 **I** (1)

4.2.2 **III** (1)

4.2.3 **IV** (1)

4.3 Consider **reaction III**. Write down the:

4.3.1 TWO reaction conditions for this reaction (2)

4.3.2 IUPAC name of the primary alcohol that is formed (2)

4.4 Draw the STRUCTURAL FORMULA for compound **B**. (2)

4.5 Consider **reaction IV**. Write down the:

4.5.1 Structural formula of organic compound **C** (2)

4.5.2 NAME or FORMULA of the catalyst that is used (1)
**[13]**





**QUESTION 5 (Start on a new page.)**

The calcium carbonate ($CaCO_3$) in antacid tablets reacts with dilute hydrochloric acid ($HC\ell$) according to the following balanced equation:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell) \quad \triangle H < 0$$

5.1 Is the above reaction EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer. (2)

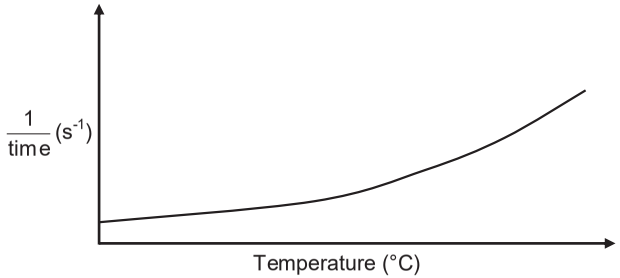
An antacid tablet of mass 2 g is placed in $HC\ell(aq)$. After 30 s the mass of the tablet was found to be 0,25 g.

5.2 Calculate the average rate (in $g \cdot s^{-1}$) of the above reaction. (3)

The antacid tablet contains 40% calcium carbonate. Another antacid tablet of mass 2 g is allowed to react completely with $HC\ell(aq)$.

5.3 Calculate the volume of carbon dioxide, $CO_2(g)$ that will be collected at STP. Assume that all the $CO_2(g)$ produced is from the calcium carbonate. (5)

The reaction rate of similar antacid tablets with excess $HC\ell(aq)$ of concentration 0,1 $mol \cdot dm^{-3}$ at DIFFERENT TEMPERATURES is measured. The graph below was obtained.




Use the information in the graph to answer the following questions.

5.4 Write down ONE controlled variable for this investigation. (1)

5.5 Write down a conclusion that can be made from the graph. (2)

5.6 Use the collision theory to fully explain the answer to QUESTION 5.5 (3)

5.7 Redraw the graph above in the ANSWER BOOK. On the same set of axes, sketch the curve that will be obtained if $HC\ell(aq)$ of concentration 0,2 $mol \cdot dm^{-3}$ is now used. Label this curve **Y**. (2)
**[18]**

**QUESTION 6 (Start on a new page.)**

Initially 60,8 g pure carbon dioxide, $CO_2(g)$, is reacted with carbon, C(s), in a sealed container of volume 3 $dm^3$. The reaction reaches equilibrium at temperature **T** according to the following balanced equation:

$$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$$

6.1 Define the term *chemical equilibrium*. (2)

6.2 At equilibrium it is found that the concentration of the carbon dioxide is 0,054 $mol{\cdot}dm^{-3}$.

Calculate the:

6.2.1 Equilibrium constant, $K_C$, for this reaction at temperature **T** (7)

6.2.2 Minimum mass of C(s) that must be present in the container to obtain this equilibrium (3)

6.3 How will EACH of the following changes affect the AMOUNT of CO(g) at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 More carbon is added to the container (1)

6.3.2 The pressure is increased by reducing the volume of the container at constant temperature.
Use Le Chatelier's principle to explain the answer. (3)

6.4 The table below shows the percentages of $CO_2(g)$ and CO(g) in the container at different temperatures.

| TEMPERATURE (°C) | % $CO_2(g)$ | % CO(g) |
|---|---|---|
| 827 | 6,23 | 93,77 |
| 950 | 1,32 | 98,68 |
| 1 050 | 0,37 | 99,63 |
| 1 200 | 0,06 | 99,94 |

6.4.1 Is the reaction EXOTHERMIC or ENDOTHERMIC?
Refer to the data in the table and explain the answer. (3)

6.4.2 Use the information in the table to determine temperature **T**.
Show clearly how you arrived at the answer. (3)
**[22]**





**QUESTION 7 (Start on a new page.)**

A hydrogen bromide solution, HBr(aq), reacts with water according to the following balanced chemical equation:

$$HBr(aq) + H_2O(\ell) \rightleftharpoons Br^-(aq) + H_3O^+(aq)$$

The $K_a$ value of HBr(aq) at 25 °C is 1 x $10^9$.

7.1 Is hydrogen bromide a STRONG ACID or a WEAK ACID? Give a reason for the answer. (2)

7.2 Write down the FORMULAE of the TWO bases in the above reaction. (2)

7.3 HBr(aq) reacts with $Zn(OH)_2(s)$ according to the following balanced equation:

$$Zn(OH)_2(s) + 2HBr(aq) \rightarrow ZnBr_2(aq) + 2H_2O(\ell)$$

An unknown quantity of $Zn(OH)_2(s)$ is reacted with 90 $cm^3$ of HBr(aq) in a flask. (Assume that the volume of the solution does not change during the reaction.)

The EXCESS HBr(aq) is then neutralised by 16,5 $cm^3$ of NaOH(aq) of concentration 0,5 $mol{\cdot}dm^{-3}$. The balanced equation for the reaction is:

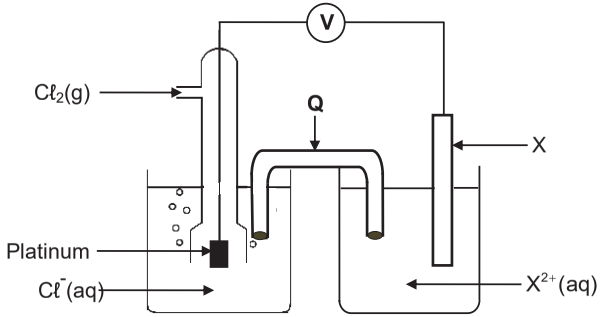
$$HBr(aq) + NaOH(aq) \rightarrow NaBr(aq) + H_2O(\ell)$$

7.3.1 Calculate the pH of the HBr solution remaining in the flask AFTER the reaction with $Zn(OH)_2(s)$. (7)

7.3.2 Calculate the mass of $Zn(OH)_2(s)$ INITIALLY present in the flask if the initial concentration of HBr(aq) was 0,45 $mol{\cdot}dm^{-3}$. (6)
**[17]**

**QUESTION 8 (Start on a new page.)**

A standard electrochemical cell is set up using two standard half-cells, as shown in the diagram below.




8.1 State the energy conversion that takes place in this cell. (1)

8.2 What is the function of component **Q**? (1)

**X** is a metal. A voltmeter connected across the cell initially registers 1,49 V.

8.3 Use a calculation to identify metal **X**. (5)

8.4 Write down the NAME or FORMULA of the reducing agent. (1)

8.5 The reading on the voltmeter becomes ZERO after this cell operates for several hours.

8.5.1 Give a reason for this reading by referring to the rates of oxidation and reduction half-reactions taking place in the cell. (1)

A silver nitrate solution, $AgNO_3(aq)$, is NOW added to the chlorine half-cell and a precipitate forms.

8.5.2 How will the reading on the voltmeter be affected?
(Choose from INCREASES, DECREASES or REMAINS the same) (1)

8.5.3 Use Le Chatelier's principle to explain the answer to QUESTION 8.5.2. (2)
**[12]**





**QUESTION 9 (Start on a new page.)**

Chlorine is produced industrially by the electrolysis of a concentrated sodium chloride solution, $NaC\ell(aq)$.

The balanced equation for the net (overall) cell reaction is as follows:

$$2NaC\ell(aq) + 2H_2O(\ell) \rightarrow H_2(g) + 2NaOH(aq) + C\ell_2(g)$$

9.1 Define the term *electrolysis*. (2)

9.2 For the above reaction, write down the:

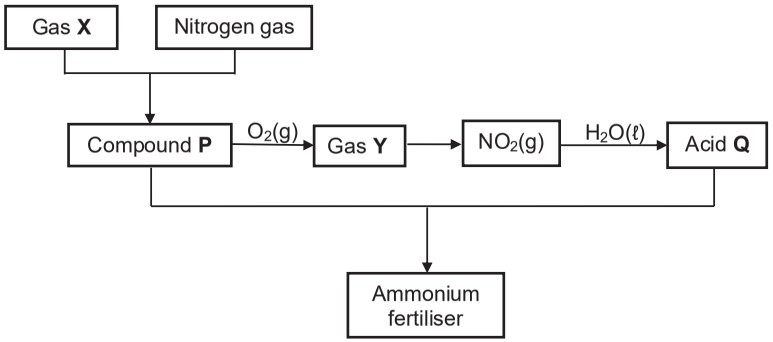
9.2.1 Half-reaction that takes place at the cathode (2)

9.2.2 NAME or FORMULA of the oxidising agent (1)

9.3 Refer to the Table of Standard Reduction Potentials to explain why sodium ions are not reduced during this process. (3)
**[8]**

**QUESTION 10 (Start on a new page.)**

The flow diagram below shows the processes involved in the industrial preparation of an ammonium fertiliser.




10.1 Write down the NAME or FORMULA of:

10.1.1 Gas **X** (1)

10.1.2 Gas **Y** (1)

10.1.3 Acid **Q** (1)

10.2 Write down the:

10.2.1 TYPE of chemical reaction that converts compound **P** into gas **Y** (1)

10.2.2 Balanced equation for the reaction between compound **P** and acid **Q** (3)

10.3 Two separate bags of fertilisers are labelled as follows:

| BAG A | BAG B |
|---|---|
| **1 : 3 : 4 (21)**<br>**50 kg** | **1 : 3 : 4 (27)**<br>**40 kg** |

10.3.1 What do the numbers (21) and (27) on the labels represent? (1)

10.3.2 Determine, by means of calculations, which bag (**A** or **B**) contains a greater mass of phosphorous. (4)
**[12]**

**TOTAL: 150**

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**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**NOVEMBER 2018**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 15 pages and 4 data sheets.**

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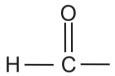
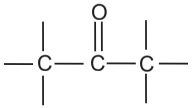
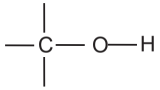
## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 D.

1.1 Which ONE of the following is the structural formula of the functional group of the KETONES?

| | | | |
|---|---|---|---|
| **A** | | **B** |  |
| **C** |  | **D** |  |

(2)

1.2 Which ONE of the formulae below represents an ALKANE?

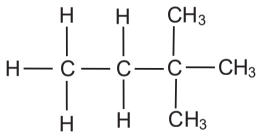
A $C_2H_4$

B $C_5H_{10}$

C $C_{14}H_{30}$

D $C_8H_{14}$ (2)

1.3 Consider the organic compound below.



The IUPAC name of this compound is …

A 2,3-dimethyl butane.

B 3,3-dimethyl butane.

C 2,2-dimethyl butane.

D 1,1,1-trimethyl propane. (2)





1.4 Activation energy can best be described as the minimum energy required to …

A cause effective collisions.

B make reactant molecules collide.

C change the orientation of reactant molecules.

D increase the kinetic energy of reactant molecules. (2)

1.5 Which statement is CORRECT for a system in DYNAMIC EQUILIBRIUM?

A All reactants are used up.

B The forward reaction is equal to the reverse reaction.

C All substances in the reaction are of equal concentration.

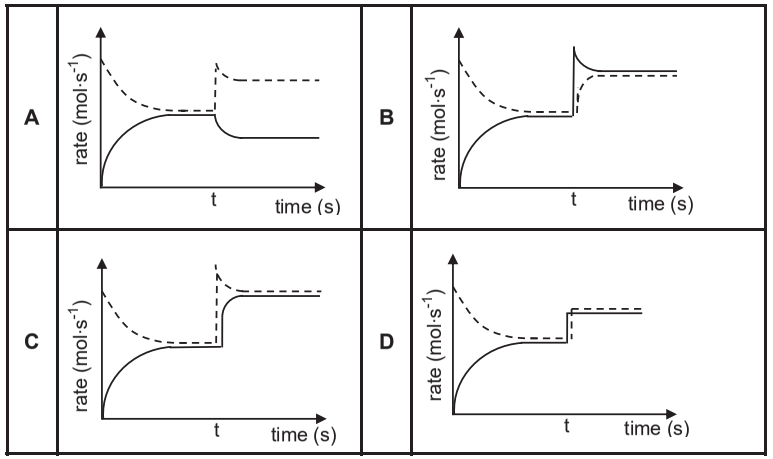
D The concentration of the reactants and products remain constant. (2)

1.6 Initially, a certain amount of P(g) was placed in an empty container. The hypothetical reaction reaches equilibrium in a closed container according to the following balanced equation:

$$P(g) \rightleftharpoons 2Q(g) \qquad \triangle H < 0$$

At time t, the temperature is increased.

Which graph below best illustrates the resulting changes in the rates of the forward and reverse reactions after the temperature is increased?




(2)

1.7 Reactions **I** and **II** below have equilibrium constants ($K_c$) greater than 1.

**I:** $H_3X + HCO_3^- \rightleftharpoons H_2X^- + H_2CO_3$ $K_c > 1$

**II:** $H_3O^+ + H_2X^- \rightleftharpoons H_2O + H_3X$ $K_c > 1$

Based on the reactions above, the ACIDS in order of INCREASING STRENGTH (weakest to strongest) are …

A $H_3X$, $H_2X^-$, $H_3O^+$

B $H_2CO_3$, $H_3X$, $H_3O^+$

C $H_3X$, $H_2CO_3$, $H_3O^+$

D $H_3X$, $H_3O^+$, $H_2CO_3$ (2)

1.8 Consider the cell notation for a galvanic cell below.

$$Ni(s) \mid Ni^{2+}(aq) \parallel H^+(aq) \mid H_2(g) \mid Pt(s)$$

Which ONE of the following half-reactions takes place at the ANODE of this cell?

A $2H^+(aq) + 2e^- \rightarrow H_2(g)$

B $H_2(g) \rightarrow 2H^+(aq) + 2e^-$

C $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

D $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$ (2)

1.9 Which ONE of the following is applicable to an ELECTROLYTIC CELL?

A Reduction takes place at the anode.

B Oxidation takes place at the cathode.

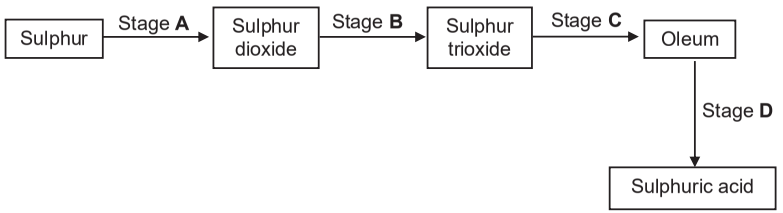
C It uses alternating current.

D A battery is used for the cell to function. (2)





1.10 The flow diagram below shows four stages (**A**, **B**, **C** and **D**) in the conversion of sulphur to sulphuric acid.




At which stage is a catalyst used?

A **A**

B **B**

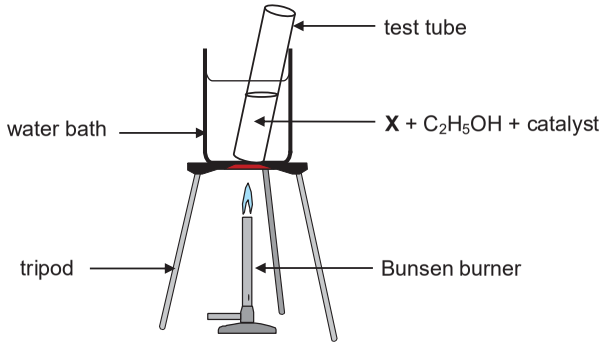
C **C**

D **D** (2)

**[20]**

**QUESTION 2 (Start on a new page.)**

A test tube containing a straight chain organic acid **X**, ethanol and a catalyst is heated in a water bath, as illustrated below.




Organic compound **Y** is produced according to the following equation:

$$\mathbf{X} + C_2H_5OH \longrightarrow \mathbf{Y} + H_2O$$

2.1 Give a reason why the test tube is heated in a water bath instead of directly over the flame. (1)

2.2 Write down the:

2.2.1 Type of reaction that takes place here (1)

2.2.2 FORMULA of the catalyst needed (1)

2.2.3 Homologous series to which compound **Y** belongs (1)

The molecular mass of compound **Y** is 144 $g \cdot mol^{-1}$ and its empirical formula is $C_4H_8O$.

2.3 Determine the molecular formula of compound **Y**. (2)

2.4 Write down the IUPAC name of compound **Y**. (2)

2.5 Write down the structural formula of the organic acid **X**. (2)
**[10]**





**QUESTION 3 (Start on a new page.)**

The boiling points of different organic compounds are given below.

| | COMPOUND | BOILING POINT (°C) |
|---|---|---|
| **A** | HCOOH | 101 |
| **B** | $CH_3COOH$ | 118 |
| **C** | $CH_3CH_2COOH$ | 141 |
| **D** | $CH_3CH_2CH_2COOH$ | 164 |

3.1 Define *boiling point*. (2)

3.2 Write down the:

3.2.1 Name of the FUNCTIONAL GROUP of these compounds (1)

3.2.2 IUPAC name of compound **C** (1)

3.2.3 Structural formula of the FUNCTIONAL isomer of compound **B** (2)

3.3 Which ONE of the compounds, **A** or **B** or **C**, has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)

3.4 The boiling point of compound **B** is now compared with of compound **X**.

| | COMPOUND | BOILING POINT (°C) |
|---|---|---|
| **B** | $CH_3COOH$ | 118 |
| **X** | $CH_3CH_2CH_2OH$ | 98 |

3.4.1 Besides the conditions used to determine boiling points, give a reason why this is a fair comparison. (1)

3.4.2 Is compound **X** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

3.4.3 Fully explain the difference between the boiling points by referring to the types of intermolecular forces present in each of these compounds. (4)
**[15]**

**QUESTION 4 (Start on a new page.)**

4.1 Three reactions of organic compounds from the same homologous series are shown below.

| | |
|---|---|
| **I:** | Butane + $Br_2$ ⟶ 2-bromobutane + **P** |
| **II:** | Pentane + excess oxygen $\xrightarrow{\text{heat}}$ |
| **III:** | Hexane ⟶ $C_2H_4$ + **Q** |

4.1.1 Define a *homologous series*. (2)

4.1.2 Name the type of reaction represented by **I**. (1)

4.1.3 Write down the formula of the inorganic compound **P**. (1)

4.1.4 Give the structural formula of a POSITIONAL isomer of 2-bromobutane. (2)

4.1.5 Using molecular formulae, write down the balanced equation for reaction **II**. (3)

Reaction **III** is an example of a cracking reaction.

4.1.6 Define a *cracking reaction*. (2)

4.1.7 Give the structural formula of organic compound **Q**. (2)

4.2 Study the flow diagram below.

2-bromobutane $\xrightarrow{\text{Hydrolysis}}$ Compound **R** ⟶ Alkene

4.2.1 Write down the IUPAC name of compound **R**. (2)

4.2.2 Compound **R** reacts in the presence of concentrated phosphoric acid to form an alkene.

Write down the structural formula of the MAJOR PRODUCT in this reaction. (2)
**[17]**





**QUESTION 5 (Start on a new page.)**

The reaction of zinc and EXCESS dilute hydrochloric acid is used to investigate factors that affect reaction rate. The balanced equation for the reaction is:

$$Zn(s) + 2HC\ell(aq) \longrightarrow ZnC\ell_2(aq) + H_2(g)$$

The reaction conditions used and the results obtained for each experiment are summarised in the table below.

The same mass of zinc is used in all the experiments. The zinc is completely covered in all reactions. The reaction time is the time it takes the reaction to be completed.

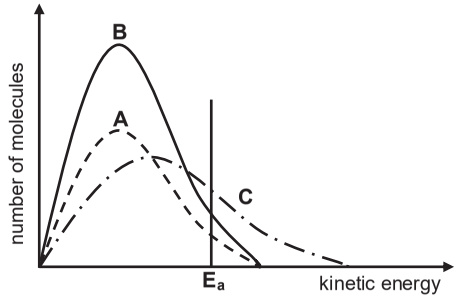
| EXPERIMENT | CONCENTRATION OF $HC\ell$ ($mol\cdot dm^{-3}$) | VOLUME OF $HC\ell$ ($cm^3$) | STATE OF DIVISION OF Zn | TEMPERATURE OF $HC\ell$ (°C) | REACTION TIME (min.) |
|---|---|---|---|---|---|
| **1** | 2,0 | 200 | powder | 25 | 7 |
| **2** | 1,5 | 200 | granules | 25 | 14 |
| **3** | 5,0 | 200 | powder | 25 | 5 |
| **4** | 1,5 | 400 | granules | 25 | **x** |
| **5** | 2,0 | 200 | powder | 35 | 4 |

5.1 Experiment **1** and experiment **5** are compared. Write down the independent variable. (1)

5.2 Define *reaction rate*. (2)

5.3 Write down the value of **x** in experiment **4**. (2)

5.4 The Maxwell-Boltzmann energy distribution curves for particles in each of experiments **1**, **3** and **5** are shown below.




Identify the graph (**A** or **B** or **C**) that represents the following:

5.4.1 Experiment **3**
Give a reason for the answer. (2)

5.4.2 Experiment **5**
Give a reason for the answer. (2)

5.5 Experiment **6** is now conducted using a catalyst and the SAME reaction conditions as for Experiment **1**.

5.5.1 What is the function of the catalyst in this experiment? (1)

5.5.2 How will the heat of reaction in experiment **6** compare to that in experiment **1**? Choose from: GREATER THAN, EQUAL TO or LESS THAN. (1)

5.6 Calculate the average rate of the reaction (in $mol \cdot min^{-1}$) with respect to zinc for experiment **2** if 1,5 g of zinc is used. (4)
**[15]**

**QUESTION 6 (Start on a new page.)**

Dinitrogen tetraoxide, $N_2O_4(g)$, decomposes to nitrogen dioxide, $NO_2(g)$, in a sealed syringe of volume 2 $dm^3$.

The mixture reaches equilibrium at 325 °C according to the following balanced equation:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$
colourless brown

When equilibrium is reached, it is observed that the colour of the gas in the syringe is brown.

6.1 State Le Chatelier's principle. (2)

6.2 The syringe is now dipped into a beaker of ice water. After a while the brown colour disappears.

Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer using Le Chatelier's principle. (3)

6.3 The volume of the syringe is now decreased while the temperature is kept constant.

How will EACH of the following be affected? Choose from: INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The number of moles of $N_2O_4(g)$ (1)

6.3.2 The value of the equilibrium constant (1)

6.3.3 The rate of the forward and reverse reactions (1)

6.4 Initially **X** moles of $N_2O_4(g)$ were placed in the syringe of volume 2 $dm^3$. When equilibrium was reached, it was found that 20% of the $N_2O_4(g)$ had decomposed.

If the equilibrium constant, $K_c$, for the reaction is 0,16 at 325 °C, calculate the value of **X**. (8)
**[16]**





**QUESTION 7 (Start on a new page.)**

7.1 Sulphuric acid is a strong acid present in acid rain. It ionises in two steps as follows:

**I:** $H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$

**II:** $HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Write down the FORMULA of the conjugate base of $H_3O^+(aq)$. (1)

7.1.3 Write down the FORMULA of the substance that acts as an ampholyte in the ionisation of sulphuric acid. (2)

7.2 Acid rain does not cause damage to lakes that have rocks containing limestone ($CaCO_3$). Hydrolysis of $CaCO_3$ results in the formation of ions, which neutralise the acid.

7.2.1 Define *hydrolysis* of a salt. (2)

7.2.2 Explain, with the aid of the relevant HYDROLYSIS reaction, how limestone can neutralise the acid. (3)

7.3 The water in a certain lake has a pH of 5.

7.3.1 Calculate the concentration of the hydronium ions in the water. (3)

The volume of water in the lake is $4 \times 10^9$ $dm^3$. Lime, CaO, is added to the water to neutralise the acid according to the following reaction:

$$CaO + 2H_3O^+ \rightleftharpoons Ca^{2+} + 3H_2O$$

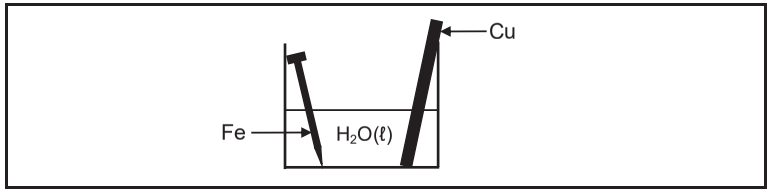
7.3.2 If the final amount of hydronium ions is $1,26 \times 10^3$ moles, calculate the mass of lime that was added to the lake. (7)
**[20]**

**QUESTION 8 (Start on a new page.)**

8.1 Corrosion is a redox reaction that takes place in the presence of oxygen and water. Rusting is the corrosion of iron leading to the formation of iron(III) ions.

8.1.1 Define *oxidation* in terms of electron transfer. (2)

A cleaned copper rod and a cleaned iron nail are placed in a beaker containing water at 25°C, as shown below.



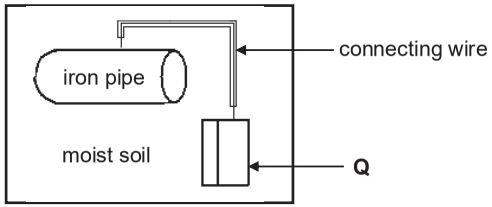

After a while it was observed that the iron nail was coated with rust. The copper rod showed no visible signs of corrosion.

8.1.2 Write down the half-reaction for the iron nail. (2)

8.1.3 Does iron act as REDUCING AGENT or OXIDISING AGENT in the beaker? (1)

8.1.4 Explain the above observation by referring to the Table of Standard Reduction Potentials. (3)

To prevent rusting of an underground iron pipe, the pipe is connected to a metal (**Q**) that corrodes easily.




8.1.5 You are given two metals, Zn and Cu, to use as metal **Q**. Which metal would more suitable? Give a reason. (2)

8.2 A galvanic cell is constructed using a Fe | $Fe^{3+}$ half-cell and a Cu | $Cu^{2+}$ half-cell.

8.2.1 Write down the overall (net) cell reaction that takes place when the cell is functioning. (3)

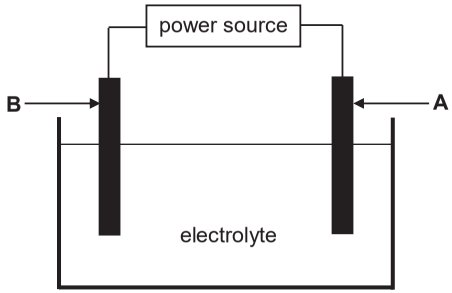
8.2.2 Calculate the cell potential of this cell under standard conditions. (4)
**[17]**





**QUESTION 9 (Start on a new page.)**

The electrolytic cell below is set up to obtain pure copper from a piece of impure copper.




The impure copper contains other metals, such as platinum, iron, cobalt, silver and nickel.

The cell potential of the power source is adjusted so that only copper is deposited on electrode **B**.

9.1 Define an *electrolytic cell*. (2)

9.2 Write down the FORMULA of a suitable electrolyte for this cell. (1)

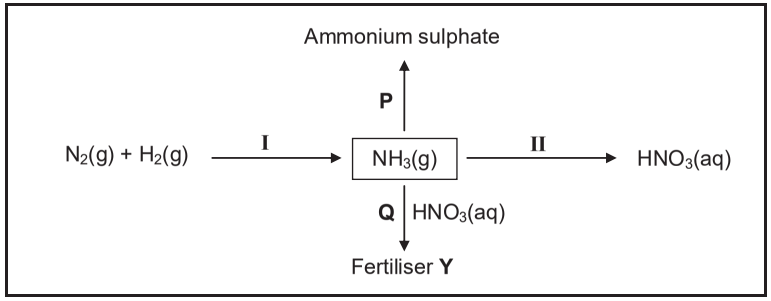
9.3 Which electrode (**A** or **B**) is the cathode?
Write down the relevant half-reaction taking place at this electrode. (3)

9.4 Sludge forms below one of the electrodes while the cell above is in operation. Which of the metals, PLATINUM, IRON, COBALT, SILVER or NICKEL, will be present in the sludge? (2)
**[8]**

**QUESTION 10 (Start on a new page.)**

In the flow diagram below, **I** and **II** represent industrial processes used in the fertiliser industry.

**P** and **Q** are chemical reactions that take place to produce ammonium sulphate and fertiliser **Y** respectively.




10.1 Write down the name of the industrial process:

10.1.1 **I** (1)

10.1.2 **II** (1)

10.2 Write down the NAME or FORMULA of:

10.2.1 Fertiliser **Y** (1)

10.2.2 The catalyst used in process **I** (1)

10.3 In reaction **P**, $NH_3(g)$ reacts with another substance. Write down a balanced equation for this reaction. (3)

10.4 The following substances are present in a bag of fertiliser:

- 20 kg ammonium nitrate ($NH_4NO_3$)
- 12 kg sodium phosphate ($Na_3PO_4$)
- 18 kg potassium chloride ($KC\ell$)

Calculate the NPK ratio of the fertiliser. (5)
**[12]**

**TOTAL: 150**

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Province of the
EASTERN CAPE
EDUCATION

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**SEPTEMBER 2018**

# PHYSICAL SCIENCES P2

**MARKS:** **150**

**TIME:** **3 hours**

This question paper consists of 22 pages, including 4 data sheets.

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Write only the correct letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

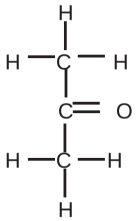
1.1 Consider the compound given below.

**CH ≡ CH**

To which homologous series does the compound belong?

A Alkanes
B Alkenes
C Alkynes
D Haloalkanes (2)

1.2 Study the structural formula of a ketone shown below.



Which ONE of the following is a structural isomer of the ketone shown above?

A Propane
B Propanal
C Propan-1-ol
D Propan-2-ol (2)





1.3 The CRACKING process and POLYMERISATION process are represented by the reactions given below. Compounds **P** and **Q** are organic compounds. Compound **P** is the same in both processes.

$$C_{15}H_{32} \rightarrow 2\,\mathbf{P} + \mathbf{Q} + C_8H_{18} \quad \ldots \quad \text{CRACKING}$$

$$5\,\mathbf{P} \rightarrow \left[ CH_2CH_2 \right]_5 \quad \ldots \quad \text{POLYMERISATION}$$

Which ONE of the following gives the CORRECT IUPAC names of compound **P** and compound **Q**?

| | P | Q |
|---|---|---|
| A | Ethene | Propene |
| B | Ethane | Propane |
| C | Ethene | Hex-1-ene |
| D | Ethane | Hexane |

(2)

1.4 Consider the equation below:

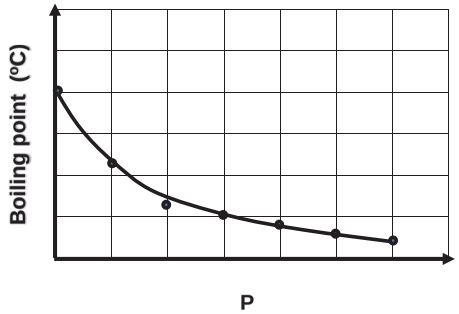
$$HCO_3^-(aq) + OH^-(aq) \rightarrow CO_3^{2-}(aq) + H_2O(\ell)$$

Which ONE of the following pairs is a conjugate **acid-base** pair?

A $HCO_3^-$ and $OH^-$
B $HCO_3^-$ and $CO_3^{2-}$
C $H_2O$ and $HCO_3^-$
D $OH^-$ and $CO_3^{2-}$ (2)

1.5 The graph below shows boiling points of alkanes with the same molecular mass plotted against a quantity **P**.

**GRAPH OF BOILING POINT VERSUS QUANTITY P**




Which ONE of the following is most likely represented by **P**?

A Chain length
B Strength of intermolecular forces
C Surface area of chain isomers
D Number of methyl side chains in chain isomers (2)

1.6 The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$

Which ONE of the following changes will favour the forward reaction?

A Add water
B Add a catalyst
C Decrease pH
D Increase pH (2)

1.7 The reaction in a galvanic cell are shown below. Assume the cell functions under standard conditions.

$$Ni(s) + 2Ag^+(aq) \rightleftharpoons Ni^{2+}(aq) + 2Ag(s)$$

Which ONE of the following statements regarding this cell is TRUE?

A Silver is reduced
B Nickel is oxidised
C Silver is the anode
D Nickel is the cathode (2)





1.8 One mole of magnesium reacts with EXCESS sulphuric acid solution at 25 °C.

$$Mg(s) + H_2SO_4(g) \rightarrow MgSO_4(aq) + H_2(g) \qquad \Delta H < 0$$

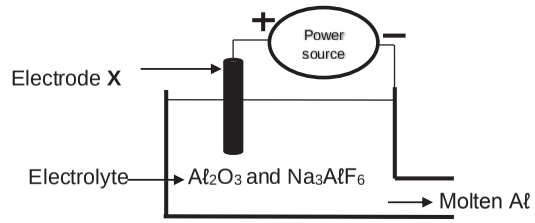
Which ONE of the following changes will INCREASE the rate of reaction?

A Increase temperature
B Decrease temperature
C Increase the volume of sulphuric acid
D Decrease the concentration of sulphuric acid (2)

1.9 Which ONE of the following substances is a REACTANT in the first step of the Ostwald process?

A Nitrogen
B Nitric acid
C Ammonia
D Nitrogen monoxide (2)

1.10 A simplified diagram below shows the industrial extraction of aluminium (Aℓ) from aluminium oxide ($A\ell_2O_3$) at temperature 1 000 °C.




Consider the following statements regarding electrode **X** above:

**I** Electrode **X** is the anode

**II** $A\ell^{3+}$ is reduced to Aℓ at electrode **X**

**III** $O_2(g)$ produced in the cell reacts with electrode **X** to form $CO_2(g)$.

Which one of the following statements is/are CORRECT?

A **I** only
B **I** and **II** only
C **I** and **III** only
D **I**, **II** and **III** (2)

**[20]**

**QUESTION 2 (Start on a new page.)**

2.1 The IUPAC name of an organic compound is 2,2,4-trimethylpentane.

For this compound write down:

2.1.1 The NAME of the homologous series to which it belongs (1)

2.1.2 Its STRUCTURAL formula (3)

2.1.3 The MOLECULAR formulae of the TWO products formed when the compound undergoes combustion in excess oxygen (2)

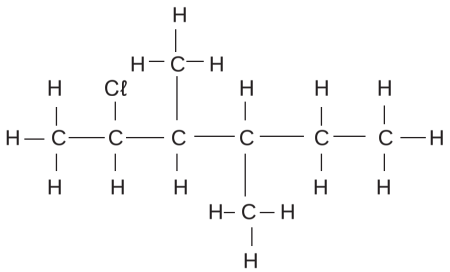
2.2 Study the condensed structural formulae for compounds **A** and **B** given below.

**A.** $(CH_3)_2CHC(=O)CH_2CH_3$ **B.** $(CH_3)_2CH_2CH_2C(=O)CH_3$

2.2.1 Give a reason why compounds **A** and **B** are said to be positional isomers. (2)

2.2.2 Write down the compound STRUCTURAL formula and IUPAC name of another positional isomer of compounds **A** and **B**. (4)

2.3 Consider the compound given below:



For this compound, write down the:

2.3.1 IUPAC name (3)

2.3.2 TYPE of halo-alkane. Choose from PRIMARY, SECONDARY or TERTIARY (1)

**[16]**





**QUESTION 3 (Start on a new page.)**

The table below shows the vapour pressure values for the organic compounds **A** to **E**. The letters **X**, **Y** and **Z** represent vapour pressure values for compounds **A** to **C**.

| COMPOUND | IUPAC NAME | VAPOUR PRESSURE (kPa) at 20 °C |
|---|---|---|
| **A** | Pentane | **X** |
| **B** | 2-methyl butane | **Y** |
| **C** | 2,2-dimethyl propane | **Z** |
| **D** | Ethanol | 5,95 |
| **E** | Methanoic acid | 4,6 |

3.1 Give a reason why compounds **A**, **B** and **C** are said to be hydrocarbons. (2)

The values **X**, **Y** and **Z** are given in random order below.

| | | | |
|---|---|---|---|
| Vapour pressure at 20 °C (kPa) | 53,3 | 14,6 | 77 |

3.2 Choose the vapour pressure value that represents **Y**.

Fully explain the choice you made. (4)

3.3 Which ONE of the compound (**D** or **E**), has a HIGHER boiling point? (1)

Explain the answer by referring to:

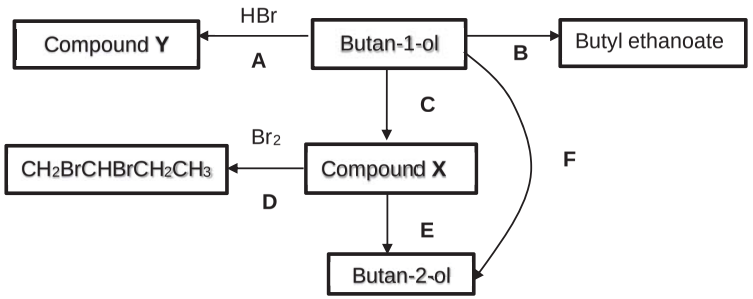
3.3.1 Data in the table (1)

3.3.2 STRENGTH of the hydrogen bonds (2)

**[10]**

**QUESTION 4 (Start on a new page.)**

The flow diagram shows how an alcohol can be used to prepare other organic compounds. The letters **A, B, C, D, E** and **F** represent different organic reactions. **X** and **Y** are organic compounds.




4.1 Write down the type of reaction represented by reaction **A**. (1)

4.2 In reaction **B,** butan-1-ol reacts with a carboxylic acid in the presence of a catalyst to produce butyl ethanoate. Butyl ethanoate can be identified by its characteristic smell.

4.2.1 What safety precaution must be taken when smelling chemical compounds? (1)

For reaction **B** write down the:

4.2.2 Type of reaction (1)

4.2.3 IUPAC name of the carboxylic acid used (2)

4.2.4 STRUCTURAL formula of butyl ethanoate (2)

4.3 Use STRUCTURAL formulae to write down a balanced equation for reaction **A**. (4)

4.4 Reaction **F** involves two reactions (reaction **C** and reaction **E**). In reaction **F** butan-1-ol is converted to butan-2-ol through an intermediary, compound **X**.

Write down the:

4.4.1 STRUCTURAL formula of compound **X** produced in reaction **C** (2)

4.4.2 NAME or FORMULA of the inorganic reagent needed in reaction **C** (1)

4.4.3 Reaction condition needed for reaction **E** (1)

**[15]**



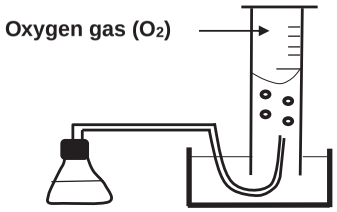


**QUESTION 5 (Start on a new page.)**

A group of learners used the apparatus below to investigate one of the factors that affects the rate of decomposition of hydrogen peroxide, $H_2O_2$.

The balanced equation for the reaction is:

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$




5.1 Define *rate of reaction* in words. (2)

The learners conduct TWO experiments. The reaction conditions are summarised below.

**Experiment I:** 50 $cm^3$ of a 1 $mol.dm^{-3}$ of hydrogen peroxide solution initially at 25 ˚C is heated to 40 ˚C.

**Experiment II:** 50 $cm^3$ of a 1 $mol.dm^{-3}$ of hydrogen peroxide solution, to which a small amount of a **substance Y** initially at 25 ºC is heated to 40 ºC.

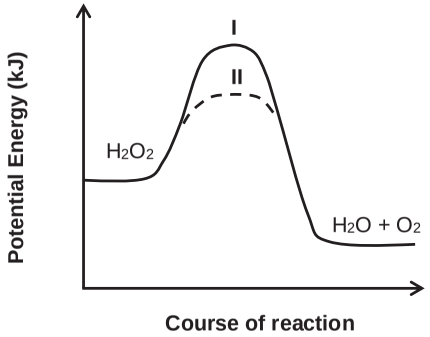
5.2 How does the *initial average kinetic energy* of $H_2O_2$ molecules in experiment **I** compare with the *initial average kinetic energy* of $H_2O_2$ molecules in experiment **II**?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

5.3 The reaction in **experiment I** takes 15 seconds to run to completion producing a total volume of oxygen of 28 $cm^3$.

Calculate the average rate of reaction (in $cm^3.s^{-1}$) from the start to completion of the reaction in **experiment I**. (2)

The graph below shows changes in the potential energy during the decomposition of hydrogen peroxide in experiment **I** and experiment **II**.




5.4 Write down the *investigative* question for this investigation. (2)

5.5 Is the reaction ENDOTHERMIC or EXOTHERMIC?

Give a reason for the answer. (2)

5.6 In which experiment (**I** or **II**) is the rate of reaction HIGHER? (1)

5.7 Use the collision theory to fully explain the answer to QUESTION 5.6 above. (3)
**[13]**





**QUESTION 6 (Start on a new page.)**

The reaction below takes place in a sealed container. Equilibrium is established after some time.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

6.1 Define the term *equilibrium* in words. (2)

6.2 The pressure on the system is increased by decreasing the volume at constant temperature. How will this action affect the following?

Choose from INCREASES, DECREASES or NO EFFECT.

6.2.1 Number of moles of $NO_2$ at equilibrium (1)

6.2.2 Equilibrium constant $K_c$
Give a reason for the answer. (2)

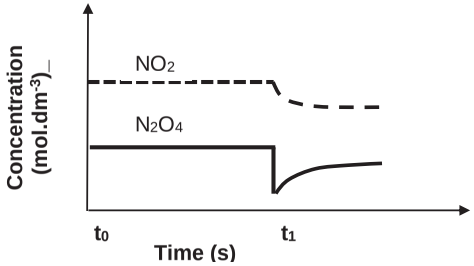
6.3 Three experiments are conducted to study changes in equilibrium concentrations of the $N_2O_4$ and $NO_2$ when different initial concentrations of $N_2O_4$ are placed in a 2 $dm^3$ flask which is then sealed.

The table below shows the equilibrium concentrations obtained in the experiments.

| **Experiment** | **Temperature at which equilibrium is reached (°C)** | **Equilibrium concentration of $N_2O_4$ ($mol.dm^{-3}$)** | **Equilibrium concentration of $NO_2$ ($mol.dm^{-3}$)** |
|---|---|---|---|
| 1 | 25 | 0,0336 | 0,0125 |
| 2 | 25 | 0,0246 | 0,0107 |
| 3 | 25 | **X** | 0,0156 |

6.3.1 Calculate the initial number of moles of $N_2O_4$ placed in the flask in **experiment 3**. (9)

The graph of concentration versus time for **experiment I** is given below.
A change is made to the reaction mixture at $t_1$.




6.3.2 How does the rate of forward reaction compare to the rate of the reverse reaction during the interval $t_0$ to $t_1$?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

6.3.3 Write down the change made at $t_1$. (1)
**[16]**





**QUESTION 7 (Start on a new page.)**

7.1 Oxalic acid, $H_2C_2O_4$ ionises in water in two steps as shown below.

**STEP I** $H_2C_2O_4(aq) + H_2O(\ell) \rightleftharpoons (HC_2O_4)^-(aq) + H_3O^+(aq)$
**Ka = 5,4 x $10^{-4}$ at 25 °C**

**STEP II** $(HC_2O_4)^-(aq) + H_2O(\ell) \rightleftharpoons$ **Q** $+ H_3O^+(aq)$

7.1.1 Is oxalic acid classified as a WEAK ACID or STRONG ACID? Explain the answer by referring to the given information. (2)

7.1.2 Write down the formula for substance **Q**. (1)

7.2 The acetate ion, $CH_3COO^-$ undergoes hydrolysis producing an alkaline solution.

7.2.1 Define the term *hydrolysis* of a salt. (2)

7.2.2 Write down the formulae of the TWO products of the hydrolysis of the acetate ion. (2)

7.3 A group of learners perform an experiment to determine the percentage purity of calcium carbonate in an IMPURE sample of calcium carbonate.

The learners first added a certain volume **V** of a hydrochloric acid solution of pH = 1 to the impure calcium carbonate sample of mass **m**.

7.3.1 Calculate the concentration of hydronium ions, $[H_3O^+]$ in the hydrochloric acid solution. (3)

The acid added to the impure sample was found to be in excess. The excess hydrochloric acid was completely neutralised by 32,2 $cm^3$ of a sodium hydroxide solution of concentration 0,025 $mol.dm^{-3}$ according to the balanced equation.

$$NaOH(aq) + HC\ell(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

Calculate the:

7.3.2 Number of moles of $HC\ell$ that were in excess (3)

7.3.3 Percentage purity of the calcium carbonate if **V** = 50 $cm^3$ and **m** = 0,3 g (6)
**[19]**

**QUESTION 8 (Start on a new page.)**

An electrochemical cell (cell **P**) consisting of half-cells **A** and **B** is assembled under standard conditions. The two half cells (**A** and **B**) are shown below. Nitrate solutions are used as electrolytes in the cell.

| | |
|---|---|
| Half-cell **A** | $Sn(s) / Sn^{2+}(aq)$ (1 mol.dm$^{-3}$) |
| Half-cell **B** | Pt, $\mathbf{X_2}(g) / X^-(aq)$ (1 mol.dm$^{-3}$) |

8.1 Define the term *electrolyte.* (2)

8.2 Write down:

8.2.1 ONE standard condition needed for half-cell **B,** but not needed in half-cell **A** (1)

8.2.2 The function of platinum in the above cell (1)

8.3 The Tin (Sn) electrode is connected to the NEGATIVE terminal of the voltmeter when the cell is functioning.

Is the Sn electrode the ANODE or CATHODE? (1)

8.4 The initial EMF of this cell is 1,5 V.

Identify gas $\mathbf{X_2}$ by means of calculations. (5)

8.5 The saltbridge is **now removed** after the cell was functioning for some time.

What effect will this change have on the voltmeter reading?
Choose from INCREASES, DECREASES or BECOMES ZERO.

Give a reason for the answer. (2)

8.6 Another cell (cell **Q**) is set up under standard conditions.

The following cell notation summarises cell **Q**: $Mg/Mg^{2+}$ // $A\ell^{3+}/A\ell$

Write down the balanced equation for the net (overall) reaction that takes place in cell **Q.** (3)
**[15]**



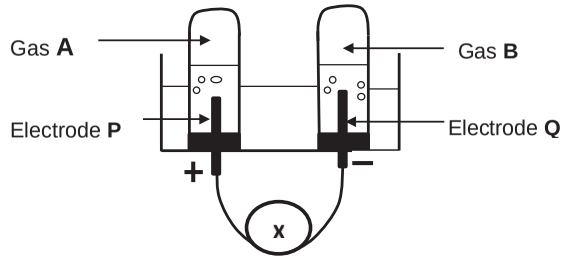


**QUESTION 9 (Start on a new page.)**

The diagram below shows the apparatus used during the electrolysis of a concentrated sodium chloride solution at 25 ˚C using carbon electrodes.

The balanced equation for the net (overall) cell reaction is:

$$2NaC\ell(aq) + 2H_2O(\ell) \rightarrow C\ell_2(g) + H_2(g) + 2NaOH(aq)$$




9.1 Write down the:

9.1.1 NAME of component **X** (1)

9.1.2 NAME or FORMULA of gas **A** (1)

9.1.3 Half-reaction taking place at electrode **Q** (2)

9.1.4 FORMULA of the reducing agent (1)

9.2 Which ONE of the following CORRECTLY describes the concentration of hydronium ions, $[H_3O^+]$, in mol.dm$^{-3}$, in the electrolyte after the cell reaction has run to completion?

| | | |
|---|---|---|
| $[H_3O^+] < 1 \times 10^{-7}$ | $[H_3O^+] > 1 \times 10^{-7}$ | $[H_3O^+] = 1 \times 10^{-7}$ |

Explain the answer. (2)

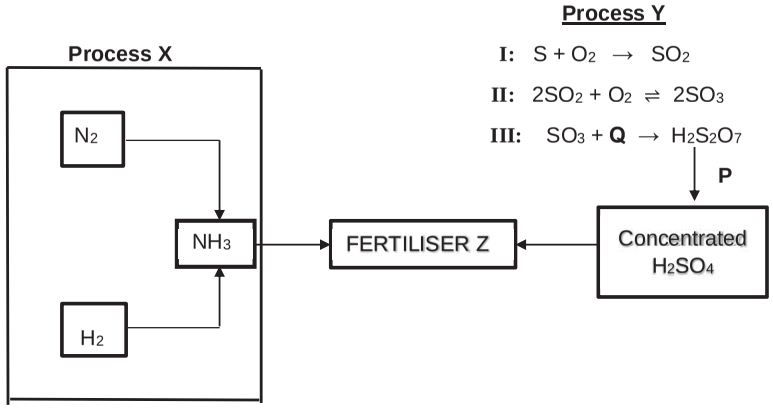
9.3 The electrolyte ($NaC\ell$) is replaced with a $CuC\ell_2$ solution.
The following observation is made about the products formed at electrode **Q**.

*When $CuC\ell_2$ solution is used, a metallic product is formed at **Q** but there is NO metallic product at **Q** when $NaC\ell$ solution is used.*

Explain this observation in terms of the *strengths of oxidising agents* involved. (3)
**[10]**

**QUESTION 10 (Start on a new page.)**

10.1 The equations below represent TWO industrial processes **X** and **Y** involved in the preparation of a fertiliser **Z.**




Compound **P** is added to oleum, $H_2S_2O_7$ to obtain concentrated $H_2SO_4$.

Write down the:

10.1.1 NAME or FORMULA of the catalyst used in STEP **II** of process **Y** (1)

10.1.2 FORMULA of compound **Q** (1)

10.1.3 NAME of compound **P** (1)

10.1.4 NAME of process **Y** (1)

10.1.5 Balanced equation for the preparation of fertiliser **Z** (3)

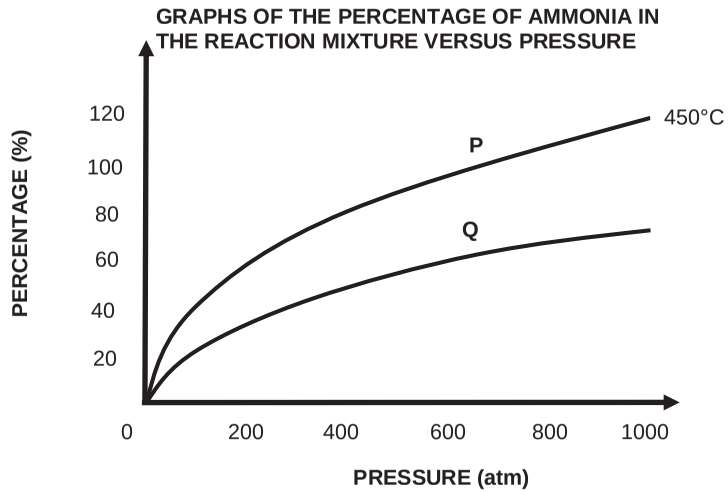




The yield of $NH_3$ changes with temperature and pressure during the industrial production of $NH_3$ in **Process X** mentioned above.

The graphs below show the percentage of ammonia produced as the pressure changes.

$$3H_2(g) + N_2(g) \rightleftharpoons NH_3(g) \qquad \Delta H < 0$$




Graph P is obtained when the reaction reaches equilibrium at 450 ˚C.

10.1.6 Is graph **Q** obtained at a temperature HIGHER THAN or LOWER THAN 450 ˚C?

Fully explain the answer. (4)

10.2 A bag of **N:P:K** fertiliser contains 4% nitrogen, 8% phosphorus, 6 kg potassium and 76% filler.

10.2.1 What is the role of potassium in plant growth? (1)

10.2.2 Calculate the mass of the bag. (4)

**[16]**

**TOTAL: 150**

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**FEBRUARY/MARCH 2018**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 16 pages, 4 data sheets and 1 graph sheet.**





**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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following is the general formula of alkynes?

A $C_nH_{2n}$

B $C_{2n}H_{2n}$

C $C_nH_{2n-2}$

D $C_nH_{2n+2}$ (2)

1.2 The type of reaction that takes place when a carboxylic acid and an alcohol react in the presence of an acid:

A Addition

B Hydrolysis

C Substitution

D Esterification (2)

1.3 Which ONE of the following isomers has the LOWEST boiling point?

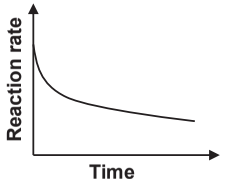
A $CH_3CH_2CH_2CH_2CH_2CH_3$

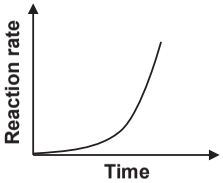
B $CH_3CH_2C(CH_3)_2CH_3$

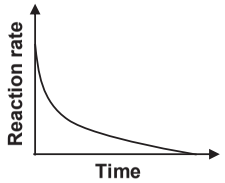
C $CH_3CH(CH_3)CH_2CH_2CH_3$

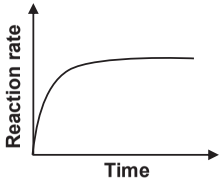
D $CH_3CH_2CH(CH_3)CH_2CH_3$ (2)

1.4 Which ONE of the reaction rate versus time graphs below best represents the reaction between magnesium and EXCESS dilute hydrochloric acid?

A



B



C



D



(2)

1.5 Which ONE of the following will NOT affect the equilibrium position of reversible chemical reactions?

A Temperature

B Catalyst

C Pressure

D Concentration (2)





1.6 The following equilibrium exists in pure water at 25 °C.

$$2H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq) \qquad \Delta H > 0$$

At this temperature, the pH = 7 and $K_w = 1 \times 10^{-14}$.

The temperature of the water is now increased to 90 °C.

Which ONE of the following is TRUE at the new temperature?

A pH = 7

B $[H_3O^+] = [OH^-]$

C $[H_3O^+][OH^-] = 10^{-14}$

D $[H_3O^+] = 10^{-7}\ mol{\cdot}dm^{-3}$ (2)

1.7 A hydrochloric acid solution is titrated against an ammonia solution. The balanced equation for the reaction is:

$$HC\ell(aq) + NH_4OH(aq) \rightarrow NH_4C\ell(aq) + H_2O(\ell)$$

Which ONE of the following gives the pH of the solution at the end point and the reason for this pH?

| | pH | REASON |
|---|---|---|
| A | 3 | $H_3O^+(aq)$ is formed during the ionisation of $HC\ell(aq)$. |
| B | 5 | $H_3O^+(aq)$ is formed during hydrolysis of $NH_4^+(aq)$. |
| C | 7 | Neutralisation takes place at the end point. |
| D | 9 | $OH^-(aq)$ is formed during hydrolysis of $NH_4^+(aq)$. |

(2)

1.8 A decrease in the oxidation number of an atom during a chemical reaction is known as …

A redox.

B oxidation.

C reduction.

D electrolysis. (2)

1.9 The two half-reactions below are used to construct a galvanic cell.

$$X^+(aq) + e^- \rightleftharpoons X(s) \qquad E^{\theta}_{reduction} = +0,15\ V$$

$$Y^{2+}(aq) + 2e^- \rightleftharpoons Y(s) \qquad E^{\theta}_{reduction} = -0,15\ V$$

Which ONE of the statements below is CORRECT when the cell is in operation?

A $X^+(aq)$ is reduced.

B Y(s) is reduced.

C $X(s) \mid X^+(aq)$ is the negative electrode.

D Electrons flow from X(s) to Y(s) in the external circuit. (2)

1.10 Which ONE of the following is CORRECT for the industrial preparation of sulphuric acid?

| | PROCESS | CATALYST |
|---|---|---|
| A | Ostwald | Platinum |
| B | Haber | Iron |
| C | Contact | Iron |
| D | Contact | Vanadium pentoxide |

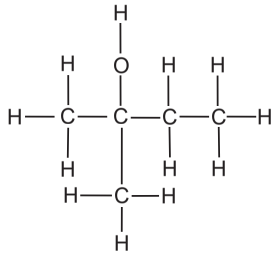
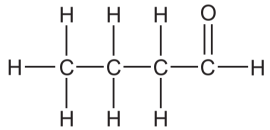
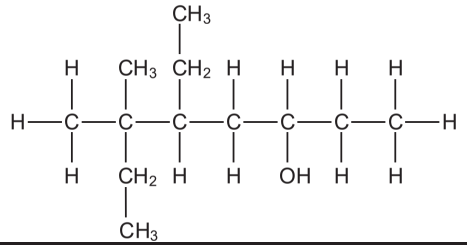
(2)
**[20]**





**QUESTION 2 (Start on a new page.)**

The letters **A** to **E** in the table below represent ~~six~~ five organic compounds.

| | | | |
|---|---|---|---|
| **A** |  | **B** |  |
| **C** | Butan-1-ol | **D** | Butan-2-one |
| **E** |  | | |

2.1 Write down the LETTER that represents EACH of the following:

2.1.1 A tertiary alcohol (1)

2.1.2 An aldehyde (1)

2.1.3 A ketone (1)

2.1.4 A functional isomer of compound **B** (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **B** (1)

2.2.2 Compound **E** (4)

2.3 Define *positional isomers*. (2)

2.4 Write down the STRUCTURAL FORMULA of:

2.4.1 A positional isomer of compound **C** (2)

2.4.2 Compound **D** (2)

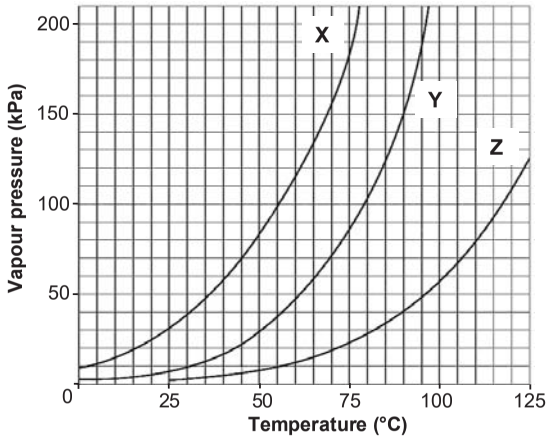
2.4.3 The organic acid that will react with compound **C** to form butyl propanoate (2)
**[17]**

**QUESTION 3 (Start on a new page.)**

Study the vapour pressure versus temperature graphs for three organic compounds, **X**, **Y** and **Z**, below which belong to different homologous series.

Atmospheric pressure is 100 kPa.

**Graphs of vapour pressure versus temperature**




3.1 Write down the vapour pressure of compound **Y** at 90 °C. (1)

3.2 The graphs can be used to determine the boiling points of the three compounds.

3.2.1 Define *boiling point*. (2)

3.2.2 Determine the boiling point of compound **X**. (1)

3.3 The homologous series to which the three compounds of similar molecular masses belong, were identified in random order as:

alcohol; carboxylic acid; ketone

3.3.1 Which compound (**X**, **Y** or **Z**) is the carboxylic acid? (1)

3.3.2 Explain the answer to QUESTION 3.3.1 by referring to the type of intermolecular forces in compounds of each of the homologous series above. (4)

3.3.3 Compound **X** has three carbon atoms per molecule. Write down the IUPAC name of compound **X**. (1)
**[10]**





**QUESTION 4 (Start on a new page.)**

Consider the incomplete equations for reactions **I** to **IV** below. **P**, **Q**, **R** and **S** are organic compounds.

| | |
|---|---|
| **I** | **Q** + $Br_2$ ⟶ 2-bromobutane + HBr |
| **II** | n**P** ⟶ $-\left[CH_2-CH_2\right]_n-$ |
| **III** | **R** $\xrightarrow{\text{heat}}$ 2**P** + **Q** |
| **IV** | 2-bromobutane + KOH (in ethanol) $\xrightarrow{\text{heat}}$ **S** + **T** + $H_2O$ |

4.1 Define a *cracking reaction*. (2)

4.2 Write down the reaction number (**I**, **II**, **III** or **IV**) that represents EACH of the following:

4.2.1 A cracking reaction (1)

4.2.2 An addition reaction (1)

4.2.3 A substitution reaction (1)

4.3 Write down:

4.3.1 ONE reaction condition for reaction **I** (1)

4.3.2 The compound (**P**, **Q**, **R** or **S**) that represents an unsaturated hydrocarbon (1)

4.3.3 The IUPAC name of compound **P** (1)

4.3.4 The molecular formula of compound **R** (2)

4.3.5 The structural formula of compound **Q** (2)

4.3.6 The structural formula of compound **S** (2)
**[14]**

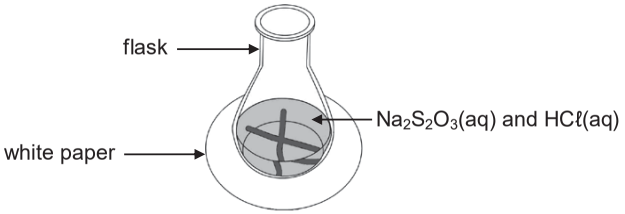
**QUESTION 5 (Start on a new page.)**

**ANSWER QUESTION 5.3 ON THE ATTACHED GRAPH PAPER.**

Learners use the reaction between sodium thiosulphate and hydrochloric acid to investigate one of the factors that affects reaction rate. The balanced equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + H_2O(\ell) + SO_2(g) + S(s)$$

The diagram below shows the experimental setup.




In the first experiment, 50 $cm^3$ of the sodium thiosulphate solution is added to 100 $cm^3$ of a 2 $mol{\cdot}dm^{-3}$ dilute hydrochloric acid solution in a flask that is placed over a cross drawn on a sheet of white paper. The hydrochloric acid is in EXCESS.

The time taken for the cross to become invisible, when viewed from the top, is recorded.

The experiment is then repeated four times with different volumes of the sodium thiosulphate solution. The results obtained are shown in the table below.

| EXPERIMENT | VOLUME OF $Na_2S_2O_3$ ($cm^3$) | VOLUME OF $H_2O$ ($cm^3$) | TIME (s) | AVERAGE RATE ($\frac{1}{time}$) ($\times 10^{-2}\ s^{-1}$) |
|---|---|---|---|---|
| 1 | 50 | 0 | 22,7 | 4,4 |
| 2 | 40 | 10 | 28,6 | 3,5 |
| 3 | 30 | 20 | 38,5 | 2,6 |
| 4 | 20 | 30 | 58,8 | 1,7 |
| 5 | 10 | 40 | 111,1 | 0,9 |

5.1 Define *reaction rate*. (2)

5.2 How does the concentration of the sodium thiosulphate solution used in experiment **2** compare to that used in experiment **5**? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)





5.3 Draw a graph of average reaction rate versus volume of sodium thiosulphate used on the attached GRAPH SHEET.
(ATTACH THIS GRAPH SHEET TO YOUR ANSWER BOOK.) (3)

5.4 Use the information in the graph to answer the following questions.

5.4.1 Determine the volume of dilute sodium thiosulphate solution that needs to react in order for the cross to become invisible in 40 seconds.

USE DOTTED LINES ON THE GRAPH TO SHOW HOW YOU ARRIVED AT THE ANSWER. (3)

5.4.2 Write down a conclusion for this investigation. (2)

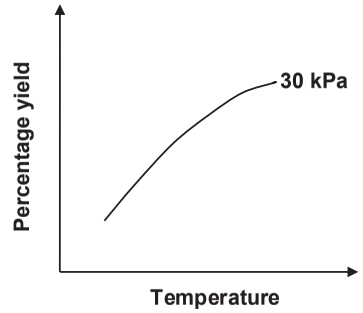
5.5 Use the collision theory to explain the effect of an increase in concentration on reaction rate. (3)

5.6 The mass of sulphur produced in experiment **1** is 1,62 g. Calculate the mass of the sodium thiosulphate used in experiment **1**. (4)
**[18]**

**QUESTION 6 (Start on a new page.)**

6.1 A reversible gaseous reaction is allowed to reach equilibrium in a closed container at different temperatures and pressures.

The graph below shows the percentage yield for this reaction at 30 kPa as the temperature is increased.

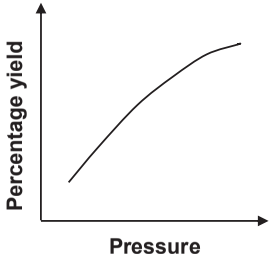



Use the information in the graph above to answer the following questions.

6.1.1 State Le Chatelier's principle. (2)

6.1.2 The heat of reaction ($\Delta H$) for the forward reaction is POSITIVE. Use Le Chatelier's principle to explain this statement. (3)

The graph below show the percentage yield for this reaction as pressure changes at constant temperature.




6.1.3 Explain the effect of an increase in pressure on the equilibrium position of a reaction. (2)

6.1.4 Which ONE of the following equations (**I**, **II** or **III**) represents the equilibrium above?

**I:** $2A(g) + 3B(g) \rightleftharpoons 3C(g)$

**II:** $A(g) + B(g) \rightleftharpoons 3C(g)$

**III:** $A(g) + B(g) \rightleftharpoons 2C(g)$ (2)

6.2 A mixture of 0,2 moles of hydrogen chloride ($HC\ell$) and 0,11 moles of oxygen gas ($O_2$) is sealed in a 200 $cm^3$ flask at a certain temperature. The reaction reaches equilibrium according to the balanced equation below:

$$4HC\ell(g) + O_2(g) \rightleftharpoons 2C\ell_2(g) + 2H_2O(g)$$

It is found that 1,825 g of hydrogen chloride is present at equilibrium.

Calculate the equilibrium constant, $K_c$, for this reaction at this temperature. (9)
**[18]**





**QUESTION 7 (Start on a new page.)**

7.1 The balanced equation below represents the first step in the ionisation of sulphuric acid ($H_2SO_4$) in water:

$$H_2SO_4(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$$

7.1.1 Write down the FORMULAE of the TWO bases in the equation above. (2)

7.1.2 Is sulphuric acid a STRONG or a WEAK acid? Give a reason for the answer. (2)

7.2 Learners use the reaction of a 0,15 $mol{\cdot}dm^{-3}$ sulphuric acid solution with a sodium hydroxide solution in two different experiments. The balanced equation for the reaction is:

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + H_2O(\ell)$$

7.2.1 They use 24 $cm^3$ of $H_2SO_4(aq)$ in a titration to neutralise 26 $cm^3$ of NaOH(aq).

Calculate the concentration of the NaOH(aq). (5)

7.2.2 In another experiment, 30 $cm^3$ of the $H_2SO_4(aq)$ is added to 20 $cm^3$ of a 0,28 $mol{\cdot}dm^{-3}$ NaOH solution in a beaker.

Calculate the pH of the final solution. (8)
**[17]**

**QUESTION 8 (Start on a new page.)**

8.1 A group of learners use the redox reaction below to construct an electrochemical cell.

$$Sn^{2+}(aq) + 2Ag^{+}(aq) \rightarrow 2Ag(s) + Sn^{4+}(aq)$$

8.1.1 Define a *reducing agent* in terms of *electron transfer*. (2)

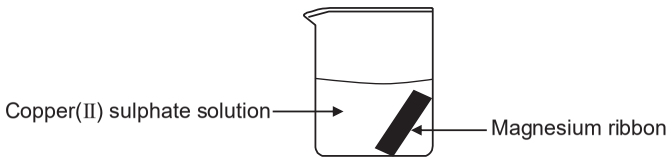
8.1.2 Name a substance that should be used as electrode in the anode half-cell. (1)

8.1.3 Write down the NAME or FORMULA of the reducing agent. (1)

8.1.4 Write down the cell notation of the cell. (3)

8.1.5 Calculate the initial emf of this cell under standard conditions. (4)

8.2 In a separate experiment, the learners place magnesium ribbon in a beaker containing a blue solution of copper(II) sulphate. After a while the solution becomes colourless.




8.2.1 State ONE observable change in the beaker, besides a colour change of the solution, that the learners can make. (1)

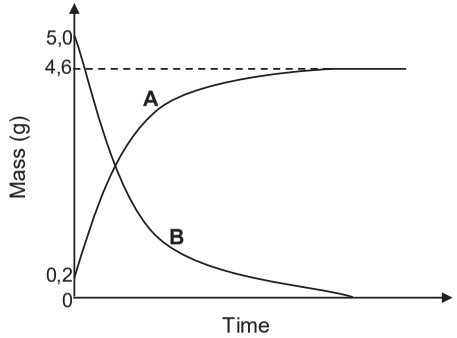
8.2.2 Refer to the relative strengths of oxidising agents or reducing agents to explain why the solution becomes colourless. (3)
**[15]**





**QUESTION 9 (Start on a new page.)**

The graph below represents the changes in mass that occur at electrode **A** and electrode **B** in an electrolytic cell during the purification of copper.




9.1 Define *electrolysis*. (2)

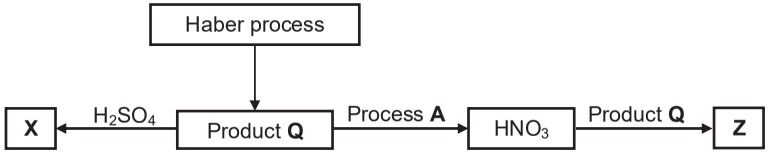
9.2 Which graph, **A** or **B**, represents the change in mass of the anode during electrolysis? (1)

9.3 Write down the equation of the half-reaction which takes place at the cathode of this cell. (2)

9.4 Use the information in the graph and calculate the percentage purity of the impure copper. (4)
**[9]**

**QUESTION 10 (Start on a new page.)**

10.1 The diagram below shows processes involved in the production of fertiliser **X** and fertiliser **Z**.




Write down the:

10.1.1 Balanced equation for the formation of product **Q** (3)

10.1.2 FORMULA of fertiliser **X** (1)

10.1.3 NAME of process **A** (1)

10.1.4 NAME of fertiliser **Z** (1)

10.2 A 10 kg bag of NPK fertiliser is labelled 6 : 1 : 5 (22).

10.2.1 What is the meaning of NPK? (1)

10.2.2 What is the meaning of (22) on the label? (1)

10.2.3 Calculate the mass of potassium in the bag. (4)
**[12]**

**TOTAL: 150**

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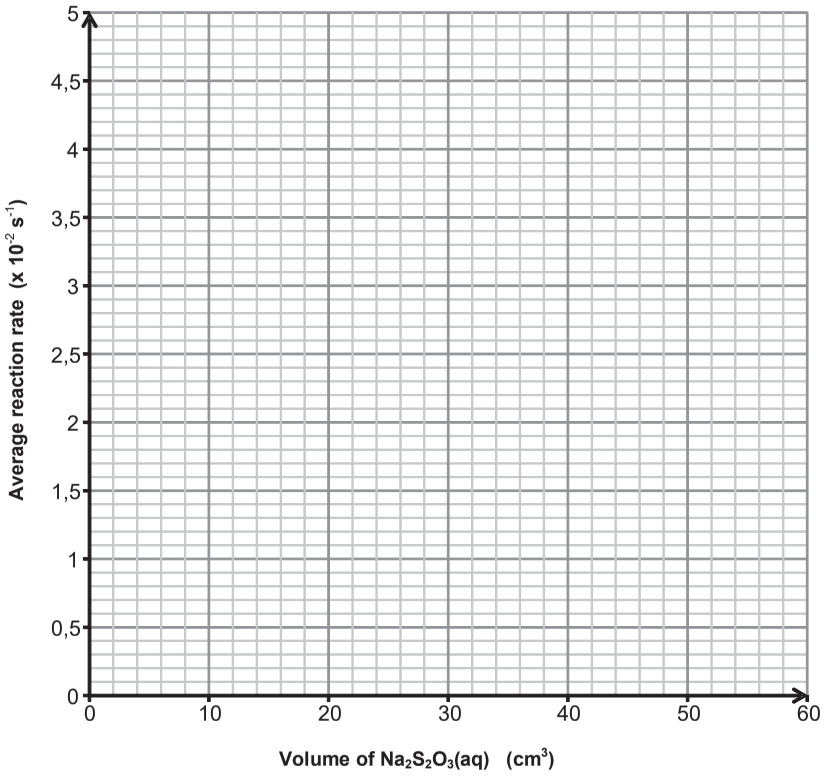
| CENTRE NUMBER: | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EXAMINATION NUMBER: | | | | | | | | | | | | | |

**QUESTION 5.3**

**Hand in this GRAPH SHEET with your ANSWER BOOK.**

**Graph of reaction rate versus volume**

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Department:
Basic Education
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**NOVEMBER 2017**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 16 pages and 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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The IUPAC name of an organic compound with molecular formula $C_7H_{14}O_2$:

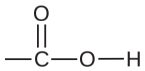
A Heptanal

B Heptan-1-ol

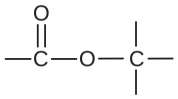
C Heptan-2-ol

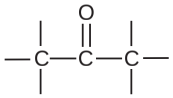
D Heptanoic acid (2)

1.2 Which ONE of the following structures is the functional group of aldehydes?

A 

B

C 

D 

(2)

1.3 Which ONE of the following equations represents a cracking process?

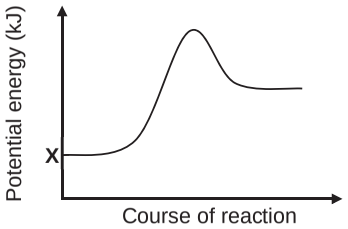
A $5CH_2 = CH_2 \rightarrow —(CH_2CH_2)_5—$

B $CH_3(CH_2)_5CH = CH_2 + H_2 \rightarrow CH_3(CH_2)_6CH_3$

C $CH_3(CH_2)_6CH_3 \rightarrow CH_3(CH_2)_4CH_3 + CH_2 = CH_2$

D $CH_3(CH_2)_7OH \rightarrow CH_3(CH_2)_5CH = CH_2 + H_2O$ (2)

1.4 The potential energy diagram for a chemical reaction is shown below.




Consider the following statements regarding the graph above:

**I:** **X** represents the potential energy of the products formed during the reverse reaction.

**II:** The graph could be a representation of the change in potential energy for the following reaction:

$$CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq) \quad \Delta H > 0$$

**III:** The graph could be a representation of the change in potential energy for the combustion of methane.

Which of the statements above are TRUE?

A **I** and **II** only

B **II** and **III** only

C **I** and **III** only

D **I**, **II** and **III** (2)

1.5 A certain chemical reaction reaches equilibrium at 25 °C. The equilibrium constant, $K_c$, for the reaction at this temperature is $1,0 \times 10^{-4}$.

Which ONE of the following statements regarding this reaction at equilibrium is CORRECT?

A The concentration of the products is equal to that of the reactants.

B The concentration of the products is higher than that of the reactants.

C The concentration of the products is lower than that of the reactants.

D The rate of the forward reaction is lower than the rate of the reverse reaction. (2)





1.6 Consider the following chemical reaction at equilibrium in a closed container:

$$2HgO(s) \rightleftharpoons 2Hg(\ell) + O_2(g)$$

More HgO(s) is now added to the container at constant temperature.

How will the number (in moles) of $O_2(g)$ and the value of $K_c$ be affected at equilibrium?

| | **NUMBER OF MOLES OF $O_2$** | **$K_c$** |
|---|---|---|
| A | Increases | Increases |
| B | Increases | Remains the same |
| C | Remains the same | Remains the same |
| D | Remains the same | Increases |

(2)

1.7 Which ONE of the following solutions, each of concentration $0,1\ mol{\cdot}dm^{-3}$, has the highest pH?

A $HNO_3(aq)$

B $NH_4C\ell(aq)$

C $Na_2CO_3(aq)$

D $CH_3COOH(aq)$ (2)

1.8 The cell notation for a galvanic cell is as follows:

$$Ni(s) \mid Ni^{2+}\ (1\ mol{\cdot}dm^{-3}) \parallel Pb^{2+}\ (1\ mol{\cdot}dm^{-3}) \mid Pb(s)$$

Which ONE of the following statements is CORRECT for this cell?

A Ni is oxidised.

B Pb(s) is reduced.

C $Ni^{2+}(aq)$ is the oxidising agent.

D $Pb^{2+}$ is the reducing agent. (2)

1.9 Which ONE of the following combinations CORRECTLY shows the products formed during the electrolysis of a CONCENTRATED sodium chloride solution?

| | CATHODE | ANODE |
|---|---|---|
| A | Hydrogen | Sodium |
| B | Hydrogen | Chlorine |
| C | Chlorine | Sodium |
| D | Chlorine | Hydrogen |

(2)

1.10 Which ONE of the following is NOT part of the eutrophication process?

A Algal bloom

B Bacterial nitrogen fixation

C Depletion of oxygen in water

D Increase in plant nutrients in water (2)

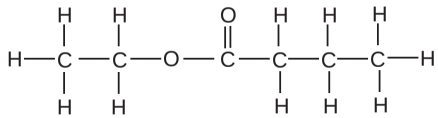
**[20]**





**QUESTION 2 (Start on a new page.)**

2.1 Study the structural formula below.



For this compound, write down the:

2.1.1 Homologous series to which it belongs (1)

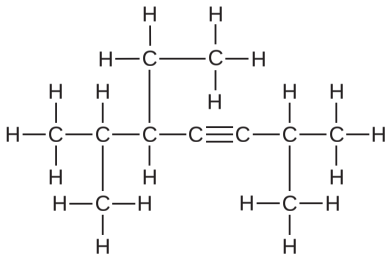
2.1.2 IUPAC name (2)

2.1.3 IUPAC name of the organic acid used in its preparation (1)

2.1.4 STRUCTURAL FORMULA of its straight chain (unbranched) functional isomer (2)

2.2 Write down the structural formula of 4-methylpentan-2-one. (3)

2.3 Consider the structural formula below.



For this compound, write down the:

2.3.1 General formula of the homologous series to which it belongs (1)

2.3.2 IUPAC name (3)

**[13]**

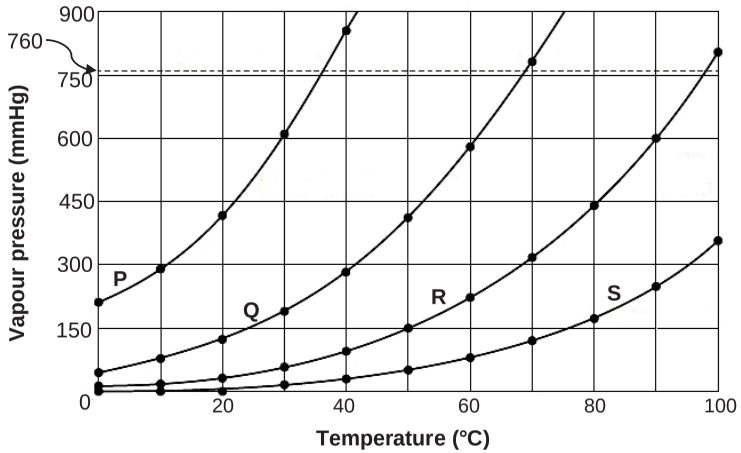
**QUESTION 3 (Start on a new page.)**

The vapour pressure versus temperature graph below was obtained for four straight chain (unbranched) alkanes (**P**, **Q**, **R** and **S**).

FROM **P** TO **S**, EACH COMPOUND DIFFERS FROM THE PREVIOUS COMPOUND BY A $–CH_2$ GROUP.

The vapour pressures are measured in mmHg. Atmospheric pressure is 760 mmHg.

**Graph of vapour pressure versus temperature**




3.1 Give a reason why alkanes are said to be SATURATED. (1)

3.2 Define *vapour pressure.* (2)

3.3 Use the information in the graph above to answer the following questions.

3.3.1 What is the effect of an increase in temperature on vapour pressure? Choose from INCREASES, DECREASES or NO EFFECT. (1)

3.3.2 Which compound has a boiling point of approximately 68 °C? Give a reason for the answer. (2)

3.3.3 Which compound has the longest chain length? Fully explain the answer. (4)

3.4 Compound **P** has FIVE carbon atoms.

3.4.1 Draw the structural formula of a chain isomer of **P**. Write down the IUPAC name of this isomer. (3)

3.4.2 How will the vapour pressure of this isomer compare with that of compound **P**? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

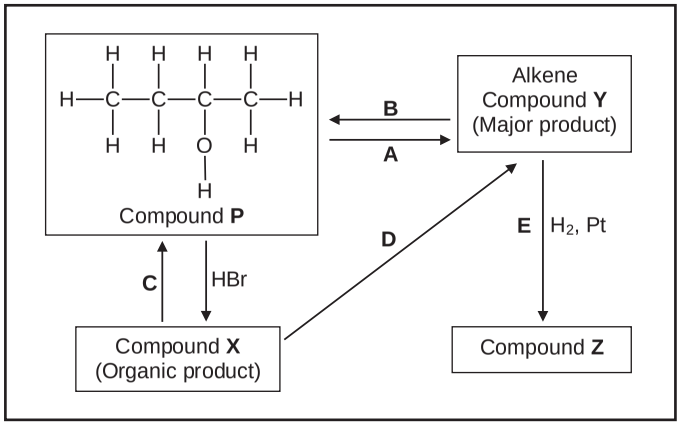
**[14]**





**QUESTION 4 (Start on a new page.)**

The flow diagram below shows how an alcohol (compound **P**) can be used to prepare other organic compounds. The letters **A** to **E** represent different organic reactions. **X**, **Y** and **Z** are organic compounds.




4.1 Is compound **P** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

4.2 Write down the type of:

4.2.1 Elimination reaction represented by **A** (1)

4.2.2 Addition reaction represented by **B** (1)

4.2.3 Elimination reaction represented by **D** (1)

4.3 Sodium hydroxide is used as one of the reactants in reaction **C**.

4.3.1 What type of reaction takes place here? (1)

4.3.2 State the TWO reaction conditions for this reaction. (2)

4.3.3 Write down the IUPAC name of compound **X**. (2)

4.4 Write down the FORMULA of an inorganic reactant needed for reaction **D**. (1)

4.5 Using STRUCTURAL FORMULAE, write down a balanced equation for reaction **E**. (3)

4.6 Write down the IUPAC name of compound **Z**. (1)

**[15]**

**QUESTION 5 (Start on a new page.)**

A group of learners uses the reaction between powdered zinc and EXCESS dilute hydrochloric acid to investigate one of the factors that affects the rate of a chemical reaction. The balanced equation for the reaction is:

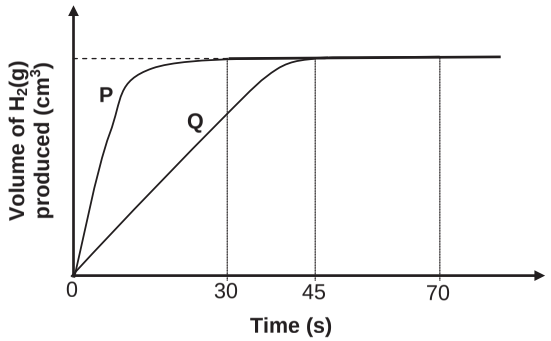
$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

They conduct two experiments. The reaction conditions used are summarised in the table below.

| EXPERIMENT | TEMPERATURE (°C) | VOLUME OF HCℓ ($cm^3$) | CONCENTRATION OF HCℓ ($mol \cdot dm^{-3}$) | MASS OF Zn (g) |
|---|---|---|---|---|
| I | 25 | 200 | 0,25 | x |
| II | 25 | 200 | 0,40 | x |

The results obtained are shown in the graph (not drawn to scale) below.

**Graph of volume of $H_2(g)$ produced versus time**




5.1 Define *reaction rate*. (2)

5.2 Write down an investigative question for this investigation. (2)

5.3 Which curve, **P** or **Q**, represents the results of experiment **I**? Explain the answer. (3)

5.4 The average rate of the production of hydrogen gas, as represented by graph **P**, was 15 $cm^3 \cdot s^{-1}$. Calculate the mass of zinc used. **Take the molar gas volume at 25 °C as 24 000 $cm^3$.** (5)





5.5 In a third experiment (experiment **III**), 200 $cm^3$ of a 0,25 $mol \cdot dm^{-3}$ dilute hydrochloric acid solution at 35 °C reacts with the same amount of zinc powder as in experiment **I** and experiment **II**.

5.5.1 How will the heat of reaction of experiment **II** compare with that of experiment **III**? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)

5.5.2 How will the activation energy of the reaction in experiment **I** compare with that of the reaction in experiment **III**? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)

5.6 The rate of the reaction in experiment **III** is higher than that of experiment **I**.

Fully explain this statement by referring to the collision theory. (3)
**[17]**

**QUESTION 6 (Start on a new page.)**

Carbonyl bromide, $COBr_2$, decomposes into carbon monoxide and bromine according to the following balanced equation:

$$COBr_2(g) \rightleftharpoons CO(g) + Br_2(g) \qquad \Delta H > 0$$

Initially $COBr_2(g)$ is sealed in a 2 $dm^3$ container and heated to 73 °C. The reaction is allowed to reach equilibrium at this temperature. The equilibrium constant for the reaction at this temperature is 0,19.

6.1 Define *chemical equilibrium*. (2)

At equilibrium it is found that 1,12 g CO(g) is present in the container.

6.2 Calculate the:

6.2.1 Equilibrium concentration of the $COBr_2(g)$ (7)

6.2.2 Percentage of $COBr_2(g)$ that decomposed at 73 °C (4)

6.3 Which ONE of the following CORRECTLY describes the $K_c$ value when equilibrium is reached at a lower temperature?

| | | |
|---|---|---|
| $K_c < 0,19$ | $K_c > 0,19$ | $K_c = 0,19$ |

(1)

6.4 The pressure of the system is now decreased by increasing the volume of the container at 73 °C and the system is allowed to reach equilibrium.

How will the number of moles of $COBr_2(g)$ be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)
**[17]**

**QUESTION 7 (Start on a new page.)**

7.1 Ammonia ionises in water to form a basic solution according to the following balanced equation:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

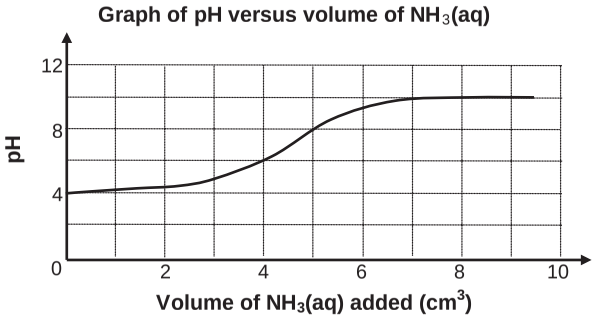
7.1.1 Is ammonia a WEAK or a STRONG base? Give a reason for the answer. (2)

7.1.2 Write down the conjugate acid of $NH_3(g)$. (1)

7.1.3 Identify ONE substance in this reaction that can behave as an ampholyte in some reactions. (1)

7.2 A learner adds distilled water to a soil sample and then filters the mixture. The pH of the filtered liquid is then measured.

He then gradually adds an ammonia solution, $NH_3(aq)$, to this liquid and measures the pH of the solution at regular intervals. The graph below shows the results obtained.




7.2.1 Is the soil sample ACIDIC or BASIC? Refer to the graph above and give a reason for the answer. (2)

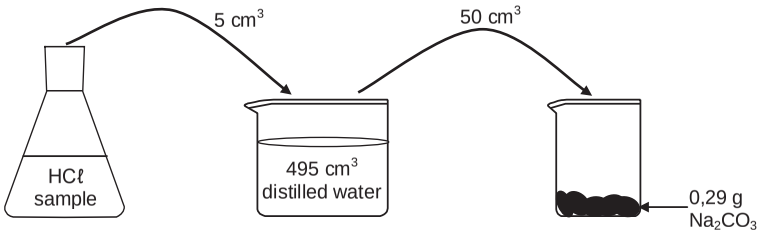
7.2.2 Calculate the concentration of the hydroxide ions ($OH^-$) in the reaction mixture after the addition of 4 $cm^3$ of $NH_3(aq)$. (4)





7.3 A laboratory technician wants to determine the concentration of a hydrochloric acid (HCℓ) sample. He adds 5 $cm^3$ of the HCℓ sample to 495 $cm^3$ of distilled water to give 500 $cm^3$ of dilute hydrochloric acid, HCℓ(aq).

During a reaction 50 $cm^3$ of this dilute hydrochloric acid solution, HCℓ(aq), reacts completely with 0,29 g of sodium carbonate, $Na_2CO_3(s)$.



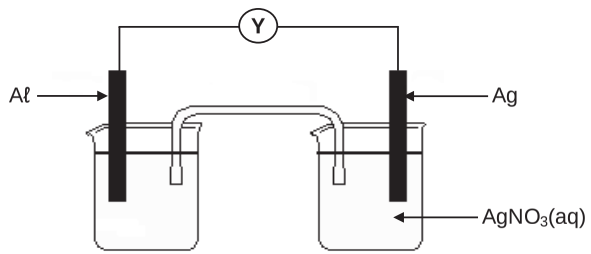

The balanced equation for the reaction is:

$$Na_2CO_3(s) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

Calculate the concentration of the hydrochloric acid sample. (7)
**[17]**

**QUESTION 8 (Start on a new page.)**

8.1 Learners set up a galvanic cell and measure its emf under standard conditions.




8.1.1 Write down the name of component **Y**. (1)

8.1.2 Is Aℓ the ANODE or the CATHODE? (1)

8.1.3 Write down the overall (net) cell reaction that takes place in this cell when it is working. (3)

8.1.4 Calculate the initial emf of this cell. (4)

8.2 Consider the half-cells, **P**, **Q** and **R**, represented in the table below.

| HALF-CELL | | |
|---|---|---|
| **P** | **Q** | **R** |
| $Zn \mid Zn^{2+}(aq)$ | $C\ell_2 \mid C\ell^-(aq)$ | $Cu \mid Cu^{2+}(aq)$ |

Different combinations of the half-cells above are compared to determine the highest emf produced under standard conditions.

8.2.1 Write down the NAME of a suitable electrode for half-cell **Q**. (1)

8.2.2 State the standard conditions under which the half-cells should operate to ensure a fair comparison. (2)

8.2.3 Write down the NAME or FORMULA of the strongest reducing agent in the half-cells above. (1)

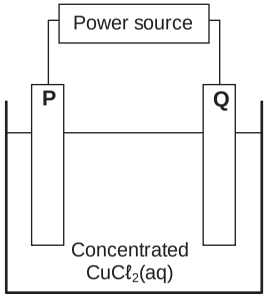
8.2.4 Which combination of half-cells will produce the highest emf? Choose from **PR**, **PQ** or **QR**. (NO calculation is required.) (1)
**[14]**





**QUESTION 9 (Start on a new page.)**

The simplified diagram below represents an electrochemical cell used in the refining of copper. One of the electrodes consists of impure copper.




9.1 What type of power source, AC or DC, is used to drive the reaction in this cell? (1)

9.2 When an electric current passes through the $CuC\ell_2(aq)$, the mass of electrode **P** increases.

Is electrode **P** the CATHODE or the ANODE?
Write down the relevant half-reaction to support the answer. (3)

9.3 The impure copper contains zinc impurities which are oxidised to zinc ions.

Refer to the relative strengths of oxidising agents to explain why zinc ions will not influence the quality of the pure copper produced in this cell. (3)

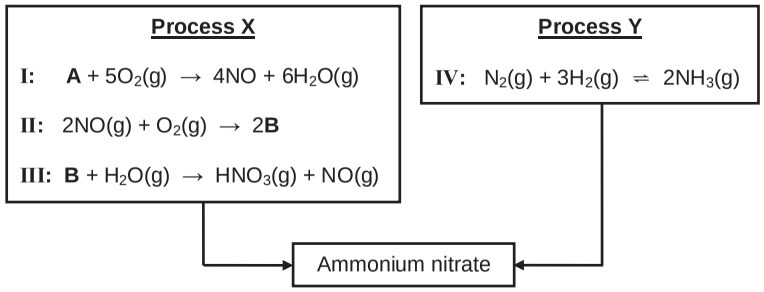
9.4 Electrodes **P** and **Q** are now replaced by carbon electrodes.

9.4.1 What will be observed at electrode **Q**? (1)

9.4.2 How will the concentration of the electrolyte change as the reaction proceeds? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
**[9]**

**QUESTION 10 (Start on a new page.)**

10.1 The equations below represent two industrial processes involved in the preparation of ammonium nitrate.




Write down the:

10.1.1 NAME of substance **A** (1)

10.1.2 FORMULA of substance **B** (1)

10.1.3 NAME given for reaction **I** (1)

10.1.4 NAME or FORMULA of the catalyst used in reaction **I** (1)

10.1.5 Name of process **X** (1)

10.1.6 Name of process **Y** (1)

10.1.7 Balanced equation for the preparation of ammonium nitrate from the products obtained in process **X** and process **Y** (3)

10.2 A 15 kg bag of fertiliser contains 5% phosphorus, 10% nitrogen and 15% potassium.

Calculate the:

10.2.1 Mass of phosphorus in the bag (2)

10.2.2 Mass of filler in the bag (3)
**[14]**

**TOTAL: 150**



basic education
Department:
Basic Education
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**NOVEMBER 2016**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 18 pages and 4 data sheets.**

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Write down the question number (1.1–1.10), choose the answer and make a cross (X) over the letter (A–D) of your choice in the ANSWER BOOK.

EXAMPLE:

1.11 | A | B | C | ~~D~~ |

1.1 In a chemical reaction an oxidising agent will …

A lose protons.

B gain protons.

C lose electrons.

D gain electrons. (2)

1.2 A catalyst is added to a reaction mixture at equilibrium.

Which ONE of the following statements about the effect of the catalyst is FALSE?

A The rate of the forward reaction increases.

B The rate of the reverse reaction increases.

C The equilibrium position shifts to the right.

D The equilibrium position remains unchanged. (2)

1.3 What product will be formed when an alkene reacts with water vapour ($H_2O$) in the presence of an acid catalyst?

A Ester

B Alkane

C Alcohol

D Aldehyde (2)

1.4 Which ONE of the following represents a SUBSTITUTION REACTION?

A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$

B $CH_2 = CH_2 + H_2O \rightarrow CH_3CH_2OH$

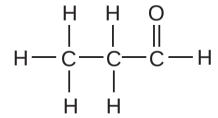
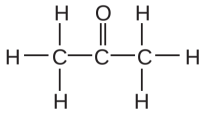
C $CH_3CH_2OH \rightarrow CH_2 = CH_2 + H_2O$

D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$ (2)





1.5 Consider the two organic molecules **I** and **II** below.

| **I** | **II** |
|---|---|
|  |  |

Which ONE of the following represents the homologous series to which compound **I** and compound **II** belong?

| | **I** | **II** |
|---|---|---|
| A | Ketones | Alcohols |
| B | Aldehydes | Ketones |
| C | Aldehydes | Alcohols |
| D | Ketones | Aldehydes |

(2)

1.6 Consider the balanced equations for three reactions represented below:

**I:** $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

**II:** $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

**III:** $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

Which of the above reactions form(s) part of the Ostwald process?

A **I** only

B **II** only

C **III** only

D **II** and **III** only (2)

1.7 Which ONE of the following pairs is NOT a conjugate acid-base pair?

A $H_3O^+$ and $OH^-$

B $NH_4^+$ and $NH_3$

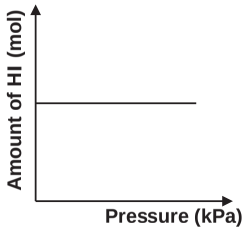
C $H_2PO_4^-$ and $HPO_4^{2-}$

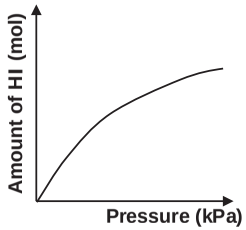
D $H_2CO_3$ and $HCO_3^-$ (2)

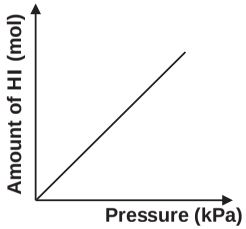
1.8 The reaction between hydrogen gas and iodine gas reaches equilibrium in a closed container according to the following balanced equation:

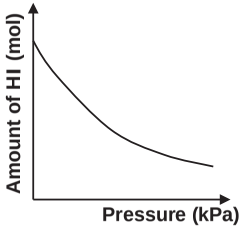
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the graphs below shows the relationship between the amount of HI(g) at equilibrium and the pressure in the container at constant temperature?

A



B



C



D



(2)

1.9 Which ONE of the equations below represents the half-reaction occurring at the CATHODE of an electrochemical cell that is used to electroplate an object?

A $Ag \rightarrow Ag^+ + e^-$

B $Cr^{3+} + 3e^- \rightarrow Cr$

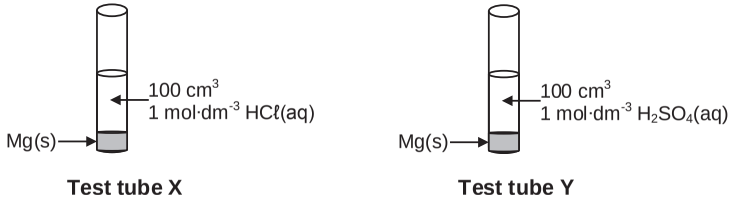
C $Cr^{3+} + e^- \rightarrow Cr^{2+}$

D $Cu^{2+} + e^- \rightarrow Cu^+$ (2)





1.10 Equal amounts of magnesium (Mg) powder react respectively with equal volumes and equal concentrations of HCℓ(aq) and $H_2SO_4$(aq), as shown below.




**Test tube X** **Test tube Y**

The magnesium is in EXCESS.

Consider the following statements regarding these two reactions:

**I:** The initial rate of the reaction in test tube **X** equals the initial rate of the reaction in test tube **Y**.

**II:** After completion of the reactions, the mass of magnesium that remains in test tube **X** will be greater than that in test tube **Y**.

**III:** The amount of hydrogen gas formed in **X** is equal to the amount of hydrogen gas formed in **Y**.

Which of the above statements is/are TRUE?

A **I** only

B **II** only

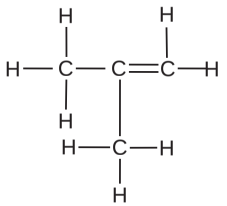
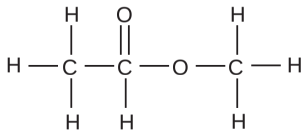
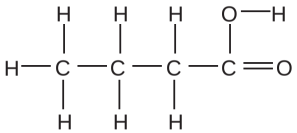
C **III** only

D **I** and **III** only (2)

**[20]**

**QUESTION 2 (Start on a new page.)**

The letters **A** to **F** in the table below represent six organic compounds.

| | | | |
|---|---|---|---|
| **A** |  | **B** | Ethyl ethanoate |
| **C** | 2,3-dibromo-3-methylpentane | **D** | Polyethene |
| **E** |  | **F** |  |

2.1 Write down the LETTER that represents the following:

2.1.1 A hydrocarbon (1)

2.1.2 A functional isomer of compound **F** (1)

2.1.3 A compound which belongs to the same homologous series as compound **B** (1)

2.1.4 A plastic (1)

2.2 Write down the STRUCTURAL FORMULA of EACH of the following:

2.2.1 Compound **C** (3)

2.2.2 The acid used to prepare compound **B** (2)

2.2.3 The monomer used to make compound **D** (2)

2.3 Compound **A** reacts with an unknown reactant, **X**, to form 2-methylpropane.

Write down the:

2.3.1 NAME of reactant **X** (1)

2.3.2 Type of reaction that takes place (1)
**[13]**





**QUESTION 3 (Start on a new page.)**

The boiling points of three isomers are given in the table below.

| | ISOMERS | BOILING POINT (°C) |
|---|---|---|
| **A** | 2,2-dimethylpropane | 9 |
| **B** | 2-methylbutane | 28 |
| **C** | pentane | 36 |

3.1 Define the term *structural isomer*. (2)

3.2 What type of isomers (POSITIONAL, CHAIN or FUNCTIONAL) are these three compounds? (1)

3.3 Explain the trend in the boiling points from compound **A** to compound **C**. (3)

3.4 Which ONE of the three compounds (**A**, **B** or **C**) has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)

3.5 Use MOLECULAR FORMULAE and write down a balanced equation for the complete combustion of compound **B**. (3)
**[11]**

**QUESTION 4 (Start on a new page.)**

Butane ($C_4H_{10}$) is produced in industry by the THERMAL cracking of long-chain hydrocarbon molecules, as shown in the equation below. **X** represents an organic compound that is produced.

$$C_{10}H_{22} \rightarrow \mathbf{X} + C_4H_{10}$$

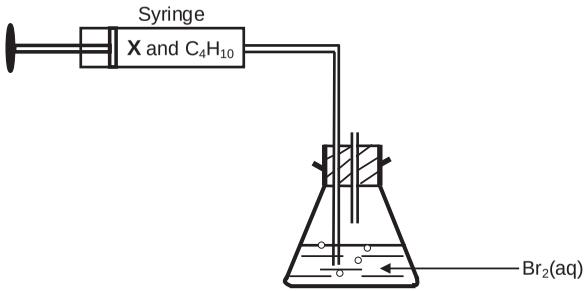
4.1 Write down:

4.1.1 ONE condition required for THERMAL cracking to take place (1)

4.1.2 The molecular formula of compound **X** (1)

4.1.3 The homologous series to which compound **X** belongs (1)

4.2 A mixture of the two gases, compound **X** and butane, is bubbled through bromine water, $Br_2(aq)$, in a conical flask, as illustrated below. THE REACTION IS CARRIED OUT IN A DARKENED ROOM.



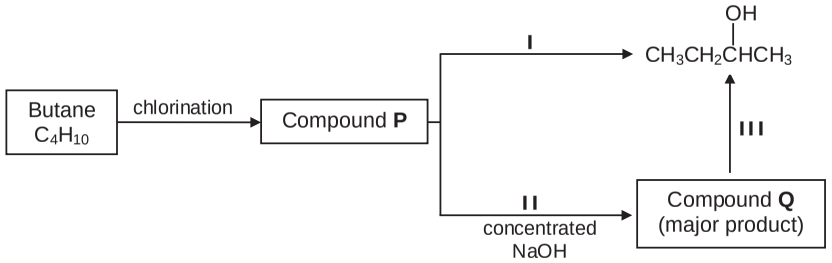

The colour of the bromine water changes from reddish brown to colourless when the mixture of the two gases is bubbled through it.

Which ONE of the gases (**X** or BUTANE) decolorises the bromine water? Explain the answer. (4)





4.3 Study the flow diagram below, which represents various organic reactions, and answer the questions that follow.




Write down the:

4.3.1 IUPAC name of compound **P** (2)

4.3.2 Type of reaction labelled **I** (1)

4.3.3 Structural formula of compound **Q** (2)

4.3.4 The type of addition reaction represented by reaction **III** (1)
**[13]**

**QUESTION 5 (Start on a new page.)**

Hydrogen peroxide, $H_2O_2$, decomposes to produce water and oxygen according to the following balanced equation:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

5.1 The activation energy ($E_A$) for this reaction is 75 kJ and the heat of reaction ($\Delta H$) is −196 kJ.

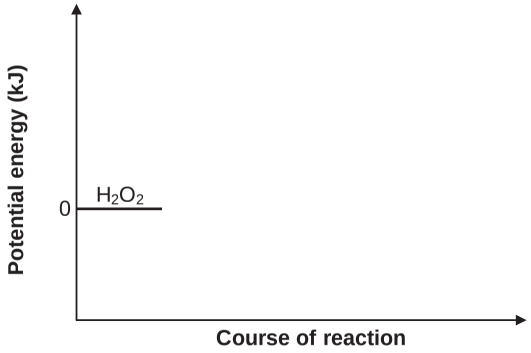
5.1.1 Define the term *activation energy*. (2)

5.1.2 Redraw the set of axes below in your ANSWER BOOK and then complete the potential energy diagram for this reaction.

Indicate the value of the potential energy of the following on the y-axis:

- Activated complex
- Products

(The graph does NOT have to be drawn to scale.)




(3)

When powdered manganese dioxide is added to the reaction mixture, the rate of the reaction increases.

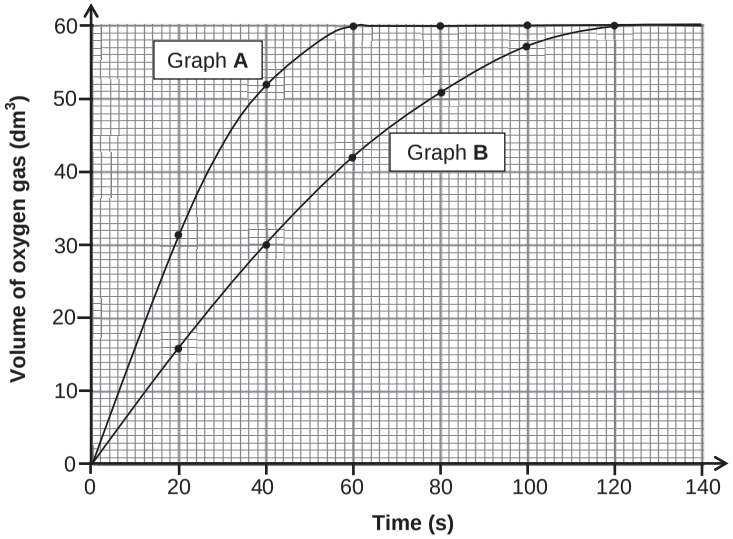
5.1.3 On the graph drawn for QUESTION 5.1.2, use broken lines to show the path of the reaction when the manganese dioxide is added. (2)

5.1.4 Use the collision theory to explain how manganese dioxide influences the rate of decomposition of hydrogen peroxide. (3)





5.2 Graphs **A** and **B** below were obtained for the volume of oxygen produced over time under different conditions.



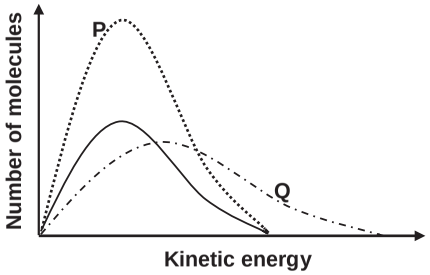

5.2.1 Calculate the average rate of the reaction (in $dm^3 \cdot s^{-1}$) between t = 10 s and t = 40 s for graph **A**. (3)

5.2.2 Use the information in graph **A** to calculate the mass of hydrogen peroxide used in the reaction. Assume that all the hydrogen peroxide decomposed. Use 24 $dm^3 \cdot mol^{-1}$ as the molar volume of oxygen. (4)

5.2.3 How does the mass of hydrogen peroxide used to obtain graph **B** compare to that used to obtain graph **A**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

5.3 Three energy distribution curves for the oxygen gas produced under different conditions are shown in the graph below.

The curve with the solid line represents 1 mol of oxygen gas at 90 °C.




Choose the curve (**P** or **Q**) that best represents EACH of the following situations:

5.3.1 1 mol of oxygen gas produced at 120 °C (1)

5.3.2 2 moles of oxygen gas produced at 90 °C (1)
**[20]**

**QUESTION 6 (Start on a new page.)**

Hydrogen gas, $H_2(g)$, reacts with sulphur powder, S(s), according to the following balanced equation:

$$H_2(g) + S(s) \rightleftharpoons H_2S(g) \qquad \Delta H < 0$$

The system reaches equilibrium at 90 °C.

6.1 Define the term *chemical equilibrium*. (2)

6.2 How will EACH of the following changes affect the number of moles of $H_2S(g)$ at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

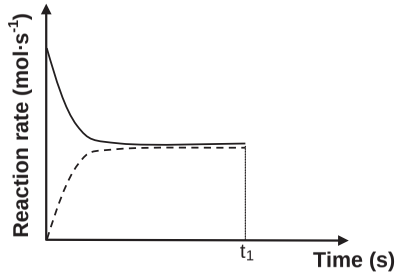
6.2.1 The addition of more sulphur (1)

6.2.2 An increase in temperature
Use Le Chatelier's principle to explain the answer. (4)





6.3 The sketch graph below was obtained for the equilibrium mixture.




A catalyst is added to the equilibrium mixture at time $t_1$.

Redraw the graph above in your ANSWER BOOK. On the same set of axes, complete the graph showing the effect of the catalyst on the reaction rates. (2)

Initially 0,16 mol $H_2(g)$ and excess S(s) are sealed in a 2 $dm^3$ container and the system is allowed to reach equilibrium at 90 °C.

An exact amount of $Pb(NO_3)_2$ solution is now added to the container so that ALL the $H_2S(g)$ present in the container at EQUILIBRIUM is converted to PbS(s) according to the following balanced equation:

$$Pb(NO_3)_2(aq) + H_2S(g) \rightarrow PbS(s) + 2HNO_3(aq)$$

The mass of the PbS precipitate is 2,39 g.

6.4 Calculate the equilibrium constant $K_c$ for the reaction $H_2(g) + S(s) \rightleftharpoons H_2S(g)$ at 90 °C. (9)
**[18]**

**QUESTION 7 (Start on a new page.)**

7.1 A learner dissolves ammonium chloride ($NH_4C\ell$) crystals in water and measures the pH of the solution.

7.1.1 Define the term *hydrolysis* of a salt. (2)

7.1.2 Will the pH of the solution be GREATER THAN, SMALLER THAN or EQUAL TO 7? Write a relevant equation to support your answer. (3)

7.2 A sulphuric acid solution is prepared by dissolving 7,35 g of $H_2SO_4(\ell)$ in 500 $cm^3$ of water.

7.2.1 Calculate the number of moles of $H_2SO_4$ present in this solution. (2)

Sodium hydroxide (NaOH) pellets are added to the 500 $cm^3$ $H_2SO_4$ solution.

The balanced equation for the reaction is:

$$H_2SO_4(aq) + 2NaOH(s) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

After completion of the reaction, the pH of the solution was found to be 1,3. Assume complete ionisation of $H_2SO_4$.

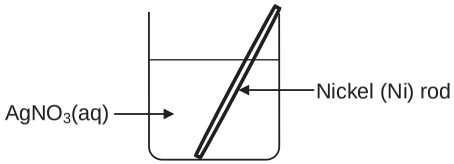
7.2.2 Calculate the mass of NaOH added to the $H_2SO_4$ solution. Assume that the volume of the solution does not change. (9)
**[16]**





**QUESTION 8 (Start on a new page.)**

8.1 A nickel (Ni) rod is placed in a beaker containing a silver nitrate solution, $AgNO_3(aq)$ and a reaction takes place.



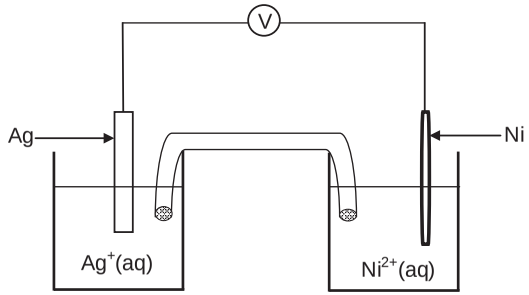

Write down the:

8.1.1 NAME or FORMULA of the electrolyte (1)

8.1.2 Oxidation half-reaction that takes place (2)

8.1.3 Balanced equation for the net (overall) redox reaction that takes place (3)

8.2 A galvanic cell is now set up using a nickel half-cell and a silver half-cell.




8.2.1 Which electrode (**Ni** or **Ag**) must be connected to the negative terminal of the voltmeter? Give a reason for the answer. (2)

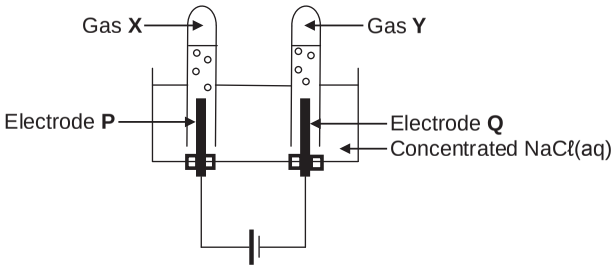
8.2.2 Write down the cell notation for the galvanic cell above. (3)

8.2.3 Calculate the initial reading on the voltmeter if the cell functions under standard conditions. (4)

8.2.4 How will the voltmeter reading in QUESTION 8.2.3 be affected if the concentration of the silver ions is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
**[16]**

**QUESTION 9 (Start on a new page.)**

In the electrochemical cell below, carbon electrodes are used during the electrolysis of a concentrated sodium chloride solution.




The balanced equation for the net (overall) cell reaction is:

$$2H_2O(\ell) + 2C\ell^-(aq) \rightarrow C\ell_2(g) + H_2(g) + 2OH^-(aq)$$

9.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? (1)

9.2 Is electrode **P** the ANODE or the CATHODE? Give a reason for the answer. (2)

9.3 Write down the:

9.3.1 NAME or FORMULA of gas **X** (1)

9.3.2 NAME or FORMULA of gas **Y** (1)

9.3.3 Reduction half-reaction (2)

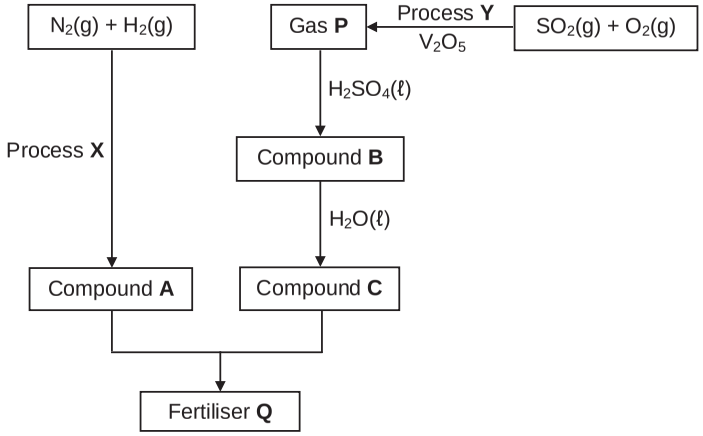
9.4 Is the solution in the cell ACIDIC or ALKALINE (BASIC) after completion of the reaction? Give a reason for the answer. (2)
**[9]**





**QUESTION 10 (Start on a new page.)**

10.1 The flow diagram below shows the processes involved in the industrial preparation of fertiliser **Q**.




Write down the:

10.1.1 Name of process **X** (1)

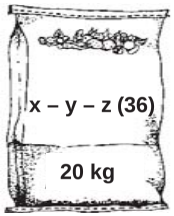
10.1.2 Name of process **Y** (1)

10.1.3 NAME or FORMULA of gas **P** (1)

10.1.4 Balanced equation for the formation of compound **B** (3)

10.1.5 Balanced equation for the formation of fertiliser **Q** (4)

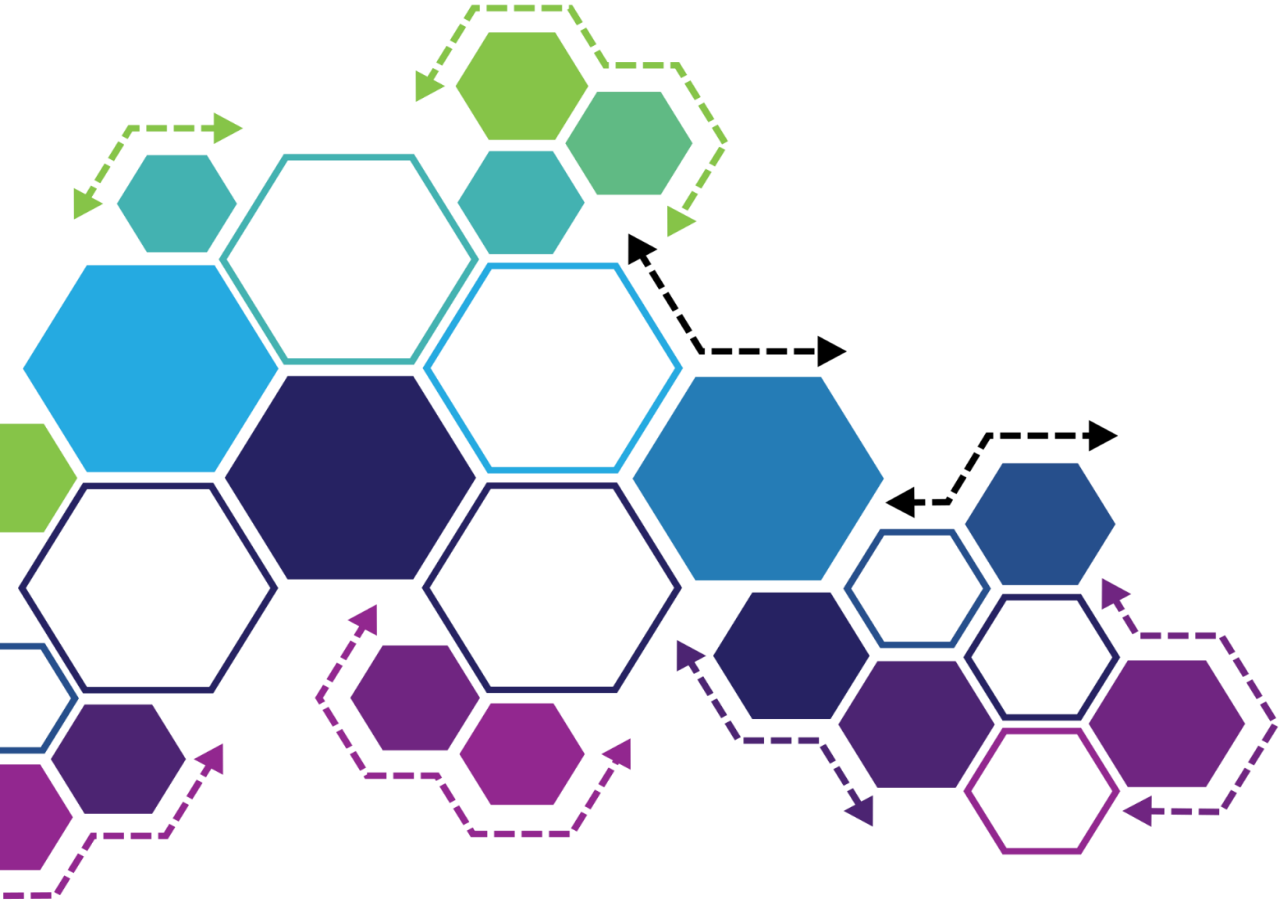
10.2 The diagram below shows a bag of NPK fertiliser of which the NPK ratio is unknown. It is found that the mass of nitrogen in the bag is 4,11 kg and the mass of phosphorus is 0,51 kg.




Calculate the NPK ratio of the fertiliser. (4)
**[14]**

**TOTAL: 150**

# Physics Paper 1 - Memoranda



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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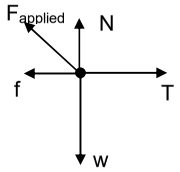
## QUESTION 2/*VRAAG 2*

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: | **Marking criteria/*Nasienriglyne*** |
|---|---|
| $F_{net} = ma$<br>$T - f - F_{Ax} = ma$ ✓<br>$T - 5 - 35\cos 40° ✓ = 0$ ✓<br>$T = 31{,}81$ N<br><br>For/*vir* m:<br>$F_{net} = ma$<br>$mg - T = ma$<br>$m(9{,}8) - 31{,}81$ ✓ $= 0$<br>$m = 3{,}25$ kg ✓ | • Formula for 20 kg or m kg/*Formule vir 20 kg of m kg* / $F_{net} = ma$ ✓<br>• Substitution of zero into either formula ✓ *Vervanging van nul in een van die formules*<br>• All substitutions into $F_{net}$ for 20 kg as shown ✓ *Alle vervanging in $F_{net}$ for 20 kg soos getoon*<br>• Substitution of value of T in eqn for m /*Substitusie van waarde vir T in vgl vir m* ✓<br>• 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*** |
|---|---|
| $\Delta t = \frac{(1{,}90 - 0{,}67)}{2}$ ✓<br>$= 0{,}62$ s ✓ (0,615 s) | $\Delta x = v_i\Delta t + ½ a\Delta t^2$<br>$(-1{,}85) = 0 + ½(-9{,}8)\Delta t^2$ ✓<br>$\Delta t = 0{,}61$ s ✓ (0,6145 s) |
| **OPTION 3/*OPSIE 3*** | **OPTION 4/*OPSIE 4*** |
| $\Delta t = \frac{(1{,}90 + 0{,}67)}{2} = 1{,}285$ s<br>$\Delta t = 1{,}285 - 0{,}67$ ✓<br>$= 0{,}62$ s ✓ (0,615 s) | $v_f^2 = v_i^2 + 2a\Delta x$<br>$0 = v_i^2 + 2(-9{,}8)(1{,}85)$<br>$v_i = 6{,}02\ m\cdot s^{-1}$<br><br>$v_f = v_i + a\Delta t$<br>$0 = 6{,}02 + (-9{,}8)\Delta t$ ✓<br>$\Delta t = 0{,}61$ 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***

$(E_{mech})_{top} = (E_{mech})_{bot/ond}$
$(E_p + E_k)_{top} = (E_p + E_k)_{Bot/Ond}$
$(mgh + ½mv^2)_{top} = (mgh + ½mv^2)_{Bot/Ond}$
✓Any one/*Enige een*
$(9,8)(1,2) + 0 = 0 + (½)v^2$ ✓
$v_i = 4,85\ m\cdot s^{-1}$ 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*<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>1,2 ✓= 0 + ½(9,8) $\Delta t^2$✓<br>$\Delta t$ = 0,49 s<br>t = 1,97 + ✓ 2(0,49) ✓<br>= 2,96 s ✓<br>Upwards positive/*Opwaarts positief*<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>-1,2 ✓= 0 + ½(-9,8)$\Delta t^2$✓<br>$\Delta t$ = 0,49 s<br>t = 1,97 + ✓ 2(0,49) ✓<br>= 2,96 s ✓ | • Formula ✓/*Formule*<br>• Substitution/*Vervanging* $\Delta y$ = 1,2 ✓<br>• Substitution/*Vervanging* 0 + ½(9,8) $\Delta t^2$<br>• 1,97 s + ✓<br>• 2 $\Delta t$ ✓<br>• 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***<br>$\sum p_i = \sum p_f$<br>$m_pv_{pi} + m_Qv_{Qi} = m_pv_{pf} + m_Qv_{Qf}$ ✓Any one/*Enige een*<br><br>(0,16)(10) + (0,2)(-15) ✓= (0,16)(-5) +(0,2)$v_{Qf}$✓<br>$v_{Qf}$ = -3 m·s$^{-1}$<br>$v_{Qf}$ = 3 m·s$^{-1}$ ✓ west/*wes* ✓ |
| **OPTION 2/*OPSIE 2*** |
| **West as positive/*Wes as positief***<br>$\sum p_i = \sum p_f$<br>$m_pv_{pi} + m_Qv_{Qi} = m_pv_{pf} + m_Qv_{Qf}$ ✓Any one/*Enige een*<br><br>(0,16)(-10) + (0,2)(15) ✓= (0,16)(5) +(0,2)$Q_{Nf}$✓<br>$v_{Qf}$ = 3 m·s$^{-1}$ ✓ west/*wes* ✓ |
| **OPTION 3/*OPSIE 3*** |
| $\Delta p_p = -\Delta p_Q$ ✓<br>(0,16)(-5 – 10) ✓= -(0,2)(v – (-15))✓<br>v = -3 m·s$^{-1}$<br>= 3 m·s$^{-1}$ ✓west/*wes* ✓ |

(5)





4.2.2

| For ball/*Vir bal* P: | **POSITIVE MARKING FROM QUESTION 4.2.1 /*POSITIEWE NASIEN VANAF VRAAG 4.2.1*** |
|---|---|
| West as negative/*Wes as negatief*<br>Impulse = $\Delta p$<br>$F_{net}\Delta t = \Delta p$<br>$\Delta p = m(v_{Pf} - v_{Pi})$ ✓Any one/ *Enige een*<br>= 0,16(-5 – 10) ✓<br>= - 2,4<br>∴ 2,4 N·s ✓ (2,4 kg·m·s$^{-1}$)<br><br>**OR/*OF***<br>West as positive /*Wes as positief*<br>Impulse = $\Delta p$<br>$F_{net}\Delta t = \Delta p$<br>= $m(v_{Pf} - v_{Pi})$ ✓Any one/ *Enige een*<br>= 0,16(5 – (-10)) ✓<br>= 2,4 N·s ✓ | For ball/*Vir bal* Q:<br>West as negative/*Wes as negatief*<br>Impulse = $\Delta p$<br>$F_{net}\Delta t = \Delta p$<br>= $m(v_{Qf} - v_{Qi})$ ✓ Any one/ *Enige een*<br>= 0,2[-3 – (-15)] ✓<br>= 2,4 N·s ✓ (2,4 kg·m·s$^{-1}$)<br><br>**OR/*OF***<br>West as positive /*Wes as positief*<br>Impulse = $\Delta p$<br>$F_{net}\Delta t = \Delta p$<br>= $m(v_{Qf} - v_{Qi})$ ✓Any one/ *Enige een*<br>= 0,16(3 – (15)) ✓<br>= - 2,4 N·s<br>∴ 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<br>*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
$K = ½ mv^2 / E_k = ½ mv^2$
$\Delta K = K_f - K_i$
$\Delta K = ½mv_f^2 - ½mv_i^2$
$= ½m(v_f^2 - v_i^2)$
$= ½(200)(2^2 - 4^2)$✓
✓Any one /*Enige een*
$\Delta K$ = - 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***

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$= ½ m (v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓Any one/*Enige een*
$-3{,}40 \times 10^3$ ✓ $= -1\,200 + 200(9{,}8)(h_f - 10)$ ✓
h = 8,88 m ✓ (8,87765 m)

**OPTION 2/*OPSIE 2***

$E_{(mech/meg)A} + W_f = E_{(mech)B}$
$(E_p + E_k)_A + W_f = (E_p + E_k)_B$
$(mgh + ½mv^2)_A + W_f = (mgh + ½mv^2)_B$ ✓Any one/*Enige een*
$200(9{,}8)(10) + ½(200)(4^2) - 3{,}40 \times 10^3$ ✓ $= 200(9{,}8)(h) + ½(200)(2)^2$ ✓
h = 8,88 m ✓ (8,87755)

**OPTION 3/*OPSIE 3***

$W_{net} = \Delta K$
$W_f + W_w = ½mv_f^2 - ½mv_i^2$
$W_f - \Delta E_p = ½mv_f^2 - ½mv_i^2$
$W_f - mg(h_f - h_i) = ½m(v_f^2 - v_i^2)$ ✓Any one/*Enige een*
$-3{,}40 \times 10^3 - 200(9{,}8)(h-10)$ ✓ $= -1\,200$ ✓
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***

$W_{nc} = \Delta K + \Delta U$
$W_{engine} + W_f = ½mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$= ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓✓Any one/*Enige een*
$W_{engine} + (50)(15)(2)\cos 180°$ ✓✓ $= 0 + 200(9{,}8)$ ✓$(22 - 8{,}88)$
$W_{engine} = 27\,215{,}20$ J

$P_{engine} = \frac{W_{engine}}{\Delta t}$
$= \frac{27\,215{,}20}{15}$
$= 1\,814{,}35$ W





**OPTION 2/*OPSIE 2***

$W_{net} = \Delta K$
$W_N + W_{engine} + W_w + W_f = 0$
$W_N + W_{engine} - \Delta Ep + W_f = 0$ ✓✓Any one/*Enige een*
$0 + W_{engine} - (200)(9{,}8)$ ✓$(13{,}12) + (50)(2)(15)\cos 180°$ ✓✓ $= 0$
$W_{engine} = 27\,215{,}20$ J

**OR/*OF***

$W_{net} = \Delta K$ ✓✓
$W_N + W_{engine} + W_{w\|} + W_f = 0$
$W_N + W_{engine} + mg\sin\theta\Delta x\cos 180° + W_f = 0$
$0 + W_{engine} - (200)(9{,}8)$ ✓$\left(\frac{13{,}12}{\Delta x}\right)\Delta x(-1) + (50)(2)(15)\cos 180°$ ✓✓ $= 0$
$W_{engine} = 27\,215{,}20$ J

$P_{engine} = \frac{W_{engine}}{\Delta t}$
$= \frac{25\,215{,}20}{15}$
$= 1\,814{,}35$ 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***

$F_{net} = ma$
$F_{engine} + F_{friction} + F_{g//} = 0$ ✓✓Any one/*Enige een*
$F_{engine} + (-50)$ ✓✓ $+ (-200)(9{,}8)$ ✓$(0{,}4373) = 0$
$F_{engine} = 906{,}52$ N (906,52 – 912,4)

$P_{ave} = Fv_{ave}$
$P_{ave} = (908{,}52)(2)$
$= 1\,813{,}04$ W (1 824,8 W)

$\sin\theta = \frac{h}{\Delta x}$
$= \frac{13{,}12}{2(15)}$
$= 0{,}4373$

**OR/*OF***

$W = F_{engine}\Delta x\cos\theta$
$= (906{,}52)(30)\cos 0°$
$= 27\,195{,}6$ J (27 372 W)

$P = \frac{W}{\Delta t} = \frac{27195{,}6}{15} = 1\,813{,}04$ 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*** $f_L = \frac{v}{v + v_s} f_s$

$3148 = \left(\frac{340+0}{340-v_s}\right) f_s$ ✓✓✓ $2073 = \left(\frac{340-0}{340+v_s}\right) f_s$ ✓✓✓

$\frac{3148(340-v_s)}{340+0} = \frac{2073(340+v_s)}{340-0}$

$v_s = 70\ m\cdot s^{-1}$ ✓ $(69{,}95 - 70{,}16\ m\cdot s^{-1})$ (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*** |
| $\Delta t = \frac{\Delta x}{v}$ <br> $\Delta t = \frac{350}{70}$ ✓ <br> $\Delta t = 5\ s$ ✓ | $\Delta x = v_i\Delta t + ½ a\Delta t^2$ <br> $350 = 70\Delta t + 0$ ✓ <br> $\Delta t = 5\ s$ ✓ | $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ <br> $350 = \left(\frac{70+70}{2}\right)\Delta t$ ✓ <br> $\Delta t = 5\ s$ ✓ |

(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 elektrieseveld*e✓
- 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

$E_{AM} = k\frac{Q}{r^2}$ ✓

$= 9\times10^{9}\frac{(4\times10^{-6})}{(0,3)^2}$ ✓

= 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,

$E_{BM} = k\frac{Q}{r^2}$

$= 9\text{x}10^{9}\frac{(3\text{x}10^{-6})}{(0,1)^2}$ ✓

= 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$^{5}$Q N

$F_{BM} = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^{9})(3\times10^{-6})Q}{(0,1)^2}$ ✓ = 2,7 x 10$^{6}$Q N

$F_{net}$ = 2,7 x 10$^{6}$Q + (-4 x 10$^{5}$Q)✓ = 2,3 x 10$^{6}$Q

$E = \frac{F}{q}$ ✓= $\frac{2,3\times10^{6}Q}{Q}$ = 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

$F_{AD} = \frac{kQ_1Q_2}{r^2}$

$7,2 = \frac{(9\times10^{9})(4\text{x}10^{-6})Q}{(0,15)^2}$ ✓

$Q_D$ = 4,5 x 10$^{-6}$ C ✓

**OR/*OF***

$F_{AD} = k\frac{Q_1Q_2}{r^2}$

$= 9\text{x}10^{9}\frac{(4\text{x}10^{-6})Q}{0,15^2}$ ✓

= 1,6 x 10$^{6}$ Q

$F_{net} = \sqrt{F_{AB}^2 + F_{AD}^2}$ **OR/*OF*** $F_{net}^2 = F_{AB}^2 + F_{AD}^2$

$7,69 = \sqrt{2,7^2 + (1,6\text{x}10^{6}Q)^2}$ ✓

Q = 4,50 x10$^{-6}$ 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*** |
| ε = I(R + r) ✓ |
| = 3(13,38 + 0,5) ✓ |
| = 41,64 V ✓ (Range/*Gebied:* 41,625 – 41,64) |
| **OPTION 2/*OPSIE 2*** |
| $\varepsilon = V_{ext/eks} + V_{int}$ ✓ |
| = (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*** |
|---|---|---|
| $P_{ave} = \frac{V_{rms}^2}{R}$ ✓<br>$200 = \frac{220^2}{R}$ ✓<br>R = 242 Ω ✓ | $P_{ave} = V_{rms}I_{rms}$ ✓<br>$200 = I_{rms}(220)$<br>$I_{rms} = 0{,}909$ A (0,91)<br>$R = \frac{V_{rms}}{I_{rms}}$ or/*of* $R = \frac{V}{I}$<br>$R = \frac{220}{0{,}909}$ ✓<br>R = 242 Ω ✓ (241,76 Ω) | $P_{ave} = V_{rms}I_{rms}$ ✓<br>$200 = I_{rms}(220)$<br>$I_{rms} = 0{,}909$ A(0,91)<br>$P_{ave} = I_{rms}^2R$<br>$200 = (0{,}909)^2R$ ✓<br>R = 242 Ω ✓<br>(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*** |
|---|---|---|
| $P_{ave} = \frac{V_{rms}^2}{R}$ ✓<br>$= \frac{150^2}{242}$ ✓<br>$P_{av} = 92{,}975$ W<br>$P = \frac{W}{\Delta t}$ ✓<br>$92{,}975 = \frac{W}{(10)(60)}$ ✓<br>W = 55 785,12 J ✓<br>(55785,12 – 55896 J) | $R = \frac{V_{rms}}{I_{rms}}$ ✓/ $R = \frac{V}{I}$<br>$242 = \frac{150}{I_{rms}}$ ✓<br>$I_{rms} = 0{,}620$ A<br>$P_{ave} = I_{rms}V_{rms}$<br>= (0,62)(150)<br>= 92,97 W (93 W)<br>$P = \frac{W}{\Delta t}$ ✓<br>$92{,}975 = \frac{W}{(10)(60)}$ ✓<br>W = 55 785,12 J ✓<br>(55785,12 – 55896 J) | $R = \frac{V_{rms}}{I_{rms}}$ ✓/ $R = \frac{V}{I}$<br>$242 = \frac{150}{I_{rms}}$ ✓<br>$I_{rms} = 0{,}620$ A<br>$W = I^2R\Delta t$ ✓<br>$= (0{,}62)^2(242)(10)(60)$ ✓<br>= 55 814,88 J ✓<br>(55785,12 – 55896 J)<br>**OR/*OF***<br>$W = VI\Delta t$<br>= (150)(0,62)(600)<br>= 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.***
$E = W_0 + E_{k(max)}$
$hf = hf_o + \frac{1}{2}mv_{max}^2$ ✓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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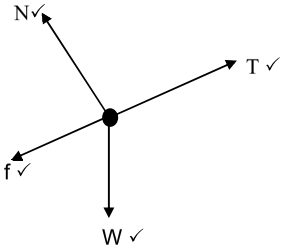
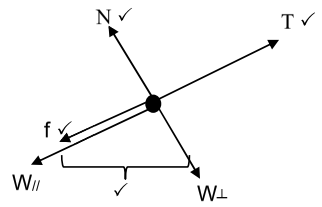
**QUESTION/*VRAAG* 2**

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)*** |
|---|---|
| $F_{net} = ma$<br>$F_{net} = 0$ N<br>$F_g - T = ma$ } Any one / *Enige een* ✓<br>$15 \times 9{,}8 - T = 0$ ✓<br>$T = 147$ N<br><br>$T - W\sin\theta - f = ma$<br>$T - mg\sin\theta - f = ma$<br>$147 - 22 \times 9{,}8\sin\theta - 43{,}86 = 0$ ✓<br>$\theta = 28{,}58^\circ$ ✓ | $F_{net} = ma$<br>$F_{net} = 0$ N<br>$T - F_g = ma$ } Any one / *Enige een* ✓<br>$\underline{T - 15 \times 9{,}8 = 0}$ ✓<br>$T = 147$ N<br><br>$W\sin\theta + f - T = ma$<br>$mg\sin\theta + f - T = ma$<br>$22 \times 9{,}8\sin\theta + \underline{43{,}86 - 147}$ ✓ $= 0$<br>$\theta = 28{,}58^\circ$ ✓ |

(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 positier vanaf Vraag 2.3*** | **Marking criteria / *Merk kriteria*** |
|---|---|
| <u>For 15 kg block / *Vir 15 kg-blok*</u><br>$F_{net} = ma$ ✓<br>$F - F_g - T = ma$<br>$\underline{172 - 147 - T}$ ✓ $= 15a$ …(1)<br><br><u>For 22 kg block / *Vir 22 kg-blok*</u><br>$T + W\sin\theta - f = ma$<br>$T + mg\sin\theta - f = ma$<br>$[T + \underline{22 \times 9{,}8\sin 28{,}58^\circ}$ ✓ $- 43{,}86]$ ✓ $= 22a$ ✓<br>$[T + 101{,}14 - 43{,}86] = 22a$ (2)<br><br>$\therefore a = 2{,}278\ m.s^{-2}$ ✓ | $F_{net} = ma$<br>$F - F_g - T = ma$<br>$T + W\sin\theta - f = ma$<br>$T + mg\sin\theta - f = ma$ } Any one / *Enige een* ✓<br>Calculating $F_{g//}$<br>*Berekening van* $F_{g//}$ ✓<br>Substitution for the 15 kg block<br>*Instelling vir die 15 kg-blok* ✓<br>Substitution for the 22 kg block<br>*Instelling vir die 22 kg-blok* ✓<br>Substitution for either 15a or 22a<br>*Instelling vir 15a of 22a* ✓<br>Answer/*Antwoord* ✓ |

(6)
**[18]**

**QUESTION/*VRAAG* 3**

3.1

| **UPWARD POSITIVE** ***OPWAARTS POSITIEF*** | **UPWARD NEGATIVE** ***OPWAARTS NEGATIEF*** |
|---|---|
| $v_f = v_i + a\Delta t$ ✓<br>$v_f = -3,28 + (-9,8) \times 1,2$ ✓<br>$v_f = -15,04$<br>$v_f = 15,04\ m.s^{-1}$ downwards/*afwaarts* ✓ | $v_f = v_i + a\Delta t$ ✓<br>$v_f = 3,28 + (9,8) \times 1,2$ ✓<br>$v_f = 15,04\ m.s^{-1}$ downwards/*afwaarts* ✓ |

(3)

3.2

| **OPTION/*OPSIE* 1** | |
|---|---|
| **UPWARD POSITIVE** ***OPWAARTS POSITIEF*** | **UPWARD NEGATIVE** ***OPWAARTS NEGATIEF*** |
| $\Delta y = v_i \Delta t + \frac{1}{2} a\Delta t^2$ ✓<br>$\Delta y = \underline{-3,28 \times 1,2}$ ✓ $+ \frac{1}{2}(-9,8)1,2^2$ ✓<br>$\Delta y = -10,99$<br>$\Delta y = 10,99$ m downwards/*afwaarts* ✓ | $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓<br>$\Delta y = \underline{3,28 \times 1,2}$ ✓ $+ \frac{1}{2}(9,8)1,2^2$ ✓<br>$\Delta y = 10,99$ 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*** |
| $v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$-15,04^2$ ✓ $= -3,28^2 + 2(-9,8)\Delta y$ ✓<br>$\Delta y = 10,99$ m downwards/*afwaarts* ✓ | $v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$15,04^2$ ✓ $= 3,28^2 + 2(9,8)\Delta y$ ✓<br>$\Delta y = 10,99$ 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*** |
| $\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓<br>$\Delta y = \frac{-15,04 + (-3,28)}{2}$ ✓ $\times 1,2$ ✓<br>$\Delta y = -10,99$ m<br>$\Delta y = 10,99$ m downwards/*afwaarts* ✓ | $\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓<br>$\Delta y = \frac{15,04 + 3,28}{2}$ ✓ $\times 1,2$ ✓<br>$\Delta y = 10,99$ m downwards/*afwaarts* ✓ |

(4)





3.3

| **OPTION 1/*OPSIE* 1** | |
|---|---|
| **UPWARD POSITIVE** ***OPWAARTS POSITIEF*** | **UPWARD NEGATIVE** ***OPWAARTS NEGATIEF*** |
| $v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$v_f^2 = -3,28^2 + 2(-9,8)(30)$ ✓<br>$v_f^2 = -24,47\ m.s^{-1}$<br>$v_f^2 = 24,47\ m.s^{-1}$ downwards/*afwaarts* ✓ | $v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$v_f^2 = 3,28^2 + 2(9,8)(30)$ ✓<br>$v_f^2 = 24,47\ m.s^{-1}$ downwards/*afwaarts* ✓ |

| **OPTION 2/*OPSIE* 2** | |
|---|---|
| **UPWARD POSITIVE** ***OPWAARTS POSITIEF*** | **UPWARD NEGATIVE** ***OPWAARTS NEGATIEF*** |
| $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$<br>$-30 = -3,28\Delta t + \frac{1}{2}(-9,8)\Delta t^2$<br>$\Delta t = 2,16$ s<br>$v_f = v_i + a\Delta t$ ✓<br>$v_f = -3,28 + (-9,8)(2,16)$ ✓<br>$v_f = -24,45\ m.s^{-1}$<br>$v_f = 24,45\ m.s^{-1}$ downwards/*afwaarts* ✓ | $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$<br>$30 = 3,28\Delta t + \frac{1}{2}(9,8)\Delta t^2$<br>$\Delta t = 2,16$ s<br>$v_f = v_i + a\Delta t$ ✓<br>$v_f = 3,28 + (9,8)(2,16)$ ✓<br>$v_f = 24,45\ m.s^{-1}$ 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*** |
| $F_{net}.\Delta t = m(v_f - v_i)$ ✓<br>$205 \times 0,1$ ✓ $= \underline{0,5\ [v_f - (-24,47)]}$ ✓<br>$v_f = 16,53\ m.s^{-1}$ upwards/*opwaarts* ✓ | $F_{net}.\Delta t = m(v_f - v_i)$ ✓<br>$-205 \times 0,1$ ✓ $= \underline{0,5\ (v_f - 24,47)]}$ ✓<br>$v_f = -16,53\ m.s^{-1}$<br>$v_f = 16,53\ m.s^{-1}$ upwards/*opwaarts* ✓ |

(4)

3.5

| **OPTION 1/*OPSIE* 1** | |
|---|---|
| **Positive marking from Question 3.1 and 3.3**<br>***Positiewe merk vanaf Vraag 3.1en 3.3*** | |
| **UPWARD POSITIVE**<br>***OPWAARTS POSITIEF*** | **UPWARD NEGATIVE**<br>***OPWAARTS NEGATIEF*** |
| $v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$0^2$ ✓ $= 16{,}53^2 + 2(-9{,}8)\Delta y$ ✓<br>$\Delta y = 13{,}94$ m<br>width of window / *wydte van venster*<br>= 30 – (10,99+13,94) ✓<br>= 5,07 m ✓ | $v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$0^2$ ✓ $= -16{,}53^2 + 2(9{,}8)\Delta y$ ✓<br>$\Delta y = -13{,}94$ m<br>width of window / *wydte van venster*<br>= 30 – (10,99 +13,94) ✓<br>= 5,07 m ✓ |

| **OPTION 2/*OPSIE* 2** |
|---|
| $W_{net} = \Delta E_k$<br>$F_{net}\,\Delta y \cos\theta = \Delta E_k$<br>$F_g \Delta y \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } Any one/*Enige een* ✓<br>$4{,}9\,\Delta y \cos 180^\circ$ ✓ $= 0 - \frac{1}{2} \times 0{,}5 \times 16{,}53^2$ ✓<br>$\Delta y = 13{,}94$ m<br>width of window / *wydte van venster*<br>= 30 – (10,99 + 13,94) ✓<br>= 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 $ME_i = ME_f$
$(E_p + E_k)_A = (E_p + E_k)_B$
$mgh_1 + E_{k(A)} = mgh_2 + E_{k(B)}$
} Any one/*Enige een* ✓
$55 \times 9{,}8 \times 15 + 0 = 0 + E_{k(B)}$ ✓
$E_{k(B)} = 8085$ 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**

$W_{ner} = \Delta E_k$
$W_f + W_{Fg//} = \Delta E_k$
$f \times \Delta x \cos\theta + mg\sin\theta\ \Delta x \cos\theta = \Delta E_k$
} Any one/*Enige een* ✓
$\underline{15 \times 10 \cos 180^\circ}$ ✓ + $\underline{55 \times 9{,}8 \sin 15^\circ \times 10 \cos 180^\circ}$ ✓ = 0 – $E_{ki}$
$E_{ki} = 1545{,}035$ J ✓

**OPTION 2/*OPSIE* 2**

$W_{nc} = \Delta E_k + \Delta E_p$
$W_f = \Delta E_k + \Delta E_p$
$f \times \Delta x \cos\theta = \Delta E_p + \Delta E_k$
} Any one/*Enige een* ✓
$\underline{15 \times 10 \cos 180^\circ}$ ✓ = $\underline{[55 \times 9{,}8 \times (10 \sin 15^\circ)] - 0}$ ✓ + $\underline{0 - E_{ki}}$
$-150 = 1395{,}035 - E_{ki}$
$E_{ki} = 1545{,}035$ J ✓

**OPTION 3/*OPSIE* 3**

$W_{ner} = \Delta E_k$
$W_f + W_{Fg} = \Delta E_k$
$f \times \Delta x \cos\theta + mg\ \Delta x \cos\theta = \Delta E_k$
} Any one/*Enige een* ✓
$\underline{15 \times 10 \cos 180^\circ}$ ✓ + $\underline{55 \times 9{,}8 \times 10 \cos (90 + 15)}$ ✓ = 0 – $E_{ki}$
$E_{ki} = 1545{,}035$ J ✓ (4)

5.4.2

| OPTION 1/*OPSIE* 1 | OPTION 2/*OPSIE* 2 |
|---|---|
| $W_{net} = \Delta E_k$<br>$W_f = \Delta E_k$<br>$f \times \Delta x \cos\theta = \Delta E_k$<br>} Any one/*Enige een* ✓<br>$\underline{f \times 10 \cos 180^\circ}$ ✓ = $\underline{1545{,}035}$ ✓ - 8085 ✓<br>654,00 N ✓ | $W_{nc} = \Delta E_k + \Delta E_p$<br>$W_f = \Delta E_k + \Delta E_p$<br>$f \times \Delta x \cos\theta = \Delta E_k + \Delta E_p$<br>} Any one/ *Enige een* ✓<br>$\underline{f \times 10 \cos 180^\circ}$ ✓ = $\underline{1545{,}035}$ ✓<br>- $\underline{8085}$ ✓<br>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 <u>frequency of the source</u>, $f_s$. ✓✓
Die afsnit op die vertikale as verteenwoordig die <u>frekwensie van die bron</u>, $f_s$. ✓✓ (2)

6.5

| OPTION 1/*OPSIE* 1 | OPTION 2/*OPSIE* 2 |
|---|---|
| Gradient/*Helling* = $\frac{492 - 470}{5 - 20}$ ✓<br>$= -\frac{22}{15}$<br>$= -\frac{f_s}{v}$ ✓<br>$-\frac{22}{15}$ ✓ $= -\frac{f_s}{340}$ ✓<br>$f_s = 498{,}67$ Hz ✓ | $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓<br>492 ✓ $= \frac{340 - 15}{340}$ ✓✓ x $f_s$<br>$f_s = 499{,}34$ Hz ✓ |

| OPTION 3/*OPSIE* 3 |
|---|
| $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓<br>470 ✓ $= \frac{340 - 15}{340}$ ✓✓ x $f_s$<br>$f_s = 499{,}38$ Hz ✓<br>Range (498,67 Hz – 499,38 Hz) |

(5)

6.6

| OPTION 1/*OPSIE* 1 | OPTION 2/*OPSIE* 2 | OPTION 3/*OPSIE* 3 |
|---|---|---|
| $v = f\lambda$<br>$340 = 498{,}67\ \lambda$ ✓<br>$\lambda = 0{,}68$ m ✓<br>The wavelength produced by the tuning fork is less than the required wavelength.<br>∴ It is not suitable. ✓<br>*Die golflengte wat voortgeplant word deur die stemvurk is minder as die benodigde golflengte.*<br>∴ *Dit is nie geskik nie.* ✓ | $v = f\lambda$<br>$340 = 499{,}34\ \lambda$ ✓<br>$\lambda = 0{,}68$ m ✓<br>The wavelength produced by the tuning fork is less than the required wavelength.<br>∴ It is not suitable. ✓<br>*Die golflengte wat voortgeplant word deur die stemvurk is minder as die benodigde golflengte.*<br>∴ *Dit is nie geskik nie.* ✓ | $v = f\lambda$<br>$340 = 499{,}38\ \lambda$ ✓<br>$\lambda = 0{,}68$ m ✓<br>The wavelength produced by the tuning fork is less than the required wavelength.<br>∴ It is not suitable. ✓<br>*Die golflengte wat voortgeplant word deur die stemvurk is minder as die benodigde golflengte.*<br>∴ *Dit is nie geskik nie.* ✓ |

(3)

**[15]**

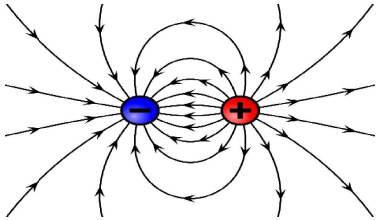
**QUESTION/*VRAAG* 7**

7.1 $n = \frac{Q}{q_e}$ ✓

$n = \frac{2 \times 10^{-6}}{1,6 \times 10^{-19}}$ ✓

$n = 1,25 \times 10^{13}$ ✓ (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 $v_f = v_i + a\Delta t$ ✓

$6,25 \times 10^3 = 0 + 2 \times 10^{-3}\ a$ ✓

$a = 3,125 \times 10^6\ m.s^{-2}$

$F_{net} = ma$

$F_{net} = 5 \times 10^{-6} \times 3,125 \times 10^6$ ✓

$F_{net} = 15,625\ N$

$E_{net} = \frac{F_{net}}{q}$ ✓

$E_{net} = \frac{15,625}{2 \times 10^{-6}}$ ✓

$E_{net} = 7,81 \times 10^6\ N.C^{-1}$ ✓ (6)

Any one /*Enige een* ✓

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** |
| $E = \frac{kQ}{r^2}$ ✓<br>$7,81 \times 10^6 = \frac{9 \times 10^9 \times 2 \times 10^{-6}}{r^2}$ ✓<br>$\therefore r = 4,80 \times 10^{-2}$ m ✓ | $v_f^2 = v_i^2 + 2a\ \Delta x$ ✓<br>$(6,25 \times 10^3)^2 = 0^2 + 2(3,125 \times 10^6)\Delta x$ ✓<br>$\Delta x = 6,25$ m ✓ |

| **Using equations of motion / *Gebruik van bewegingsvergelykings*** | |
|---|---|
| **OPTION 3/*OPSIE* 3** | **OPTION/*OPSIE* 4** |
| $\Delta x = ½(v_f + v_i)\ \Delta t$ ✓<br>$= ½(6,25 \times 10^3 + 0)(2 \times 10^{-3})$ ✓<br>$\Delta x = 6,25$ m ✓ | $\Delta x = v_i\ \Delta t + ½\ a\ \Delta t^2$ ✓<br>$= 0 + ½(3,125 \times 10^6)(2 \times 10^{-3})^2$ ✓<br>$\Delta x = 6,25$ m ✓ |

(3)





7.3.3

| **Positive marking from Question 7.3.1 and 7.3.2**<br>***Positiewe merk vanaf Vraag 7.3.1en 7.3.2*** | |
|---|---|
| **OPTION 1/*OPSIE* 1** | **OPTION 2/*OPSIE* 2** |
| $F_E = \frac{kQ_1Q_2}{r^2}$ ✓<br>$15,625$ ✓ $= \frac{9 \times 10^9 \times Q \times 2 \times 10^{-6}}{(4,80 \times 10^{-2})^2}$ ✓<br>$\therefore Q = 2,00 \times 10^{-6}$ C ✓ | $F_E = \frac{kQ_1Q_2}{r^2}$ ✓<br>$15,625$ ✓ $= \frac{(9 \times 10^9)(Q1)(2 \times 10^{-6})}{6,25^2}$ ✓<br>$\therefore Q = 3,39 \times 10^{-2}$ C ✓ |

(4)

**[19]**

**QUESTION/*VRAAG* 8**

8.1 Resistance/*Weerstand* ✓ (1)

8.2 8.2.1

Gradient/*Helling* = $\frac{4,2 - 0,2}{24 - 0}$ ✓

$= \frac{1}{6}$

$= \frac{1}{emf}$

$\frac{1}{emf} = \frac{1}{6}$ ✓

∴ 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 = $\frac{r}{emf}$<br>$0,2 = \frac{r}{emf}$ ✓<br>$0,2 = \frac{r}{6}$ ✓<br>r = 1,2 Ω ✓ | $\varepsilon = I(R + r)$ ✓<br>$6 = \frac{1}{4,2}(24 + r)$ ✓<br>r = 1,2 Ω ✓ |

(3)

8.3 8.3.1

| **OPTION 1/*OPSIE* 1** | **OPTION 2/*OPSIE* 2** |
|---|---|
| P = VI ✓<br>3 = I x 1,5 ✓<br>I = 2 A ✓ | $P = \frac{V^2}{R}$<br>$3 = \frac{1,5^2}{R}$<br>R = 0,75 Ω<br>$P = I^2 R$ ✓<br>$3 = I^2 \times 0,75$ ✓<br>I = 2 A ✓ |

(3)





8.3.2

| **Positive marking from Question 8.2.1en 8.2.2**<br>***Positiewe merk vanaf Vraag 8.2.1en 8.2.2*** | |
|---|---|
| **OPTION 1/*OPSIE* 1** | **OPTION 2/*OPSIE* 2** |
| $P = \frac{V^2}{R_{toy\ car}}$<br>$3 = \frac{1,5^2}{R_{toy\ car}}$ ✓<br>$R_{toy\ car}$ = 0,75 Ω<br>emf = I ($R_{ext}$ + r ) ✓<br>6 = 2 ($R_{ext}$ + 1,2) ✓<br>$R_{ext}$ = 1,8 Ω<br>$R_{ext} = R_{toy\ car} + R_p$<br>$1,8 = 0,75 + R_p$ ✓<br>$R_p$ = 1,05 Ω<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$<br>$\frac{1}{1,05} = \frac{1}{3} + \frac{1}{R}$ ✓<br>R = 1,62 Ω ✓ | $P = \frac{V^2}{R_{toy\ car}}$<br>$3 = \frac{1,5^2}{R_{toy\ car}}$ ✓<br>$R_{toy\ car}$ = 0,75 Ω<br>emf = I ($R_{ext}$ + r) ✓<br>6 = 2 ($R_{ext}$ + 1,2) ✓<br>$R_{ext}$ = 1,8 Ω<br>$R_{ext} = R_{toy\ car} + R_p$<br>$1,8 = 0,75 + R_p$ ✓<br>$R_p$ = 1,05 Ω<br>$R_p = \frac{R_1 R_2}{R_1 + R_2}$<br>$1,05 = \frac{3 \times R}{3 + R}$ ✓<br>R = 1,62 Ω ✓ |

(6)

8.4 No, ✓ the external resistance will increase. Current will decrease. ✓
$P = I^2R$, $P \alpha I^2$ since resistance remain constant, power will decrease. ✓
*Nee,* ✓ *die eksterne weerstand sal toeneem. Stroom sal afneem.* ✓
$P = I^2R$, $P \alpha I^2$ *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

$P_{average} = \frac{V_{rms}^2}{R}$ ✓

$1500 = \frac{230^2}{R}$ ✓

R = 35,27 Ω ✓ (3)

9.5.2

| **OPTION 1/*OPSIE* 1** | **OPTION 2/*OPSIE* 2** |
|---|---|
| $R = \frac{V_{rms}}{I_{rms}}$<br>$35,27 = \frac{230^2}{I_{rms}}$ ✓<br>$I_{rms}$ = 6,52 A<br>$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓<br>$6,52 = \frac{I_{max}}{\sqrt{2}}$ ✓<br>$I_{max}$ = 9,22 A ✓ | $P_{average} = V_{rms}I_{rms}$<br>1 500 = $I_{rms}$ x 230 ✓<br>$I_{rms}$ = 6,52 A<br>$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓<br>$6,52 = \frac{I_{max}}{\sqrt{2}}$ ✓<br>$I_{max}$ = 9,22 A ✓ |

(4)

**[13]**

**TOTAL/*TOTAAL*: 150**

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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 2019**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 24 pages. /**
***Hierdie nasienriglyne bestaan uit 24 bladsye.***





**QUESTION 1/*VRAAG 1***

| | | |
|---|---|---|
| 1.1 | C ✓✓ | (2) |
| 1.2 | A ✓✓ | (2) |
| 1.3 | A ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | D ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | B ✓✓ | (2) |
| 1.9 | D ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | **[20]** |

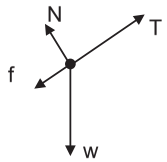
## QUESTION 2/*VRAAG 2*

**NOTE**: -1 mark for each key word/phrase omitted in the correct context
***LET WEL**: -1 punt vir elke sleutel woord/frase in die korrekte konteks weggelaat* (2)

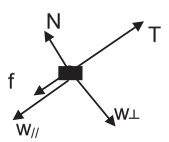
2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓ ✓
*Wanneer 'n resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die 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 (in the direction of the resultant/net force.) ✓✓
*Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwerp (in die rigting van die resulterende/netto krag.)* (2)

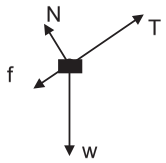
2.2




**ACCEPT/*AANVAAR***




**OR/*OF***




| | **Accept the following symbols/*Aanvaar die volgende simbole.*** |
|---|---|
| N ✓ | $F_N$/Normal/*Normaal*/Normal force/*Normaalkrag* /16,97 N |
| f ✓ | $F_f$ / $f_k$ / $f_r$ / frictional force/*wrywingskag*/kinetic frictional force/*kinetiese wrywingskrag* |
| w ✓ | $F_{g,}$/mg/weight/$F_{Earth\ on\ block}$/19,6 N/gravitational force/*gewig*/$F_{aarde\ op\ blok}$/ *gravitasiekrag* |
| T ✓ | Tension/*Spanning*/$F_T$ / $F_A$ / F / $F_s$ |

**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 force(s) do not make contact with body/dot /*Indien krag(te) nie met die voorwerp / kolletjie kontak maak nie:* Max./*Maks:* $^3/_4$
- If arrows missing/*Indien pyltjies uitgelaat is*: Max./*Maks:* $^3/_4$ (4)





2.3

| For the 2 kg (P) block/*Vir die 2 kg (P) blok:* | **Marking criteria/*Nasienriglyne*** |
|---|---|
| $F_{net} = ma$<br>$T + (-w_{//}) + (-f_k) = ma$ ✓Any one/*Enige een*<br>$T - (w_{//} + f_k) = ma$<br>$T - (2)(9,8)\sin 30° ✓ - 2,5 ✓ = 2a$ ✓<br>$T - 9,8 - 2,5 = 2a$<br>$T - 12,3 = 2a$ …….(1)<br><br>For the 3 kg (Q) block/*Vir die 3 kg (Q) blok:*<br>$F_x + (-T) + (-w_{//}) = ma$<br>$F_x - (T + w_{//}) = ma$<br>$[40 \cos 25° ✓ - T - (3)(9,8)\sin 30° ✓] ✓ = 3a$<br>$36,25 - T - 14,7 = 3a$<br>$21,55 - T = 3a$ ……(2)<br><br>$9,25 = 5a$<br>$a = 1,85\ m\cdot s^{-2}$ ✓ | • Formula/*Formule* ✓<br>• Substitution of /*vervanging van* $w_{//}$ for/*vir* 2 kg: (2)(9,8)sin30° ✓<br>• Substitution of -2,5 N /*Vervanging van -2,5 N* ✓<br>• 2a **OR/*OF*** 3a ✓<br>• Calculate/*Bereken* $F_x$: 40 cos 25° ✓ (40 Sin 65°)<br>• Substitution of/*vervanging van* $w_{//}$ for/*vir* for 3 kg: (3)(9,8)sin30° ✓<br>• Left hand side substitution for 3 kg/*Linkerkant vervanging vir 3 kg* ✓<br>• Final answer/*Finale antwoord*: $1,85\ m\cdot s^{-2}$ ✓ |
| **Systems Approach (Massless String Approximation / *Sisteembenadering (Massalose Tou Benadering)***<br>**(Max 5/8 marks / *Maks 5/8 punte)***<br><br>$F_{net} = ma$<br>$F_x + (-w_{//}) + (-f_k) = ma$ ✓Any one/*Enige een*<br>$F_x - (w_{//} + f_k) = ma$<br>$40\cos 25° ✓ - (5)(9,8)\sin 30° ✓ - 2,5 ✓ = 5a$<br>$a = 1,85\ m\cdot s^{-2}$ ✓ | |

(8)

2.4 Greater than/*groter as* ✓
$F_{net}$ increases. /$F_{net}$ *neem toe.* ✓

**ACCEPT/*AANVAAR***
There is no friction. /*Daar is geen wrywing nie.*
**OR/*OF***
The surface is smooth / *Die oppervlak is glad* (2)
**[16]**

**QUESTION 3/*VRAAG 3***

3.1 (Motion during which) the only force acting is the force of gravity. ✓✓
(*Beweging waartydens) die enigste krag wat inwerk gravitasiekrag is.*
**(2 or/*of* 0)** (2)

3.2

**Marking criteria/*Nasienriglyne:***
- Any appropriate formula for Δy/*Enige toepaslike formule vir Δy*✓
- Whole substitution to calculate 5,1 m /*Hele vervanging om 5,1 m te bereken* ✓
- 40 + answer from calculation/*antwoord van berekening* ✓
- Final answer/*Finale antwoord*: 45,10 m ✓(Accept/*aanvaar* 45,1 m)

**OPTION 1/*OPSIE 1***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (10)^2 + (2)(-9,8)\Delta y$ ✓
$\Delta y = 5,10$ m (5,102 m)

Height = 40 + 5,10 ✓
= 45,10 m ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (-10)^2 + (2)(9,8)\Delta y$ ✓
$\Delta y = -5,10$ m (5,102)

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OPTION 2/*OPSIE 2***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

$v_f = v_i + a\Delta t$
$0 = (10) + (-9,8)\Delta t$
$\Delta t = 1,02$ s

Accept swopping of $v_i$ and $v_f$
*Aanvaar die omruiling van $v_i$ en $v_f$*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$= (10)(1,02) + ½ (-9,8)(1,02)^2$ ✓
$= 5,10$ m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OR/*OF***

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{10 + 0}{2}\right)(1,02)$ ✓
$= 5,10$ m

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

$v_f = v_i + a\Delta t$
$0 = (-10) + (9,8)\Delta t$
$\Delta t = 1,02$ s

Accept swopping of $v_i$ and $v_f$
*Aanvaar die omruiling van $v_i$ en $v_f$*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$= (-10)(1,02) + ½ (9,8)(1,02)^2$ ✓
$= 5,10$ m
Height = 40 + 5,10 ✓
= 45,10 m ✓





**OPTION 3/OPSIE 3**

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$0 = (10)\Delta t + ½(-9,8)\Delta t^2$
$\Delta t = 2,04$ s

½ Δt

$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$= (10)(1,02) + ½ (-9,8)(1,02)^2$ ✓
$= 5,10$ m

Height = 40 + ✓5,10
= 45,10 m ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$0 = (-10)\Delta t + ½(9,8)\Delta t^2$
$\Delta t = 2,04$ s

½ Δt

$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$= (-10)(1,02) + ½ (9,8)(1,02)^2$ ✓
$= -5,10$ m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OPTION 4/*OPSIE 4***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$0 = (10)\Delta t + ½(-9,8)\Delta t^2$
$\Delta t = 2,04$ s

½ Δt

Accept swopping of $v_i$ and $v_f$
*Aanvaar die omruiling van $v_i$ en $v_f$*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{10 + 0}{2}\right)(1,02)$ ✓
$= 5,10$ m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$0 = (-10)\Delta t + ½(9,8)\Delta t^2$
$\Delta t = 2,04$ s

½ Δt

Accept swopping of $v_i$ and $v_f$
*Aanvaar die omruiling van $v_i$ en $v_f$*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{-10 + 0}{2}\right)(1,02)$ ✓
$= -5,10$ m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OPTION 5/*OPSIE 5***

$E_{(mech/meg)roof/dak} = E_{(mech/meg)top/bo}$
$(E_p + E_k)_{roof/dak} = (E_p + E_k)_{top/bo}$
$(mgh + ½ mv^2)_{roof/dak} = (mgh + ½ mv^2)_{top/bo}$ ✓Any one/*Enige een*
$[m(9,8)(0) + ½m (10)^2 = m(9,8) (h)+ 0)]$ ✓
h = 5,10 m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OPTION 6/*OPSIE 6***

$W_{net} = \Delta E_k$ ✓
$w\Delta x\cos\theta = ½ mv_f^2 – ½ mv_i^2$
$(m)(9,8)\Delta x\cos180^o = 0 – ½ m(10)^2$✓
$\Delta x = 5,10$ m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OPTION 7/*OPSIE 7***

$W_{nc} = \Delta E_p + \Delta E_k$✓
$0 = m(9,8)(h_f – 0) + ½ m( 0 – 10^2)$ ✓
$h_f = 5,10$ m

Height = 40 + 5,10 ✓
= 45,10 m ✓

**OPTION 8/*OPSIE 8***

**Marking criteria/*Nasienriglyne:***
- Appropriate formula/*Toegepaste formule* ✓
- Substitution left/*Vervanging links* ✓
- Substitution right/*Vervanging regs*✓
- Final answer/*Finale antwoord*: 45,10 m ✓

$E_{(mech/meg)roof/dak} = E_{(mech/meg)top/bo}$
$(E_p + E_k)_{roof/dak} = (E_p + E_k)_{top/bo}$
$(mgh + ½ mv^2)_{roof/dak} = (mgh + ½ mv^2)_{top/bo}$ ✓Any one/*Enige een*
$m(9,8)(40) + ½m (10)^2$ ✓$= m(9,8) (h)+ 0)$ ✓
h = 45,10 m ✓ (4)

3.3 9,8 $m\cdot s^{-2}$ ✓ downwards/*afwaarts* ✓ (2)





3.4

**Marking criteria/*Nasienriglyne***
- Calculation/use of 10,26 m./*Berekening/gebruik van 10,26 m.* ✓
- Appropriate formula to calculate Δt/*Toepaslike formule om Δt te bereken*✓
- Substitution for stone A/*Vervanging vir klip A* ✓
- Substitution for stone B/*Vervanging vir klip B* ✓
- Calculating time difference between two stones. /*Berekening van tydverskil tussen klippe.* ✓
- Final answer/*Finale antwoord*: 1,34 (s) ✓

**OPTION 1/*OPSIE 1***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***
Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt* = -40 + 29,74 = - 10,26 m

**Stone/*Klip* A**
$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
-10,26 ✓$= 10\Delta t + ½(-9,8)\Delta t^2$ ✓
Δt = 2,79 s

**Stone/*Klip* B**
$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$-10,26 = 0 + ½(-9,8)\Delta t^2$ ✓
Δt = 1,45 s (1,447 s)

x = 2,79 – 1,45 ✓ = 1,34 (s) ✓

**OR/*OF***
[-10,26 = 0(2,79 – x) + ½ (-9,8)$(2,79 – x)^2$✓]✓
x = 1,34 (s)✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(-9,8)(-10,26)$
$v_f = -14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-14,18 = 0 + (-9,8)\Delta t$✓
Δt = 1,45 s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***
Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt* = 40 - 29,74 = 10,26 m

**Stone/*Klip* A**
$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
10,26✓ $= -10\Delta t + ½(9,8)\Delta t^2$ ✓
Δt = 2,79 s

**Stone/*Klip* B**
$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$10,26 = 0 + ½(9,8)\Delta t^2$ ✓
Δt = 1,45 s (1,447 s)

x = 2,79 – 1,45 ✓ = 1,34 (s) ✓

**OR/*OF***
[-10,26 = 0(2,79 – x) + ½ (-9,8)$(2,79 – x)^2$✓]✓
x = 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(9,8)(10,26)$
$v_f = 14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$14,18 = 0 + (9,8)\Delta t$✓
Δt = 1,45 s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**OPTION 2/*OPSIE 2***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt*= - 40 + 29,74 = - 10,26 m

Displacement of stone A from max height to meeting point/ *Verplasing van klip A vanaf maksimum hoogte tot ontmoetingspunt* = -15,36 m

**Stone/*Klip* A**

$v_f = v_i + a\Delta t$
$0 = 10 + (-9,8)\Delta t$
$\Delta t = 1,02$ s

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
$-15,36 = 0 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 1,77$ s
$\Delta t_{tot} = 1,77 + 1,02 = 2,79$s

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$-10,26$ ✓$= 0 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓ = 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(-9,8)(-10,26)$
$v_f = -14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-14,18 = 0 + (-9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt*= 40 - 29,74 = 10,26 m ✓

Displacement of ball A from max height to meeting point/ *Verplasing van bal A vanaf maksimum hoogte tot ontmoetingspunt* = 15,36 m

**Stone/*Klip* A**

$v_f = v_i + a\Delta t$
$0 = -10 + (9,8)\Delta t$
$\Delta t = 1,02$ s

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
$15,36 = 0 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,77$ s
$\Delta t_{tot} = 1,77 + 1,02 = 2,79$s

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$10,26 = 0 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓ = 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(9,8)(10,26)$
$v_f = 14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$14,18 = 0 + (9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓





**OPTION 3/*OPSIE 3***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

Displacement of stones A and B from roof to meeting point/*Verplasing van klippe A en B vanaf dak tot by ontmoetingspunt* = - 40 + 29,74
= - 10,26 m

**Stone/*Klip* A**

$v_f = v_i + a\Delta t$
$0 = 10 + (-9,8)\Delta t$
$\Delta t = 1,02$ s

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$✓
$-10,26$✓ $= -10 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 0,75$ s
$\Delta t_{tot} = 1,02 + 1,02 + 0,75 = 2,79$ s

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$-10,26 = 0 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓= 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(-9,8)(-10,26)$
$v_f = -14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-14,18 = 0 + (-9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

Displacement of stones A and B from roof to meeting point/*Verplasing van klippe A en B vanaf dak tot by ontmoetingspunt* = 40 - 29,74 = 10,26 m

**Stone/*Klip* A**

$v_f = v_i + a\Delta t$
$0 = -10 + (9,8)\Delta t$
$\Delta t = 1,02$ s

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
$10,26$ ✓$= 10 + ½ (9,8)\Delta t^2$ ✓
$\Delta t = 0,75$s
$\Delta t_{tot} = 1,02 + 1,02 + 0,75 = 2,79$ s

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$10,26 = 0 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓= 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(9,8)(10,26)$
$v_f = 14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$14,18 = 0 + (9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**OPTION 4/*OPSIE 4***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt* = - 40 + 29,74 = - 10,26 m

**Stone/*Klip* A**

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$
$- 5,10 = 0 + ½(-9,8)\Delta t^2$
$\Delta t = 1,02$ s

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
$- 10,26$ ✓$= -10 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 0,75$s
$\Delta t_{tot} = 1,02 + 1,02 + 0,75 = 2,79$ s

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$-10,26 = 0 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓= 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(-9,8)(-10,26)$
$v_f = -14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-14,18 = 0 + (-9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

Displacement from roof to meeting point /*verplasing vanaf dak tot by ontmoetingspunt* = 40 - 29,74 = 10,26 m

**Stone/*Klip* A**

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$
$5,10 = 0 + ½(9,8)\Delta t^2$
$\Delta t = 1,02$ s

$\Delta y_A = v_i\Delta t + ½a\Delta t^2$ ✓
$10,26$ ✓$= 10 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 0,75$s
$\Delta t_{tot} = 1,02 + 1,02 + 0,75 = 2,79$ s

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$10,26 = 0 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓= 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(9,8)(10,26)$
$v_f = 14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$14,18 = 0 + (9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓





**OPTION 5/*OPSIE 5***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt* = - 40 + 29,74 = - 10,26 m

Displacement of stone A from max height to meeting point/ *Verplasing van klip A vanaf maksimum hoogte tot ontmoetingspunt* = -15,36 m

**Stone/*Klip* A**

$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(- 9,8)(-15,36)$
$v_f = - 17,35\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-17,35 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 1,77$ s

✓

$\Delta t_{tot} = 1,02 + 1,77 = 2,79$ (s)

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$-10,26$ ✓$= 0 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓ = 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(-9,8)(-10,26)$
$v_f = -14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-14,18 = 0 + (-9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

Displacement from roof to meeting point /*Verplasing vanaf dak tot ontmoetingspunt*= 40 - 29,74 = 10,26 m

Displacement of stone A from max height to meeting point/ *Verplasing van klip A vanaf maksimum hoogte tot ontmoetingspunt* = 15,36 m

**Stone/*Klip* A**

$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(9,8)(15,36)$
$v_f = - 17,35\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$17,35 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 1,77$ s

✓

$\Delta t_{tot} = 1,02 + 1,77 = 2,79$ (s)

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$10,26$ ✓$= 0 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

x = 2,79 – 1,45 ✓ = 1,34 (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(9,8)(10,26)$
$v_f = 14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$14,18 = 0 + (9,8)\Delta t$✓
$\Delta t = 1,45$ s

x = 2,79 – 1,45 ✓
= 1,34 (s) ✓

**OPTION 6/*OPSIE 6***

**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:***

Displacement from roof to meeting point/*Verplasing vanaf dak tot by ontmoetingspunt* = - 40 + 29,74 = - 10,26 m

**Stone/*Klip* A**

$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-10)^2 + (2)(-9,8)(-10,26)$
$v_f = -17,35\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-17,35 = -10 + (-9,8)\Delta t$ ✓ ✓
$\Delta t = 0,75\ s$

Ball A: $\Delta t = 1,02 + 1,02 + 0,75 = 2,79$ (s)

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½\ a\Delta t^2$
$-10,26$ ✓ $= 0 + ½\ (-9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

$x = 2,79 – 1,45$ ✓ $= 1,34$ (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(-9,8)(-10,26)$
$v_f = -14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-14,18 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 1,45$ s

$x = 2,79 – 1,45$ ✓
$= 1,34$ (s) ✓

**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:***

Displacement from roof to meeting point/*Verplasing vanaf dak tot by ontmoetingspunt* = 40 - 29,74 = 10,26 m

**Stone/*Klip* A**

$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = [(10)^2 + (2)(9,8)(10,26)$
$v_f = 17,35\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$17,35 = 10 + (9,8)\Delta t$ ✓ ✓
$\Delta t = 0,75\ s$

Ball A: $\Delta t = 1,02 + 1,02 + 0,75 = 2,79$ (s)

**Stone/*Klip* B**

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$10,26$ ✓ $= 0 + ½(9,8)\Delta t^2$ ✓
$\Delta t = 1,45$ s (1,447 s)

$x = 2,79 – 1,45$ ✓ $= 1,34$ (s) ✓

$v_f^2 = v_i^2 + 2a\Delta y$
$= 0^2 + 2(9,8)(10,26)$
$v_f = 14,18\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$14,18 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 1,45$ s

$x = 2,79 – 1,45$ ✓
$= 1,34$ (s) ✓ (6)

3.5.1 d ✓ **Accept / *Aanvaar*** ( 0 – e; 0 – d; d – e) (1)

3.5.2 a ✓ (1)

3.5.3 f ✓ (1)

3.5.4 c ✓ (1)

**[18]**





**QUESTION 4/*VRAAG 4***

4.1 **NOTE:** -1 mark for each key word/phrase omitted in the correct context.
***LET WEL:** -1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

Isolated system is a system on which the resultant/net external force is zero.✓✓
*Geïsoleerde sisteem is 'n sisteem waarop die resultante / netto eksterne krag nul is.*

***OR/OF***

Isolated system is one that has no net / external force acting on it.
*'n Geïsoleerde stelsel is een wat geen netto eksterne krag het wat daarop inwerk nie.* (2)

4.2.1 $p = mv$ ✓
$24 = m\ (480)$ ✓
$m = 0,05$ kg ✓ (3)

Note: p and v must have the same sign
*Let wel: p en v moet dieselfde tekens hê*

4.2.2

**Marking criteria/*Nasienriglyne***

- Appropriate formula including $F_{net}$ or $W_{net.}$ /*Toepaslike formule wat $F_{net}$ of $W_{net}$ insluit.* ✓
- Substitutions/*Vervangings* ✓✓
- Final answer/*Finale antwoord*: 2 000 N ✓
- Correct direction/*Korrekte rigting:* west or left/*Wes of links* ✓

**POSITIVE MARKING FROM QUESTION 4.2.1**
***POSITIEWE NASIEN VANAF VRAAG 4.2.1***

**OPTION 1/*OPSIE 1***

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = (p_{bullet})_f - (p_{bullet})_i$
$F_{net}\Delta t = (mv_{bullet})_f - (mv_{bullet})_i$
✓Any one/*Enige een*
$F_{net}(0,01)$ ✓ $= (0,05)(80) – 24$ ✓ or/*of* $(0,05)(80) – (0,05)(480)$
$F_{net} = -2\ 000$ N
$F_{net} = 2\ 000$ N ✓ west/*wes* ✓

**OPTION 2/*OPSIE 2***

$v_f = v_i + a\Delta t$
$80 = 480 + a(0,01)$ ✓
$a = -40\ 000\ m\cdot s^{-2}$

$F_{net} = ma$ ✓
$= (0,05)(-40\ 000)$ ✓
$= -2\ 000$ N
$F_{net} = 2\ 000$ N ✓ west/*wes* ✓

**OPTION 3/*OPSIE 3***

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$= \frac{480+80}{2}(0,01)$

$= 2,80$ m

$v_f^2 = v_i^2 + 2a\Delta x$
$(80)^2 = (480)^2 + 2a(2,80)$ ✓
$a = -40\ 000\ m\cdot s^{-2}$

$F_{net} = ma$ ✓
$= (0,05)(-40\ 000)$ ✓
$= -2\ 000$ N
$F_{net} = 2\ 000$ N ✓ west/*wes* ✓

$W_{net} = \Delta K$ ✓
$F_{net}\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$
$F_{net}(2,80)\cos0° = ½(0,05)(80^2 - 480^2)$ ✓ ✓
$F_{net} = -2\ 000$ N
$F_{net} = 2\ 000$ N ✓ west/*wes* ✓

**OR/*OF***
$F_{net}(2,80)\cos180° = ½(0,05)(80^2 - 480^2)$ ✓ ✓
$F_{net} = 2\ 000$ N ✓ west/*wes* ✓ (5)

**[10]**

## QUESTION 5

5.1

**Note:** -1 mark for each key word/phrase omitted in the correct context.
***Let Wel:*** *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*
**IF:** The word "work" is omitted - 0 marks.
***INDIEN:*** *Die woord "arbeid" uitgelaat is - 0 punte.*

A *conservative force* is a force for which the work done (in moving an object between two points) is independent of the path taken. ✓✓
*'n Konserwatiewe krag is 'n krag waarvoor die arbeid wat verrig is (om 'n voorwerp tussen twee punte te beweeg) onafhanklik is van die pad wat gevat word.*

***OR/OF***
A conservative force is a force for which the work done in moving an object in a closed path is zero.
*'n Konserwatiewe krag is 'n krag waarvoor die arbeid verrig om 'n voorwerp in 'n geslote pad te beweeg, nul is.* (2)

5.2 Gravitational (force)/*Gravitasiekrag* ✓

**ACCEPT/AANVAAR**: Gravitation /Gravity /*Gravitasie* / Weight /*Gewig* (1)

5.3 No/*Nee* ✓
There is friction/non-conservative force (doing work)/It is not isolated system.✓
*Daar is wrywing/nie konserwatiewe krag (wat arbeid verrig)./Dit is nie 'n geïsoleerde sisteem nie.*

**OR/OF**
The net work done by the non-conservative forces is not zero/*Die netto arbeid deur die nie-konserwatiewe kragte is nie nul nie.* ✓ (2)





5.4

| **OPTION 1/*OPSIE 1*** | **OPTION 2/OPSIE 2** |
|---|---|
| $E_P = mgh$ ✓<br>$= (1,8)(9,8)(1,5)$ ✓<br>$= 26,46$ J ✓ | $W_w = -\Delta E_p$ ✓<br>$(1,8)(9,8)(h - 0)\cos180° = -(E_{pA} - E_{p(ground)})$<br>$(1,8)(9,8)(1,5)(-1) = -E_{pA}$ ✓<br>$E_p = 26,46$ J✓<br><br>**OR/*OF***<br>$W = F\Delta x\cos\theta$<br>$= mg\Delta h\cos\theta$ } ✓Any one/*Enige een*<br>$= (1,8)(9,8)(1,5)\cos0°$ ✓<br>$= 26,46$ J✓ |

(3)

5.5

**POSITIVE MARKING FROM QUESTION 5.4 /**
***POSITIEWE NASIEN VANAF VRAAG 5.4***

**OPTION 1/*OPSIE 1***
$W_{nc} = \Delta K + \Delta U$
$W_f = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ } ✓Any one/*Enige een*
$= ½(1,8)(4^2 - 0,95^2)$ ✓+ $(0 - 26,46)$ ✓
$= -12,87$ J ✓

**OPTION 2/*OPSIE 2***
$W_{net} = \Delta K$
$W_f + W_g = ½mv_f^2 - ½mv_i^2$
$W_f + mgh = ½m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$W_f + mgh = ½mv_f^2 - ½mv_i^2$
$W_f + 26,46$ ✓$= ½(1,8)[(4)^2 - (0,95)^2]$ ✓
$W_f = -12,87$ J (- 12,872 J) ✓

**OPTION 3/*OPSIE 3***
$E_{(mech/meg)A} = E_{(mech)B} - W_f$
$(E_p + E_k)_A = (E_p + E_k)_B - W_f$ } ✓Any one/*Enige een*
$(mgh + ½mv^2)_A = (mgh + ½mv^2)_B - W_f$
$26,46 + ½(1,8)(0,95^2)$ ✓ $= 0 + ½(1,8)(4^2) - W_f$ ✓
$W_f = -12,87$ J ✓ (4)

5.6 $W_{net} = 0$ (J ) / zero✓ (1)

**[13]**

## QUESTION 6/*VRAAG 6*

6.1 Doppler effect/*Doppler-effek* ✓ (1)

6.2 (Q): (records sounds with) longer period/ longer time per wave / lower frequency.
*(Q): (teken klank aan met) langer periode / langer tyd per golf / laer frekwensie.*

**OR/*OF***
P: (records sounds with) shorter period/ shorter time per wave / higher frequency. ✓
*P: (teken klank aan met) korter periode/ korter tyd per golf / hoër frekwensie.*

**ACCEPT/*AANVAAR***
(Q): longer wavelength. /P: shorter wavelength.
*(Q): langer golflengte./P: korter golflengte het.* (1)

6.3 **OPTION 1/*OPSIE 1***

$f = \frac{1}{T}$ ✓ $= \frac{1}{17 \times 10^{-4}}$ ✓ $= 5{,}88 \times 10^{2} = 588{,}24$ Hz ✓

| **OPTION 2/*OPSIE* 2** | **OPTION 3/*OPSIE 3*** |
|---|---|
| speed = $\frac{\text{distance}}{\text{time}}$ | $v = \frac{\lambda}{T}$ |
| $340 = \frac{\text{distance}}{25{,}5 \times 10^{-4}}$ | $340 = \frac{\lambda}{17 \times 10^{-4}}$ |
| Distance = 0,867 m | ∴λ = 0,578 m |
| Distance = 1 ½ λ | |
| ∴λ = 0,578 m | v = fλ ✓ |
| v = fλ ✓ | 340 = f(0,578) ✓ |
| 340 = f(0,578) ✓ | f = 588,24 Hz ✓ |
| f = 588,24 Hz ✓ | |

(3)

6.4 **POSITIVE MARKING FROM QUESTIONS 6.2 AND 6.3.**
***POSITIEWE NASIEN VANAF VRAE 6.2 EN 6.3***
**Do not penalise if $10^{-4}$ is again omitted. /*Moenie penaliseer indien $10^{-4}$ weer uitgelaat is nie.***

**OPTION 1/*OPSIE 1***

$f = \frac{1}{18 \times 10^{-4}}$ ✓ $= 5{,}56 \times 10^{2} = 555{,}56$ Hz

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$

$555{,}56$ ✓ $= \left(\frac{340}{340 + v}\right)$ ✓ $588{,}24$ ✓

$v = 20\ m \cdot s^{-1}$ ✓

Range/*Gebied* 19,57 – 20,09 $m \cdot s^{-1}$

**OPTION 2/*OPSIE 2***

$f_L = \frac{1}{18 \times 10^{-4}}$ ✓

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$

$\frac{1}{18 \times 10^{-4}}$ ✓ $= \left(\frac{340}{340 + v}\right)$ ✓ $\frac{1}{17 \times 10^{-4}}$ ✓

$v = 20\ m \cdot s^{-1}$ ✓

Range/*Gebied* 19,57 – 20,09 $m \cdot s^{-1}$

(6)
**[11]**





**QUESTION 7/*VRAAG 7***

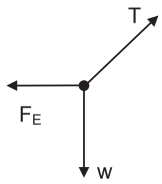
7.1.1 Positive/*Positief* ✓ (1)

7.1.2 **Marking criteria/*Nasienriglyne:***
- Appropriate formula /*Toepaslike formule*✓
- Whole substitution *Hele vervanging*✓/
- Final answer/*finale antwoord*: $2{,}26 \times 10^{-6}$ C ✓

| **OPTION 1/*OPSIE* 1** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $F = \frac{kQ_1Q_2}{r^2}$ ✓ | $E = \frac{kQ}{r^2}$ |
| $3{,}05 = \frac{(9 \times 10^{9})(6 \times 10^{-6})Q}{0{,}2^2}$ ✓ | $= \frac{(9 \times 10^{9})(6 \times 10^{-6})}{0{,}2^2}$ |
| | $= 1{,}35 \times 10^{6}\ N \cdot C^{-1}$ |
| $Q = 2{,}26 \times 10^{-6}$ C ✓ | F = Eq✓ |
| $(2{,}259 \times 10^{-6}$ C) | $3{,}05 = (1{,}35 \times 10^{6})q$✓ |
| | $q = 2{,}26 \times 10^{-6}$ N✓ |

(3)

7.1.3




| **Accepted labels/*Aanvaarde benoemings*** | |
|---|---|
| w✓ | $F_g$ / $F_w$ / weight / mg / gravitational force<br>*$F_g$ / $F_w$ / gewig / mg / gravitasiekrag* |
| T✓ | $F_T$ / tension / *spanning* |
| $F_E$/F✓ | Electrostatic force/ Coulomb force/ $F_{E\ Field}$/$F_{x\ on\ Y}$ / 3,05 N<br>*Elektrostatiese krag/ Coulombkrag* |

**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 force(s) do not make contact with dot /*Indien krag(te) nie met die kolletjie kontak maak nie:* Max/*Maks* $\frac{2}{3}$
- If arrows missing/*Indien pyltjies uitgelaat word*: Max/*Maks* $\frac{2}{3}$

(3)

7.1.4
$F_{net} = 0$
$F_E = T\sin 10°$
$F_E = T\cos 80°$

[3,05 = Tsin10°✓]✓ [**IF *INDIEN*** Tcos10° = 3,05 ($\frac{1}{3}$)]

**OR/OF**

[3,05 = Tcos80°✓]✓ [**IF/*INDIEN*** Tsin80° = 3,05 ($\frac{1}{3}$)]

T = 17,56 N ✓ (17,564 N) (3)

7.2.1

**Marking criteria/*Nasienriglyne***
-1 mark for each key word/phrase omitted in the correct context.
*-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

The electric field at a point is the (electrostatic) force experienced per unit positive charge placed at that point. ✓✓
*Die elektriese veld by 'n punt is die (elektrostatiese) krag wat per positiewe eenheidslading wat by die punt geplaas is, ondervind word.*

[**IF** the word "unit" or phrase "positive charge" is omitted in this definition: -1 for each
***INDIEN** die woord "eenheid" of frase "positiewe lading" uitgelaat is in hierdie definisie: -1 vir elk*]

**OR/*OF***
The electric field at a point is the (electrostatic) force experienced by a UNIT positive charge placed at that point. ✓✓
*Die elektriese veld by 'n punt is die (elektrostatiese) krag wat deur 'n positiewe EENHEIDSlading wat by die punt geplaas is, ondervind word.*

[**If "UNIT" is omitted in this definition, then 0 marks.**
***Indien "EENHEIDS" uitgelaat word in hierdie definisie, dan 0 punte.***] (2)

7.2.2

**OPTION 1/*OPSIE 1***
Electric field at **M** due to **A** ($+2 \times 10^{-5}$ C):

$E_A = \frac{kQ}{r^2}$ ✓

$= 9 \times 10^9 \frac{(2 \times 10^{-5})}{(0,2)^2}$ ✓

$= 4,5 \times 10^6$ N·C$^{-1}$

Electric field at **M** due to **B** ($-4 \times 10^{-5}$ C):

$E_B = \frac{kQ}{r^2}$ **OR/*OF*** $q_B = 2q_A$

$= 9 \times 10^9 \frac{(4 \times 10^{-5})}{(0,2)^2}$ ✓ $E_B = 2E_A$ ✓

$= 9 \times 10^6$ N·C$^{-1}$ $= 9 \times 10^6$ N·C$^{-1}$

$E_{net}$ at **M** = $E_A + E_B$
$= (4,5 \times 10^6 + 9 \times 10^6)$ ✓
$= 1,35 \times 10^7$ N·C$^{-1}$ ✓ to the right/*na regs*/towards B/*na B* /*away from A / weg vanaf A*✓

**OPTION 2/OPSIE 2**
Net electrostatic force at M / *Netto elektrostatiese krag by M*

$F_{net} = \frac{kQ_1Q_2}{r^2} + \frac{kQ_1Q_2}{r^2}$

If/*Indien* $F = \frac{kQ}{r^2}$ Max/*Maks* $\frac{2}{6}$

$= \frac{(9 \times 10^9)(2 \times 10^{-5})q}{(0,2)^2} + \frac{(9 \times 10^9)(4 \times 10^{-5})q}{(0,2)^2}$ ✓ (any one/ *enige een)*

$= 4,5 \times 10^6 q$ +✓ $9 \times 10^6$ q
$= 1,35 \times 10^7$ q N

$F_{net} = E_{net}q$ ✓
$1,35 \times 10^7 q$ ✓$= E_{net}q$
$E_{net} = 1,35 \times 10^7$ N·C$^{-1}$ ✓to the right/*na regs* ✓/towards B / *na B* (6)

**[18]**





**QUESTION 8/*VRAAG 8***

8.1 (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/eenheidlading wat daardeur beweeg.*

**ACCEPT/*AANVAAR*:**
The reading on a voltmeter connected across a battery when there is no current/ in an open circuit.✓✓
*Lesing op 'n voltmeter oor 'n battery as daar geen stroom is nie* (2)

8.2 13 V ✓ (1)

8.3.1

$R = \frac{V}{I}$ ✓
$5,6 = \frac{10,5}{I}$ ✓
I = 1,88 A ✓ (1,875 A)

**Marking criteria/*Nasienriglyne:***
- Appropriate formula/*Toepaslike formule* ✓
- Whole substitution/*Hele vervanging* ✓
- Final answer/*Finale antwoord*: 1,88 A ✓

(3)

8.3.2

**POSITIVE MARKING FROM QUESTION 8.3.1.**
***POSITIEWE NASIEN VANAF VRAAG 8.3.1***

**OPTION 1**
P = VI ✓
= (10,5)(1,88) ✓
= 19,74 W ✓ (19,688 W)

**OPTION 2**
$P = I^2R$ ✓
$= (1,88)^2(5,6)$ ✓
= 19,79 W ✓ (19,688 W)

**OPTION 3**
$P = \frac{V^2}{R}$ ✓
$= \frac{10,5^2}{5,6}$ ✓
= 19,69 W ✓ (19,688 W) (3)

8.3.3

**POSITIVE MARKING FROM QUESTIONS 8.2 AND 8.3.1.**
***POSITIEWE NASIEN VANAF VRAE 8.2 EN 8.3.1***

**OPTION 1/*OPSIE 1***
$\varepsilon = I(R + r)$ ✓
$13 = 1,88\ (5,6 + r)$ ✓
r = 1,31 Ω ✓ (1,31 – 1,33 Ω)

**OPTION 2/*OPSIE 2***
$r = \frac{V_{internal}}{I}$ ✓
$= \frac{2,5}{1,88}$ ✓
= 1,33 Ω ✓ ( 1,31 – 1,33 Ω)

**OPTION 3/*OPSIE 3***
$\varepsilon = V_{ext} + V_{int}$
$13 = 10,5 + V_{int}$
$V_{int} = 2,5$ V
$V_{int} = Ir$ ✓
$2,5 = (1,88)r$✓
r = 1,31 Ω ✓ (1,31 – 1,33 Ω) (3)

8.4.1 Decreases/*Neem af* ✓
$V_{internal\ resistance}$/Internal volts increase ✓
$V_{interne\ weerstand}$/*Interne volts neem toe* (2)

8.4.2

**Marking criteria/*Nasienriglyne***
- Formula/*Formule* $\varepsilon = I(R + r)$ ✓
- Correct substitution into/ *Korrekte vervanging in* $\varepsilon = I(R + r)$ ✓
- Substitution of values into $R_p$ formula/*Vervanging van waarde van $R_p$ in formule*✓
- Halving value of $R_{2X}$/*Halvering van waarde van $R_{2X}$* ✓
- Final answer/*Finale antwoord*: 1,49 Ω ✓ Range/*Gebied*: 1,46 Ω – 1,49 Ω

**POSITIVE MARKING FROM QUESTIONS 8.2 AND 8.3.3**
***POSITIEWE NASIEN VANAF VRAE 8.2 EN 8.3.3***

**OPTION 1/*OPSIE 1***
$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1,31)$ ✓
$R_{ext} = 1,94\ \Omega$ (1,92 Ω)
$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{1,94} = \frac{1}{5,6} + \frac{1}{R_2}$ ✓
$R_2 = 2,97\ \Omega$ (2,92 Ω)
$X = \frac{1}{2}(2,97)$ ✓
$= 1,49\ \Omega$ ✓ (1,46 – 1,49 Ω)

**OPTION 2/*OPSIE 2***
$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1,31)$ ✓
$R_{ext} = 1,94\ \Omega$ (1,92 Ω)
$R_p = \frac{R_1 R_2}{R_1 + R_2}$
$1,94 = \frac{5,6\ R_2}{5,6 + R_2}$ ✓
$R_2 = 2,97\ \Omega$ (2,92 Ω)
$X = \frac{1}{2}(2,97)$ ✓
$= 1,49\ \Omega$ ✓ (1,46 – 1,49 Ω)

**OPTION 3/*OPSIE 3***
$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1,31)$ ✓
$R_{ext} = 1,94\ \Omega$ (1,92 Ω)
$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$
$\left[\frac{1}{1,94} = \frac{1}{5,6} + \frac{1}{2X}✓\right]$ ✓
$X = 1,49\ \Omega$ ✓ (1,46 – 1,49 Ω)

**OPTION 4/*OPSIE 4***
$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1,31)$ ✓
$R_{ext} = 1,94\ \Omega$ (1,92 Ω)
$R_p = \frac{R_1 R_2}{R_1 + R_2}$
$\left[1,94 = \frac{(5,6)(2X)}{5,6 + 2X}✓\right]$ ✓
$X = 1,49\ \Omega$ ✓

**OPTION 5/*OPSIE 5***
$\varepsilon = I(R + r)$ ✓
$V_{ext} = 13 - (4)(1,31)$ ✓
$= 7,76$ V
$V_p = IR_{5,6}$
$7,76 = I(5,6)$
$I_{5,6\Omega} = 1,37$ A
$I_T = I_{2X} + I_{5,6}$
$4 = I_{2x} + 1,37$
$I_{2X} = 2,63$ A
$V = IR_{2X}$
$[7,76 = (2,63)2X✓]$✓
$X = 1,46\ \Omega$✓

**OPTION 6/*OPSIE 6***
$\varepsilon = I(R + r)$ ✓
$V_{ext} = 13 - (4)(1,31)$ ✓
$V_{ext} = 7,76$ V
$I_{5,6\Omega} = \frac{7,76}{5,6} = 1,39$ A
$I_{2x} = 4 - 1,39 = 2,61$ A

$V_{2x} = I_{2X}R_{2X}$
$[7,76 = (2,61)2X✓]$✓
$2X = 2,97\ \Omega$
$X = 1,49\ \Omega$✓

$V_X = I_X R_X$
$3,88✓ = (2,61)R_X$✓
$R_X = 1,49\ \Omega$✓





**OPTION 7/*OPSIE 7***
$\varepsilon = I(R + r)$ ✓
$V_{ext} = 13 - (4)(1,31)$ ✓
$= 7,76$ V
$V_{ext} = IR_{ext}$
$7,76 = (4)\left(\frac{1}{2X}✓ + \frac{1}{5,6}\right)^{-1}$ ✓
$X = 1,48\ \Omega$ ✓ (5)

**[19]**

**QUESTION 9/*VRAAG 9***

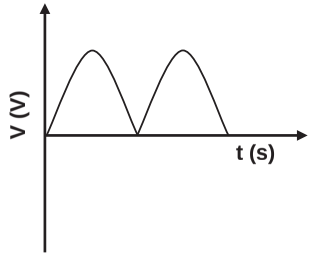
9.1
9.1.1 DC/*GS* ✓ (1)

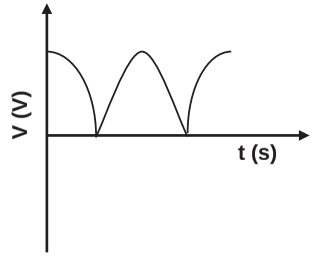
9.1.2

**NOTE:** -1 mark for each key word/phrase omitted in correct context.
***LET WEL:*** *-1 punt vir elke sleutel woord/frase weggelaat in die korrekte konteks.*

Emf is induced as a result of change of magnetic flux (linked) with the coil. ✓✓
*Emk word geïnduseer as gevolg van verandering van die magnetiese vloedkoppeling.* (2)

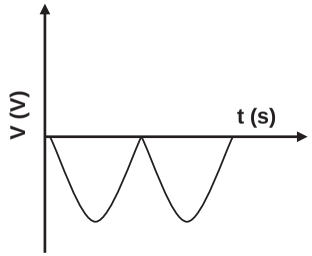
9.1.3 **POSITIVE MARKING FROM QUESTION 9.1.1**
***POSITIEWE NASIEN VANAF VRAAG 9.1.1***

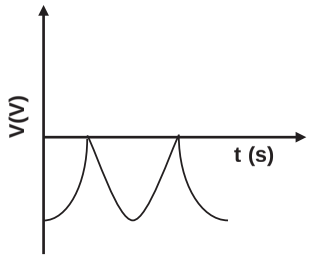



**OR/*OF***

| **Marking criteria for graph:** | |
|---|---|
| Correct shape *Korrekte vorm* | ✓ |
| One complete cycle/*Een volledige siklus* | ✓ |




(2)

9.2.1 The AC potential difference/voltage which dissipates the same amount of energy ✓ as DC potential difference. ✓
*Die WS potensiaalverskil/spanning wat dieselfde hoeveelheid energie verbruik as GS potensiaalverskil/spanning*

**OR/*OF***
(The rms value of AC is) the DC potential difference/voltage which dissipates the same amount of energy ✓ as AC potential difference/voltage. ✓
*Dit is die GS potensiaalverskil/spanning wat dieselfde hoeveelheid energie verbruik as WS potensiaalverskil/spanning.* (2)

9.2.2

| **OPTION 1/ *OPSIE 1*** | **OPTION 2 / *OPSIE 2*** | **OPTION 3 / *OPSIE 3*** | **OPTION 4 / *OPSIE 4*** |
|---|---|---|---|
| $W = \frac{V^2}{R}\Delta t$ ✓<br>$500 = \frac{V^2}{200}(10)$ ✓<br>$V = V_{rms} = 100$ V<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$100 = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$V_{max} = 141,42$ V✓ | $W = I^2R\Delta t$<br>$500 = I^2(200)(10)$<br>$I = I_{rms} = 0,5$ A<br>$P_{ave} = V_{rms}I_{rms}$ ✓<br>$\frac{500}{10} = V_{rms}(0,5)$✓<br>$V_{rms} = 100$ V<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$100 = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$V_{max} = 141,42$ V✓ | $P_{ave} = I^2_{rms}R$<br>$\frac{500}{10} = I^2_{rms}(200)$<br>$I_{rms} = 0,5$ A<br>$P_{ave} = V_{rms}I_{rms}$ ✓<br>$\frac{500}{10} = V_{rms}(0,5)$ ✓<br>$V_{rms} = 100$ V<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$100 = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$V_{max} = 141,42$ V✓ | $R = \frac{V_{rms}}{I_{rms}}$ ✓<br>$200 = \frac{V_{rms}}{0,5}$ ✓<br>$V_{rms} = 100$ V<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$100 = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$V_{max} = 141,42$ V✓ |
| **OPTION 5 / *OPSIE 5*** | **OPTION 6 / *OPSIE 6*** | **OPTION 7 / *OPSIE 7*** | **OPTION 8 / *OPSIE 8*** |
| $P_{ave} = \frac{V^2_{rms}}{R}$ ✓<br>$\frac{500}{10} = \frac{V^2_{rms}}{200}$ ✓<br>$V_{rms} = 100$ V<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$100 = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$V_{max} = 141,42$ V✓ | $P_{ave} = \frac{P_{max}}{2}$ ✓<br>$\frac{500}{10} = \frac{P_{max}}{2}$ ✓<br>$P_{max} = 100$ W<br>$P_{max} = \frac{V^2_{max}}{R}$ ✓<br>$100 = \frac{V^2_{max}}{200}$ ✓<br>$V_{max} = 141,42$ V✓ | $P = \frac{W}{\Delta t} = \frac{500}{10}$<br>$= 50$ W<br>$P_{ave} = \frac{V^2_{rms}}{R}$ ✓<br>$50 = \frac{V^2_{rms}}{200}$ ✓<br>$V_{rms} = 100$ V<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$100 = \frac{V_{max}}{\sqrt{2}}$ ✓<br>$V_{max} = 141,42$ V✓ | $P_{ave} = I^2_{rms}R$ ✓<br>$\frac{500}{10} = I^2_{rms}(200)$✓<br>$I_{rms} = 0,5$ A<br>$I_{rms} = \frac{I_{max}}{\sqrt{2}}$<br>$0,5 = \frac{I_{max}}{\sqrt{2}}$<br>$I_{max} = 0,71$ A<br>$V_{max} = I_{max}R$ ✓<br>$= (0,71)(200)$✓<br>$= 142$ V✓ |

(5)
**[12]**





**QUESTION 10/*VRAAG 10***

10.1 **Note:** -1 mark for each key word/phrase omitted in correct context.
***Let Wel:*** *-1 punt vir elke sleutel woord/frase weggelaat in die korrekte konteks.*

The process whereby electrons are ejected from a metal / surface when light (of suitable frequency) is incident on that surface. ✓✓
*Die proses waarby elektrone vanaf 'n (metaal)oppervlak vrygestel word wanneer lig (van geskikte frekwensie) daarop skyn/inval.* (2)

10.2 $7,48 \times 10^{-19}$ (J) ✓
$E = W_o + E_{k(max)}$ $(= W_o + ½mv^2_{max})$ ✓
When/*Wanneer* $E_{k(max)} = 0$ / $v = 0$ / $v^2 = 0$ / $E = W_o$ / $W_o$ is the y-intercept / *is die y-afsnit* ✓ (3)

10.3 Mass (of photo-electron)/*Massa (van foto-elektron)*/m ✓

**ACCEPT/*AANVAAR:***
½m (1)

10.4

**OPTION 1/*OPSIE 1***
Gradient = ½m
$\frac{11,98 \times 10^{-19} - 7,48 \times 10^{-19}}{X - 0}$ ✓✓ $= ½(9,11 \times 10^{-31})$ ✓
X = 0,9879 ✓ (0,99 or 0,988)

**ACCEPT/*AANVAAR***
$X = 0,9879 \times 10^{12}$ $(m^2 \cdot s^{-2})$

**POSITIVE MARKING FROM 10.2/*POSITIEWE NASIEN VANAF 10.2***
**OPTION 2/ *OPSIE 2***
$E = W_o + E_{k(max)}$
$E = W_o + ½mv^2_{(max)}$ } ✓Any one / *Enige een*
$11,98 \times 10^{-19}$ ✓ $= 7,48 \times 10^{-19}$✓ $+ ½(9,11 \times 10^{-31})\,v^2$✓ [or/*of* $½(9,11 \times 10^{-31})X$]
$4,5 \times 10^{-19} = 4,56 \times 10^{-31}v^2$
$v^2 = 0,9868 \times 10^{12}$
$X/v^2 = 0,9868$ ✓ (0,99)
Range/*gebied* $(0,9868 – 0,9879 / 9,87 \times 10^{11} – 9,88 \times 10^{11})$

**ACCEPT/*AANVAAR:***
$X = 0,9868 \times 10^{12}$ $(m^2 \cdot s^{-2})$ / $9,868 \times 10^{11}$ $(m^2 \cdot s^{-2})$ (5)

10.5.1 Remains the same /*Bly dieselfde* ✓ (1)

10.5.2 Increases / *Neem toe* ✓ (1)
**[13]**

**TOTAL/*TOTAAL*: 150**

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**NATIONAL**
**SENIOR CERTIFICATE**
***NASIONALE***
***SENIOR SERTIFIKAAT***

**GRADE/*GRAAD* 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**
***FISIESE WETENSKAPPE: FISIKA (V1)***

**NOVEMBER 2018**

**MARKING GUIDELINES/NASIENRIGLYNE**

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 29 pages.**
***Hierdie nasien riglyne bestaan uit 29 bladsye.***

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Please turn over/*Blaai om asseblief*



**QUESTION 1/*VRAAG 1***

| | | |
|---|---|---|
| 1.1 | C /D✓✓ | (2) |
| 1.2 | C ✓✓ | (2) |
| 1.3 | C ✓✓ | (2) |
| 1.4 | B ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | D ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | **[20]** |

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## QUESTION 2/*VRAAG 2*

2.1

When a (non-zero) 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 (nie-nul) resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die (netto) krag en omgekeerd eweredig aan die massa van die voorwerp.*

**OR/*OF***

The (non-zero) 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. ✓✓ (2 or 0)

*Die (nie-nul) netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum.*

**ACCEPT/*AANVAAR***

Acceleration is directly proportional to the net force and inversely proportional to the mass of the object.

*Versnelling direk eweredig is aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.*

**NOTE/*LET WEL***

If any of the underlined key words in the **correct context** is omitted deduct 1 mark.

*Indien enige van die onderstreepte sleutel woorde in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

(2)

2.2

**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.*
- If T is not shown but $T_{\parallel}$ and $T\perp$ are shown, give 1 mark for both
  *Indien T nie aangetoon is nie maat $T_{\parallel}$ en $T\perp$ is getoon. Ken 1 punt toe vir beide.*
- If force(s) do not make contact with body/*Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{3}{4}$
- Deduct 1 mark for any additional force /*Trek 1 punt af vir enige addisionele krag*

(4)





| | **Accept the following symbols /*Aanvaar die volgende simbole.*** |
|---|---|
| N | $F_N$; Normal;Normal force /*Normaal; Normaalkrag* ✓ |
| f | $F_f$ / $f_k$ / frictional force/*wrywingskag*/kinetic frictional force/ *kinetiese wrywingskrag*✓ |
| w | $F_g$; mg; Weight;$F_{Earth\ on\ block}$;Fw / G*ewig* ;Gravitational force / *Gravitasiekrag/* 78,4 N✓ |
| T | Tension/*Spanning*; $F_T$ /$F_A$, F /16,96 N ✓ |

2.3.1

The 2/8 kg block /system is accelerating/*Die 2/8 kg blok / sisteem is besig om te versnel* ✓

**OR/*OF***

The acceleration is not zero / a ≠ 0 ($m\cdot s^{-2}$) / a = 1,32 $m.s^{-2}$ / *Die versnelling is nie nul nie* ✓

**OR/*OF***

Velocity is /increasing/changing/not constant/*Snelheid neem toe/ verander/is nie konstant nie* ✓

**OR/*OF***

$F_{net}$ is not equal to zero /$F_{net}$ *is nie gelyk aan nul nie* / $F_{net}$ ≠ 0 (N) ✓

**OR/*OF***

The acceleration is changing / *Die versnelling verander* ✓

**Accept/Aanvaar**

An unbalanced force is acting on it / *'n Ongebalanseerde krag werk in op die liggaam* ✓

(1)

2.3.2

**For 2 kg/*Vir die 2 kg massa***

$F_{net}$ = ma
mg -T= ma } ✓

1 mark for any
*1 punt vir*

(2)(9,8) – T = 2(1,32) ✓
T = 16,96 N ✓

$F_{net}$ = ma
mg + T = ma
(2)(-9,8) + T = 2(-1,32) ✓
T = 16,96 N ✓

(3)

2.3.3

**POSITIVE MARKING FROM 2.3.2/*POSITIEWE NASIEN VANAF 2.3.2***

$F_{net}$ = ma
Tcos15° - f = ma } ✓

$T_x$ = Tcos15°
= 16,96 cos15°
= 16,38 N (16,382 N)

16,382 – f ✓ = (8)(1,32) ✓
f = 5,82 N (to the left/*na links*) ✓

**OR/*OF***
$F_{net} = ma$
$T\cos15^o + f = ma$ ✓

$T_x = T\cos15^o$
$= 16{,}96 \cos15^o$
$= 16{,}38$ N (16,382 N)

$-16{,}382 + f$ ✓ $= (8)(-1{,}32)$ ✓
$f = 5{,}82$ N (to the left/*na links*) ✓ (4)

2.4 **ANY ONE/*ENIGE EEN***
Normal force changes/decreases ✓/*Normaalkrag verander/neem af*
The angle (between string and horizontal) changes/increases. /*Die hoek (tussen die toutjie en die horisontaal) verander/neem toe*
The vertical component of the tension changes/increases/*Die vertikale komponent van die spanning verander / neem toe.* (1)

2.5 Yes✓/*Ja*
The frictional force (coefficient of friction) depends on the nature of the surfaces in contact. ✓
*Die wrywingskrag (wrywingskoëffisiënt) is afhanklik van die aard van die oppervlaktes in kontak met mekaar.*

**ACCEPT/*AANVAAR***
The nature of the surface changes / $\mu_k$ changes
*Die aard van die oppervlakte verander / $\mu_k$ verander* (2)
**[17]**





**QUESTION 3/*VRAAG 3***

3.1 Downwards/*Afwaarts* ✓

The only force acting on the object is the gravitational force/weight which acts downwards.✓/*Die enigste krag wat op die voorwerp inwerk is die gravitasiekrag/gewig wat afwaarts inwerk.*

**ACCEPT/*AANVAAR***:
The only force acting is gravitational/weight.✓/*Die enigste krag wat inwerk is gravitasie/gewig*

**OR/*OF***
Gravitational force/weight acts downwards.✓/*Gravitasiekrag/gewig werk afwaarts*

**OR/*OF***
The ball is in free-fall / *Die bal in vry-val* ✓

**OR/OF**
(Gravitational) acceleration is downwards/(*Gravitasionele) versnelling is afwaarts* (2)

3.2 **OPTION 1/*OPSIE 1***
**Upward positive/*Opwaarts positief***
$v_f = v_i + a\Delta t$ ✓
$0 = 7{,}5 + (-9{,}8)\Delta t$ ✓
$\Delta t = 0{,}77$ s ✓

**Downward positive/*Afwaarts positief***
$v_f = v_i + a\Delta t$ ✓
$0 = -7{,}5 + (9{,}8)\Delta t$ ✓
$\Delta t = 0{,}77$ s ✓

| **OPTION 2/*OPSIE 2*** | **OPTION 2/OPSIE 2** |
|---|---|
| **Upward positive** | **Downward positive** |
| ***Opwaarts positief*** | ***Afwaarts positief*** |
| At highest point $v_f$ is zero | At highest point $v_f$ is zero |
| *By hoogste punt is $v_f$ nul* | *By hoogste punt is $v_f$ nul* |
| $v_f^2 = v_i^2 + 2a\Delta y$ | $v_f^2 = v_i^2 + 2a\Delta y$ |
| $0 = (7{,}5)^2 + (2)(-9{,}8)\Delta y$ | $0 = (-7{,}5)^2 + (2)(9{,}8)\Delta y$ |
| $\Delta y = 2{,}87$ (2,869) m | $\Delta y = -2{,}87$ (-2,869) m |
| $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ | $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ |
| $2{,}87 = \frac{7{,}5 + 0}{2}\Delta t$ ✓ | $-2{,}87 = \frac{-7{,}5 + 0}{2}\Delta t$ ✓ |
| $\Delta t = 0{,}77$ s✓ | $\Delta t = 0{,}77$ s✓ |

| **OPTION 3/*OPSIE 3*** | **OPTION 3/OPSIE 3** |
|---|---|
| **Upward positive**<br>***Opwaarts positief***<br>$F_{net}\Delta t = m(v_f - v_i)$ ✓<br>$mg\Delta t = m(v_f - v_i)$<br>$(-9,8)\Delta t = 0 - 7,5$ ✓<br>$\therefore \Delta t = 0,76531$ s (0,77 s) ✓ | **Downward positive**<br>***Afwaarts positief***<br>$F_{net}\Delta t = m(v_f - v_i)$ ✓<br>$mg\Delta t = m(v_f - v_i)$<br>$(9,8)\Delta t = 0 - (-7,5)$ ✓<br>$\therefore \Delta t = 0,76531$ s (0,77 s)✓ |

| **OPTION 4/*OPSIE 4*** | **OPTION 4/*OPSIE 4*** |
|---|---|
| **Upward positive**<br>***Opwaarts positief***<br>(Top to Bottom / *Bo na onder*)<br>$v_f = v_i + a\Delta t$ ✓<br>$-7,5 = 0 + (-9,8)\Delta t$ ✓<br>$\therefore \Delta t = 0,76531$ s (0,77 s) ✓ | **Downward positive**<br>***Afwaarts positief***<br>(Top to Bottom /*Bo na onder*)<br>$v_f = v_i + \Delta t$ ✓<br>$7,5 = 0 + (9,8)\Delta t$✓<br>$\therefore \Delta t = 0,76531$ s (0,77 s) ✓ |

| **OPTION 5/*OPSIE 5*** | **OPTION 5/*OPSIE 5*** |
|---|---|
| **Upward positive**<br>***Opwaarts positief***<br>(Top to Bottom/ *Bo na onder*)<br>$v_f^2 = v_i^2 + 2a\Delta y$<br>$(7,5)^2 = (0)^2 + 2(-9,8)\Delta y$<br>$\Delta y = -2,87$ m<br><br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$-2,87 = (0)\Delta t + ½ (-9,8)(\Delta t)^2$ ✓<br>$\Delta t = 0,765$ s ✓ | **Downward positive**<br>***Afwaarts positief***<br>(Top to Bottom / *Bo na onder*)<br>$v_f^2 = v_i^2 + 2a\Delta y$<br>$(7,5)^2 = (0)^2 + 2(9,8)\Delta y$<br>$\Delta y = 2,87$ m<br><br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$2,87 = (0)\Delta t + ½ (9,8)\Delta t^2$ ✓<br>$\Delta t = 0,765$ s ✓ |

(3)





| **NOTES for marking QUESTION 3.3**<br>***AANTEKENINGE vir merk van VRAAG 3.3*** | |
|---|---|
| Formula mark/*Formule punt* | ✓ |
| Substitution mark /*Vervangingspunt* | ✓✓ |
| Mark for height/distance / *Punt vir hoogte/afstand* | ✓ |
| Mark for comparison/*Punt vir vergelyking* | ✓ |
| Mark for conclusion/*Punt vir gevolgtrekking* | ✓ |

3.3

**OPTION 1/*OPSIE 1***
**Upward positive/*Opwaarts positief***
At highest point $v_f$ is zero/*By hoogste punt is $v_f$ nul*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
0✓ = $(7,5)^2 + (2)(-9,8)\Delta y$ ✓
$\Delta y = 2,87$ (2,869) m✓

This is higher than height needed to reach point **T** (2,1 m)✓therefore the ball will pass point **T**.✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

**Downward positive/*Afwaarts positief***
At highest point $v_f$ is zero/*By hoogste punt is $v_f$ nul*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
0✓ = $(-7,5)^2 + (2)(9,8)\Delta y$✓
$\Delta y = -2,87$ (-2,869) m✓

This is higher than height needed to reach point **T** (2,1 m)✓therefore the ball will pass the target. ✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

**OPTION 2/*OPSIE 2* (POSITIVE MARKING FROM 3.2)**
**Upward positive/*Opwaarts positief***
$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓
$\Delta y = (7,5)(0,77)$ ✓ $+ ½ (-9,8)(0,77)^2$✓
$\Delta y = 2,87$ m (2,86 m)✓
This is higher than height needed to reach point **T** (2,1 m)✓therefore the ball will pass point **T**. ✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

**Downward positive/*Afwaarts positief***
$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓
$\Delta y = (-7,5)(0,77)$ ✓ $+ ½ (9,8)(0,77)^2$✓
$\Delta y = -2,87$ m (2,869 m)✓
This is higher than the height needed to reach point **T** (2,1 m)✓therefore the ball will pass point **T**. ✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

**OPTION 3/*OPSIE 3***

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$
$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$
$(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{Bottom/Onder}$

1 mark for any
*1 punt vir enige*

$(9,8)(h) + 0$ ✓ $= \underline{0 + (½)(7,5)^2}$ ✓
h = 2,87 m (2,869 m)✓

This is higher than height needed to pass the target (2,1 m)✓ therefore the ball will pass the target.✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) verby te gaan dus sal die bal punt **T** verbygaan.*

**OPTION 4/*OPSIE 4***

$W_{net} = \Delta E_K$
$mg\Delta x\cos\theta = ½ mv_f^2 - ½ mv_i^2$ ✓
$\underline{(9,8)\Delta x\cos180^o}$✓ $= \underline{0 - ½(7,5)^2}$✓
$\Delta x$ = 2,87 m (2,869 m)✓

This is higher than point height needed to pass point **T** (2,1 m)✓ therefore the ball will pass point **T**. ✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) verby te gaan dus sal die bal punt **T** verbygaan.*

**OPTION 5/*OPSIE 5***

**Upward positive/*Opwaarts positief***
If the highest point is $y_f$ then $\Delta y = (y_f - y_{1,6})$ At highest point $v_f$ is zero
*Indien die hoogste punt $y_f$ is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is $v_f$* nul
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
0✓ $= [\underline{(7,5)^2 + (2)(-9,8)}(y_f - 1,6)]$✓
$y_f$ = 4,47 (4,469) m✓

Yes ✓✓
**OR/*OF***
This point (4,47m) is higher than point **T** ✓✓ (or even the required height of 2,1 m) therefore the ball will pass point **T**.
*Ja* ✓✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

**Downward positive/*Afwaarts positief***
If the highest point is $y_f$ then $\Delta y = (y_f - y_{1,6})$ At highest point $v_f$ is zero
*Indien die hoogste punt $y_f$ is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is $v_f$* nul
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
0✓ $= [\underline{(-7,5)^2 + (2)(9,8)}\{y_f - (-1,6)\}]$ ✓
$y_f$ = -4,47 (-4,469) m✓
height is/*hoogte is* 4,47 m.
This point (4,47 m) is higher than point **T**✓✓ (or even the required height of 2,1 m) therefore the ball will pass point **T**.
*Hierdie punt (4,47 m) is hoer as punt **T** (of selfs die benodigde hoogte van 2,1 m ) dus sal die bal punt **T** verbygaan.*





**OPTION 6/*OPSIE 6* (POSITIVE MARKING FROM 3.2)**

**Upward positive/*Opwaarts positief***
If the highest point is $y_f$ then $\Delta y = (y_f - y_{1,6})$ At highest point $v_f$ is zero
*Indien die hoogste punt $y_f$ is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is $v_f$* nul
$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓
$(y_f - 1,6) = (7,5)(0,77)$ ✓ $+ ½ (-9,8)(0,77)^2$✓
$y_f$ = 4,47 m (4,469 m)✓

This point (4,47m) is higher than point **T** ✓✓ (or even the required height of 2,1 m) therefore the ball will pass point **T**.
*Hierdie punt (4,47 m) is hoer as punt **T** (of selfs die benodigde hoogte van 2,1 m ) dus sal die bal punt **T** verbygaan.*

**Downward positive/*Afwaarts positief***
If the highest point is $y_f$ then $\Delta y = (y_f - y_{1,6})$ At highest point $v_f$ is zero
*Indien die hoogste punt $y_f$ is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is $v_f$* nul
$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓
$\{y_f - (-1,6)\} = (-7,5)(0,765)$ ✓ $+ ½ (9,8)(0,765)^2$✓
$y_f$ = -4,47 m (-4,469 m)✓

This point (4,47m) is higher than point T✓✓ (or even the required height of (2,1m) therefore the ball will pass point **T.**
*Hierdie punt (4,47 m) is hoer as punt **T** (of selfs die benodigde hoogte van 2,1 m ) dus sal die bal punt **T** verbygaan.*

**OPTION 7/*OPSIE 7* (POSITIVE MARKING FROM 3.2)**

**Upward positive/*Opwaarts positief***

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{0 + 7,5}{2}\right)(0,77) \quad ✓✓$$
$$= 2,89 \text{ m} ✓$$

This is higher than height needed to pass the target (2,1 m)✓ therefore the ball will pass the target.✓
*Dit is hoer as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.*

**OPTION 7/*OPSIE 7* (POSITIVE MARKING FROM 3.2**

**Downward positive/*Afwaarts positief***

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \frac{0 - 7,5}{2}(0,77) \quad ✓✓$$
$$= -2,89 \text{ m} ✓$$

Height /*Hoogte* is 2,89m
This is higher than height needed to pass the target (2,1 m)✓ therefore the ball will pass the target.✓
*Dit is hoer as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.*

**OPTION 8/*OPSIE 8***

**Upward positive/*Opwaarts positief***

At highest point $v_f$ is zero/*By hoogste punt is $v_f$ nul*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0$✓ $= v_i^2 - (2)(9,8)(2,1)$ ✓

$v_i = 6,42\ m\cdot s^{-1}$ ✓

This is the actual velocity needed to reach the target.

The given velocity is greater than the actual velocity needed. ✓

The ball will pass the target. ✓

*Dit is die werklike snelheid benodig is om die teiken te bereik*

*Die gegewe snelheid is groter as die werklike snelheid benodig*

*Die bal sal die teiken verbygaan.*

**Downward positive/*Afwaarts positief***

At highest point $v_f$ is zero

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0$✓ $= v_i^2 + (2)(9,8)(-2,1)$ ✓

$v_i = 6,42\ m\cdot s^{-1}$ ✓

This is the actual velocity needed to pass the target.

The given velocity is greater than the actual velocity needed. ✓

The ball will reach the target. ✓

*Dit is die werklike snelheid benodig is om die teiken te verby te gaan.*

*Die gegewe snelheid is groter as die werklike snelheid benodig*

*Die bal sal die teiken verbygaan.*

**OPTION 9/*OPSIE 9***

$W_{nc} = \Delta E_p + \Delta E_k$ ✓

$0 = mgh_f - mgh_i + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$0$ ✓$= (9,8)h_f - (9,8)(1,6) + \frac{1}{2}(0)^2 - \frac{1}{2}(7,5)^2$✓

$0 = (9,8)h_f - 43,805$

$\therefore h_f = 4,47\ m$ ✓

∴ The ball will pass point **T** ✓✓

*Die bal sal punt **T** verbygaan.*





**OPTION 10/*OPSIE 10***

**POSITIVE MARKING FROM 3.2 / POSITIEWE NASIEN VANAF 3.2**

**Upward positive/*Opwaarts positief***

$\Delta t$(max. height/*maks. hoogte*) = 0,77 s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$2,1$✓ $= (7,5)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓

$\therefore \Delta t = 0,36$ s ✓

∴ $\Delta t$ (max height/*maks.hoogte*, 0,77 s) > $\Delta t$ (to pass point **T**/ om **T** *verby te gaan,* 0,36 s) ✓

∴ The ball passed point **T** ✓

*Die bal het punt **T** verbygegaan.*

**Downward positive/*Afwaarts positief***

$\Delta t$ (max height) = 0,77 s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$2,1$✓$= (7,5)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓

$\therefore \Delta t = 0,36$ s✓

∴ $\Delta t$ (max height, 0,77 s) > $\Delta t$ (to reach point T, 0,36 s) ✓

∴ The ball passed point **T** ✓

*Die bal het punt **T** verbygegaan*

**OPTION 11/*OPSIE 11***

**Upward positive/*Opwaarts positief***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓

$(3,7 - 1,6)$✓ $= 7,5\ \Delta t + \frac{1}{2}(-9,8)\ \Delta t^2$ ✓

$\Delta t = 0,375$ s ✓

The time to pass point **T** is less than time to reach maximum height ✓. Ball will pass point **T**.✓

*Die tyd om punt **T** verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt **T** verbygaan*

**Downward positive/*Afwaarts positief***

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓

$(3,7 - 1,6)$✓ $= -7,5\ \Delta t + \frac{1}{2}(9,8)\ \Delta t^2$ ✓

$\Delta t = 0,375$ s ✓

The time to reach point **T** is less than time to reach maximum height ✓. Ball will pass point **T**.✓

*Die tyd om punt **T** verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt **T** verbygaan*

**OPTION 12/*OPSIE 12***

**Upward positive/*Opwaarts positief***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$v_f^2 = (7,5)^2$ ✓ $+ 2(-9,8)(2,1)$ ✓

$v_f = 3,88\ m\cdot s^{-1}$ ✓

Velocity at **T** is 3,88 $m\cdot s^{-1}$ therefore the ball still moving towards its maximum height ✓✓

*Snelheid by **T** is 3,88 $\cdot m\cdot s^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte*

**Downward positive/*Afwaarts positief***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

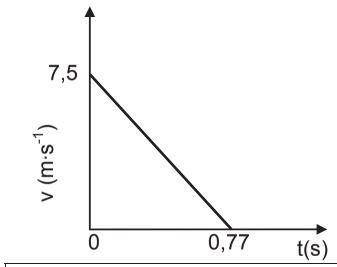
$v_f^2 = (-7,5)^2$ ✓ $+ 2(9,8)(-2,1)$ ✓

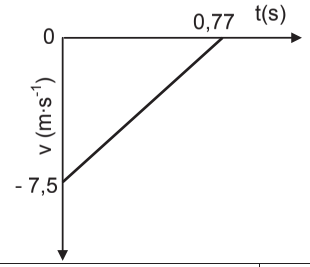
$v_f = -3,88\ m\cdot s^{-1}$ ✓

Velocity at **T** is -3,88 $m\cdot s^{-1}$ therefore the ball is still moving towards its maximum height ✓✓

*Snelheid by **T** is -3,88 $\cdot m\cdot s^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte* (6)

3.4 **POSITIVE MARKING FROM 3.2 / *POSITIEWE NASIEN VANAF 3.2***




| **Notes/*Notas*:** | |
|---|---|
| Initial velocity and time for final velocity shown<br>*Beginsnelheid en tyd vir finale snelheid aangedui.* | ✓ |
| Correct straight line (including orientation) drawn<br>*Korrekte reguitlyn (insluitend oriëntasie) geteken.* | ✓ |
| | |

(2)
**[13]**

**QUESTION 4/*VRAAG 4***

4.1 Momentum is the product of the mass of an object and its velocity ✓✓
*Momentum is die produk van die massa van 'n voorwerp en sy snelheid.*
**[NOTE/LET WEL: 2 or/of 0]** (2)

4.2 To the left/*Na links* ✓
Newton's third law/*Newton se derde wet* ✓

**ACCEPT/*AANVAAR*:**
Principle of conservation of linear momentum / law of action-reaction
*Beginsel van behoud van lineêre momentum/wet van aksie-reaksie*
Newton's third law **and** Newton's second law/*Newton se derde wet **en** Newton se tweede wet* (2)





**NOTE: For QUESTION 4.3 and 4.4 motion to the right has been taken as positive. Candidates may use the opposite direction.**
***LET WEL: Vir VRAAG 4.3 en 4.4 word beweging na regs as positief geneem. Kandidate mag die teenoorgestelde rigting gebruik.***

4.3

**OPTION 1/*OPSIE 1***

$\sum p_i = \sum p_f$ ✓

$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$

mass of girl is m / *massa van meisie is m*

$\{(m + 2)(0)\} + \{8(0)\}$ ✓ $= \{(m + 2)(-0,6)\}$ ✓ $+ (8)(4)$ ✓

m = 51,33 kg ✓

Allocate mark if 0 is substituted on left hand side/*Ken punt toe indien 0 aan linkerkant vervang is.*

**OPTION 2/*OPSIE 2***

$\sum p_i = \sum p_f$ ✓

$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$

$0 = m_1v_{1f} + m_2v_{2f}$

$0$ ✓ $= (8)(4)$ ✓ $+ m_2(-0,6)$ ✓

$\therefore m_2 = 53,33$ kg

$\therefore m_{girl} = 53,33 - 2$

$\therefore m_{girl} = 51,33$ kg ✓

**NOTE**: Penalise only once for the incorrect sign of the 0,6.
**LET WEL**: *Penaliseer slegs eenmaal die die inkorrekte teken van 0,6*

**OPTION 3/*OPSIE 3***

$\Delta p_{girl} = -\Delta p_{parcel}$ ✓

$m(v_f - v_i) = -m(v_f - v_i)$

$(m + 2)(-0,6 - 0)$ ✓ $= -8(4 - 0)$ ✓

m = 51,33 kg ✓ (5)

4.4 **POSITIVE MARKING FROM 4.3/*POSITIEWE NASIEN VANAF 4.3***

Impulse = $\Delta p = m(v_f - v_i)$ ✓

$= (51,33 + 2)(-0,6 - 0)$ ✓

$= -32\ N\cdot s\ /\ kg\cdot m\cdot s^{-1}$

Magnitude of impulse/*Grootte van die impuls* is 32 N·s /32 $kg\cdot m\cdot s^{-1}$ ✓

**OR/*OF***

Impulse = $\Delta p_{parcel/pakket} = m(v_f - v_i)$ ✓

$\Delta p = (8)(4 - 0)$ ✓ $= 32\ kg\ m\cdot s^{-1}$

$\therefore \Delta p_{girl/meisie} = 32\ kg\ m\cdot s^{-1}$ ✓ (3)

4.5 **POSITIVE MARKING FROM 4.4 /*POSITIEWE NASIEN VANAF 4.4***

32 $kg\cdot m\cdot s^{-1}$ / N·s ✓ to the right/opposite direction /*na regs /teenoorgestelde rigting* ✓ (2)

**[14]**

**QUESTION 5/*VRAAG 5***

5.1 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 van die pad afhang.*
**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 afhang van die pad wat dit neem.*

**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.* (2)

**NOTE/*LET WEL***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If the word work is omitted 0 marks
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien die woord arbeid uitgelaat is 0 punte.*

5.2 No/*Nee* ✓ (1)

5.3

**OPTION 1/ *OPSIE 1***

$P = \frac{W}{\Delta t}$ ✓

$= \frac{4{,}8\times10^6}{(90)}$ ✓

$= 53\ 333{,}33$ W

$= 5{,}33 \times 10^4$ W (53,33 kW) ✓

**OPTION 2/*OPSIE 2***

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$= \left(\frac{0 + 25}{2}\right)(90)$

$= 1\ 125$ m

$W_F = F\Delta x\cos\theta$

$4{,}80 \times 10^6 = F(1\ 125)\cos 0^\circ$

$F = 4\ 266{,}667$ N

$P_{ave} = Fv_{ave}$ ✓

$= (4\ 266{,}667)(12{,}5)$ ✓

$= 53\ 333,\ 33$ W ✓ (3)





5.4 The net/total work done on an object is equal to the change in the object's kinetic energy✓✓
*Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.*
**OR/*OF***
The work done on an object by a net force ✓is equal to the change in the object's kinetic energy. ✓
*Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.* (2)

**NOTE/*LET WEL***
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.*

5.5

**OPTION 1/*OPSIE 1***

$W_{net} = \Delta K$✓

$W_w + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$

$mg\Delta x\cos\theta + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$

$(1\ 500)(9{,}8)200\cos180^\circ$✓ $+ W_f + 4{,}8 \times 10^6$ ✓$= ½(1\ 500)(25^2 - 0)$ ✓

$-2\ 940\ 000 + W_f + 4{,}8 \times 10^6 = 468\ 750$

$W_f = -1\ 391\ 250$ J

$= -1{,}39 \times 10^6$ J✓

**OR/OF**

$W_{net} = \Delta K$✓

$W_w + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$

$-\Delta Ep + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$

$-(1\ 500)(9{,}8)(200 - 0)$✓ $+ W_f + 4{,}8 \times 10^6$ ✓$= ½(1\ 500)(25^2 - 0)$ ✓

$-2\ 940\ 000 + W_f + 4{,}8 \times 10^6 = 468\ 750$

$W_f = -1\ 391\ 250$ J

$= -1{,}39 \times 10^6$ J ✓ (5)

**NOTE/*LET WEL***
0 can be omitted in above substitutions.
*0 kan in bogenoemde vervangings weggelaat word.*

**OPTION 2/*OPSIE 2***

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$= ½ m (v_f^2 - v_i^2) + mg(h_f - h_i)$
$W_{nc} = ½ mv_f^2 + mgh_f - ½ mv_i^2 - mgh_i$ ✓

1 mark for any of these/
*1 punt vir enige van hierdie*

$W_f + W_F = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$W_f + 4,8 \times 10^6$ ✓ $= [½ (1\,500)(25)^2 + -0]$ ✓ $+ [(1\,500)(9,8)(200) - 0]$ ✓
$W_f = - 1,39 \times 10^6$ J ($-1,40 \times 10^6$ J) ✓

**OR/*OF***

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$= ½ m (v_f^2 - v_i^2) + mg(h_f - h_i)$
$W_{nc} = ½ mv_f^2 + mgh_f - ½ mv_i^2 - mgh_i$ ✓

1 mark for any of these/
*1 punt vir enige van hierdie*

$W_f + 4,8 \times 10^6$ ✓ $= [½ (1500)(25)^2$ ✓ $+ (1500)(9,8)(200)$ ✓$] - [0 + 0]$
$W_f = - 4,8 \times 10^6 + 3,4 \times 10^6$
$= - 1,39 \times 10^6$ J ($-1,40 \times 10^6$ J) ✓ (5)

**ACCEPT THE FOLLOWING FOR: /*AANVAAR DIE VOLGENDE VIR* :** (3/5)

**POSITIVE MARKING FROM 5.3/*POSITIEWE NASIEN VANAF 5.3***

$v_f = v_i + a\Delta t$
$25 = 0 + a(90)$
$a = 0,277\ldots m\cdot s^{-2}$

$F_{net} = ma$
$= (1\,500)(0,2777\ldots) = 416,66\ldots$ N

$F + (w_{||}) + (-f_k) = 416,666\ldots$
$4\,266,6667 - 1\,500(9,8)\sin\theta - f_k = 416,666\ldots$
$f_k = 1\,236,6667$ N

$W_f = f_k \Delta x \cos\theta$ ✓
$= (1\,236,6667)(1\,125)(\cos 180°)$ ✓
$= - 1\,391\,250$ J ✓ (5)

**[13]**





**QUESTION 6/*VRAAG 6***

6.1 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. ✓✓
*Die verandering in frekwensie (of 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), 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)

**NOTE/*LET WEL***
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.*

6.2 Away from/*Weg vanaf* ✓
Observed frequency lower/*Waargenome frekwensie is laer* ✓ (2)

6.3
$v = f\lambda$ ✓
$340 = f\,(0,34)$ ✓
$f = 1\,000$ Hz ✓ (3)

6.4
**POSITIVE MARKING FROM 6.3/*POSITIEWE NASIEN VANAF 6.3***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v - v_L}{v} f_s$

$950$ ✓ $= \left(\frac{340 - v_L}{340 + 0}\right)$ ✓ $1\,000$ ✓

$v_L = 17\ m\cdot s^{-1}$

distance/*afstand* $x = v\Delta t$
$= (17)(10)$ ✓
$= 170$ m ✓

**OR/*OF***

$f_L = \frac{v - v_L}{v} f_s$ ✓

$950$ ✓ $= \left(\frac{340 - 17/10}{340 + 0}\right)$ ✓ $(1000)$ ✓

distance/*afstand* $x = 170$ m ✓

**ACCEPT/*AANVAAR***
$v_L = \Delta f \lambda$ ✓
$= (50)$✓✓$(0,34)$✓
$= 17\ m \cdot s^{-1}$

distance/*afstand* $x = v\Delta t$
$= (17)(10)$ ✓
$= 170\ m$ ✓ (6)

**[13]**

**QUESTION 7/*VRAAG 7***

7.1

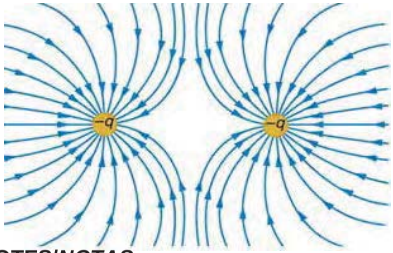
$$Q_{net/netto} = \frac{Q_1 + Q_2 + Q_3}{3}$$

$$-3 \times 10^{-9} = \frac{-15 \times 10^{-9} + Q + 2 \times 10^{-9}}{3}$$ ✓

$Q = +4 \times 10^{-9}\ C$✓

**NOTE/*LET WEL***
✓ for addition of the three correct charges
✓ correct answer (2)

7.2




**NOTES/*NOTAS***
Correct shape /*Korrekte vorm* ✓
Correct direction/*Korrekte rigting* ✓
Lines must not cross and must touch spheres ✓
*Lyne moet nie kruis nie en moet die sfere raak* (3)

7.3 The magnitude of the electrostatic force exerted by one point charge ($Q_1$) on another point charge ($Q_2$) <u>is directly proportional to the product of the (magnitudes) of the charges</u> and <u>inversely proportional to the square of the distance (r) between them</u> ✓✓
*Die grootte van die elektrostatiese krag uitgeoefen deur een puntlading ($Q_1$) op 'n ander puntlading ($Q_2$) <u>is direk eweredig aan die produk van die (grootes) van die ladings en omgekeerde eweredig aam die kwadraat van die afstand (r) tussen hulle.</u>* (2)

**NOTE/*LET WEL***
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If masses used (0/2)
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien massas gebruik word, (0/2)*





7.4

**<u>OPTION 1/*OPSIE 1*</u>**

$$F = \frac{kQ_1Q_2}{r^2}$$ ✓

$$F_{SP} = \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(0,1)^2}$$ ✓

$= 8,1 \times 10^{-6}$ N downwards/*afwaarts*

$$F_{TP} = \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(0,3)^2}$$ ✓

$= 9 \times 10^{-7}$ N left/*links* ($0,9 \times 10^{-6}$ N to the left/*na links*

$F_{net}^2 = (F_{SP})^2 + (F_{TP})^2$
$F_{net} = \sqrt{(F_{SP})^2 + (F_{TP})^2}$
$F_{net} = \sqrt{(8,1 \times 10^{-6})^2 + (0,9 \times 10^{-6})^2}$
✓ for either
$F_{net} = 8,15 \times 10^{-6}$ N ✓

**OPTION 2/*OPSIE 2***

$$E_s = \frac{kQ}{r^2}$$ ✓

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2}$$

$= 2\ 700\ N.C^{-1}$

$$E_T = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,3)^2}$$

$= 300\ N.C^{-1}$

✓ both substitutions
*beide vervangings*

$$E_{net} = \sqrt{E_S^2 + E_T^2}$$

$$= \sqrt{(2700)^2 + (30)^2}$$ ✓

$= 2\ 716,62\ N.C^{-1}$

$F = Eq$
$= (2\ 716,62)(3 \times 10^{-9})$ ✓
$= 8,15 \times 10^{-6}$ N ✓ (5)

7.5

**POSITIVE MARKING FROM 7.4 / *POSITIEWE NASIEN VANAF 7.4***
**<u>OPTION 1/*OPSIE 1*</u>**

$$E = \frac{F}{q}$$ ✓

$$= \frac{8,15 \times 10^{-6}}{3 \times 10^{-9}}$$ ✓

$= 2,72 \times 10^3\ N.C^{-1}$ ✓ (3)

**OPTION 2/*OPSIE 2***

$E_s = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^9)(3\times10^{-9})}{(0,1)^2}$ ✓

$= 2\,700\ N.C^{-1}$

$E_T = \frac{kQ}{r^2}$

$= \frac{(9\times10^9)(3\times10^{-9})}{(0,3)^2}$ ✓

$= 300\ N.C^{-1}$

$E_{net} = \sqrt{E_S^2 + E_T^2}$

$= \sqrt{(2700)^2 + (30)^2}$

$= 2\,716,62\ N.C^{-1}$ ✓

**NOTE/*LET WEL***
**Mark Allocation/*Puntetoekenning***
✓ correct formula/*korrekte formula*
✓ both subsitutions/*beide vervangings*
✓ correct answer/*korrekte antwoord*
If calculation done in 7.4 award full marks for answer written here. / *Indien berekening in 7.4 gedoen is, moet volle punte vir die antwoord wat hier geskryf is, toegeken word.*

7.6.1 Sphere/*Sfeer* P or/*of* T✓ (1)

7.6.2 **SPHERE P/*SFEER P***

$n_e = \frac{Q}{q_e}$ or/*of* $n_e = \frac{Q}{e}$

$= \frac{-15\times10^{-9}}{-1,6\times10^{-19}}$ ✓ $= 9,38 \times 10^{10}$

mass gained/*massa gewin* = $n_e m_e$
m gained /*gewin*= $(9,38 \times 10^{10})(9,11 \times 10^{-31})$✓
$= 8,55 \times 10^{-20}$ kg ✓

**SPHERE T/*SFEER T***

$n_e = \frac{Q}{q_e}$ or/*of* $n_e = \frac{Q}{e}$

$= \frac{-5\times10^{-9}}{-1,6\times10^{-19}}$ ✓ $= 3,125 \times 10^{10}$

mass gained/*massa gewin* = $n_e m_e$
m gained /*gewin*= $(3,125 \times 10^{10})(9,11 \times 10^{-31})$✓
$= 2,85 \times 10^{-20}$ kg ✓ (3)

**[19]**





**QUESTION 8/*VRAAG 8***

8.1 The battery supplies 12 J per coulomb/12 J per unit charge. ✓✓
*Die battery verskaf 12 J per coulomb lading*

**OR /*OF***
The potential difference of the battery in an open circuit is 12 V. ✓✓
*Die potensiaal verskil van die battery in 'n oop stroombaan is 12 V*

**OR/*OF***
The battery does 12 J of work per coulomb of charge.✓✓
*Die battery verrig 12 J arbeid per coulomb lading*

**OR/*OF***
Maximum work done by the battery per unit charge is 12 J
*Maksimum arbeid verrig deur die battery per eenheidslading is 12 J*

**OR/*OF***
Maximum energy supplied by the battery per unit charge is 12 J
*Maksimum energie verskaf deur die battery per eenheidslading is 12 J*

**OR/*OF***
The battery supplies 12 J of energy per coulomb/ 12 J of energy per unit charge
*Die battery verskaf 12 J energie per coulomb/12 J energie per eenheidslading*

**OR/*OF***
The greatest potential difference that can be generated by a battery is 12V
*Die grootste potensiaalveskil wat deur 'n battery gelewer word, is 12 V*

**OR/*OF***
The total energy transferred by a battery to a unit electric charge is 12 J
*Die totale energie oorgedra deur die battery aan 'n eenheid elektriese lading is 12 J*

**OR/*OF***
The total amount of electric energy supplied by the battery per coulomb/per unit charge is 12 J
*Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheid lading is 12 J* (2)

**NOTE/*LET WEL***
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*

8.2.1 **OPTION 1/*OPSIE 1***

$V_{lost/verlore} = I\,r$ ✓
$= (2)(0,5)$
$= 1\ V$

$V_{ext/eks}$ = Emf/*emk* – $V_{lost/verlore}$
$= (12 - 1)$ ✓
$= 11\ V$✓

**OPTION 2/*OPSIE 2***
$\varepsilon = I(R + r)$ ✓
$12 = V_{ext/eks} + (2)(0,5)$ ✓
$V_{ext/eks} = 11$ V✓

**OPTION 3/*OPSIE 3***
$\varepsilon = I(R + r)$ ✓
$12 = 2(R + 0,5)$
$R = 5,5\ \Omega$
$V = IR$
$= 2(5,5)$✓
$= 11$ V ✓ (3)

8.2.2 **POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1***
**OPTION 1/*OPSIE 1***
$R = \frac{V}{I}$
$= \frac{11}{2}$ ✓
$= 5,5\ \Omega$✓

**OPTION 2/*OPSIE 2***
0,5:R
1:11 ✓
$R = 5,5\ \Omega$✓

**OPTION 3/*OPSIE 3***
$\frac{1}{0,5} = \frac{11}{R}$ ✓
$R = 5,5\ \Omega$✓

**OPTION 4/*OPSIE 4***
$V_{total} = IR_{total}$
$12 = (2)R_{total}$
$R_{total} = 6\ \Omega$
$R = 6 - 0,5$ ✓
$= 5,5\ \Omega$ ✓

**OPTION 5/*OPSIE 5***
$\varepsilon = I(R + r)$
$12 = 2(R + 0,5)$ ✓
$R = 5,5\ \Omega$ ✓ (2)





8.3 Decreases /*Neem af* ✓
Total resistance decreases /*Totale weerstand neem af*✓
Current increases/*Stroom neem toe* ✓
"Lost volts" increases, ✓(emf the same)/*"Verlore volts" neem toe, (emk dieselfde)*
External potential difference decreases/*eksteme potensiaal verskil neem af*

**OR/*OF***
Decreases /*Neem af* ✓
Total resistance decreases /*Totale weerstand neem af* ✓
Current increases/*Stroom neem toe* ✓
$\varepsilon = V_{ext/eks} + Ir$
Ir increases/*Ir neem toe* ✓
ε is constant/*is konstant*
$\therefore V_{ext/eks}$ decreases/*neem af* (4)
**[11]**

**QUESTION 9/*VRAAG 9***

9.1 Temperature/*Temperatuur* ✓ (1)

9.2.1 $r = 3\ \Omega$ or/*of* $1,5\ \Omega$ ✓✓

**Accept *for one mark only*: /*Aanvaar vir slegs een punt***
$r = -3\ \Omega$ ✓ or/of $-1,5\ \Omega$ (2)

9.2.2 ε = slope (gradient) of the graph/*helling(gradiënt)van die grafiek* ✓
$\varepsilon = \frac{7,5-(-3)}{1,5-0}$ ✓
$= 7$ V✓

Accept any correct values from the graph
*Aanvaar enige korrekte waardes vanaf die grafiek*

**OR/*OF***
**POSITIVE MARKING FROM 9.2.1 / *POSITIEWE NASIEN VANAF 9.2.1***
$R = \frac{\varepsilon}{I} - r$ ✓
$7,5 = 1,5\varepsilon - 3$ ✓
$\varepsilon = 7$ V ✓

Accept any correct values on the line from the graph
*Aanvaar enige korrekte waardes op die lyn vanaf die grafiek*

**OR/OF**
$\varepsilon = I(R + r)$ ✓
$= 0,5(11 + 3)$ ✓
$\varepsilon = 7$ V ✓ (3)
**[6]**

## QUESTION 10/*VRAAG 10*

10.1.1 Y to/*na* X ✓ (1)

10.1.2 Faraday's Law Electromagnetic Induction ✓
*Faraday se wet van Elektromagnetiese Induksie*

***OR/OF***
Electromagnetic induction/Faraday's Law✓
*Elektromagnetiese induksie/Faraday se wet* (1)

10.1.3 Mechanical (kinetic) energy ✓to electrical energy ✓
*Meganiese (kinetiese) energie na elektriese energie* (2)

10.2.1 340 V ✓

**Accept / Aanvaar**
-340 V (1)

10.2.2

**POSITIVE MARKING FROM 10.2.1/*POSITIEWE NASIEN VANAF 10.2.1***

$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$= \frac{340}{\sqrt{2}}$ ✓

$V_{rms/wgk}$ = 240,42 V ✓ (3)

10.2.3

**POSITIVE MARKING FROM 10.2.2 / *POSITIEWE NASIEN VANAF 10.2.3***

**OPTION 1/*OPSIE 1***

$P_{ave/gemid} = \frac{V^2_{rms/wgk}}{R}$ ✓

$1\,600 = \frac{(240,42)^2}{R}$ ✓

R = 36,13 Ω (36,126 Ω) ✓

**OR/*OF***
R = 36,12 Ω (36,124 Ω)

**OPTION 2/ *OPSIE 2***

$P_{ave/gemid} = \frac{V^2_{rms/wgk}}{R}$ ✓ $= \frac{\frac{V^2_{max/maks}}{2}}{R} = \frac{V^2_{max/maks}}{2R}$

$1\,600 = \frac{(340)^2}{2R}$ ✓

R = 36,13 Ω (36,125 Ω) ✓





**OPTION 3/*OPSIE 3***

$P_{ave/gemid} = V_{rms/wgk} I_{rms/wgk}$

1600 = (240,416) $I_{rms/wgk}$

$I_{rms/wgk}$ = 6,66 A

$R = \frac{V_{rms}}{I_{rms}}$ ✓

$= \frac{240,416}{6,66}$ ✓

= 36,1 Ω (36,09 Ω )✓

(Do not penalise if rms is omitted in $R = \frac{V_{rms}}{I_{rms}}$ / *Moenie penaliseer indien wgk uitgelaat is nie.)*

**OPTION 4/*OPSIE 4***

$P_{ave/gemid} = \frac{V_{max/maks} I_{max/maks}}{2}$

$1600 = \frac{340 I_{max/maks}}{2}$

$I_{max/maks}$ = 9,412 A

$R = \frac{V_{max}}{I_{max}}$ ✓

$= \frac{340}{9,412}$ ✓

= 36, 12 Ω ✓

(Do not penalise if max is omitted in $R = \frac{V_{max}}{I_{max}}$ / *Moenie penaliseer indien maks uitgelaat*

(3)
**[11]**

## QUESTION 11/*VRAAG 11*

11.1 Work function of a metal is the minimum energy needed to eject an electron from the metal surface✓✓
*Arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron uit die oppervlakte van 'n metaal vry te stel.* (2)

**NOTE/*LET WEL***
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.*

11.2 Potassium / *Kalium* / K ✓

$f_o$ for potassium is greater than $f_o$ for caesium ✓
*$f_o$ vir kalium is groter as $f_o$ vir sesium*

**OR/*OF***
Work function is directly proportional to threshold frequency ✓
*Arbeidsfunksie is direk eweredig aan die drumpel frekwensie*

**ACCEPT/*AANVAAR***
$W_o = hf_o$
$W_o \propto f_o$ (2)

11.3

**OPTION 1/*OPSIE 1***

c = fλ ✓

$3 \times 10^8 = f(5,5 \times 10^{-7})$ ✓

f = 5,45 x $10^{14}$ Hz

$f_{uv} < f_{o\ of\ K(potassium)}$

∴Ammeter in circuit **B** will not show a reading ✓
*∴Ammeter in stroombaan B sal nie 'n lesing toon nie.*

**OPTION 2/*OPSIE 2***

$E = \frac{hc}{\lambda} = \frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{5{,}5 \times 10^{-7}}$
$= 3{,}6164 \times 10^{-19}$ J

$W_o = hf_o = (6{,}63 \times 10^{-34})(5{,}55 \times 10^{14}) = 3{,}68 \times 10^{-19}$ J

$W_o > E$ or/*of* $hf_o > hf$

∴The ammeter will not register a current /*ammeter sal nie lesing registreer*✓

**Mark allocation / *Puntetoekening***

✓ both correct formulae/*beide korrekte formules*: $E = \frac{hc}{\lambda}$ and $W_o = hf_o$

✓ both substitutions/*beide vervangings*: $\frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{5{,}5 \times 10^{-7}}$ and/*en* $(6{,}63 \times 10^{-34})(5{,}55 \times 10^{14})$

✓ correct conclusion

**OPTION 3/*OPSIE 3***

$c = f_o\lambda_o$ ✓
$3 \times 10^{8} = (5{,}55 \times 10^{14})\lambda$ ✓
$\lambda_o = 5{,}41 \times 10^{-7}$ m

$\lambda_o$ (threshold wavelength) < $\lambda$ (incident wavelength)
$\lambda_o$ *(drumpelgolflengte)* < $\lambda$ *(invallende golflengte)*

∴ the ammeter will not register a current / *ammeter sal nie lesing registreer* ✓ (3)

11.4 **OPTION 1/*OPSIE 1***

$E = W_0 + E_{k(max)}$
$hf = hf_o + \frac{1}{2}mv^2_{max}$
$h\frac{c}{\lambda} = h\frac{c}{\lambda_0} + E_{K(max)}$ ✓

**NOTE**: If $E_K$ of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.
***LET WEL**: Indien Ek van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord*

$\frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{5{,}5 \times 10^{-7}}$ ✓✓ = $(6{,}63 \times 10^{-34})(5{,}07 \times 10^{14}) + E_{K(max)}$ ✓
$E_K = 2{,}55 \times 10^{-20}$ J ✓ (Range/*Gebied*: $2{,}52 \times 10^{-20} – 2{,}6 \times 10^{-20}$ J)





**OPTION 2/*OPSIE 2***

**POSITIVE MARKING FROM 11.3/POSITIEWE NASIEN VANAF 11.3**

$E = W_0 + E_{k(max)}$
$hf = hf_o + \frac{1}{2}mv^2_{max}$
$h\frac{c}{\lambda} = h\frac{c}{\lambda_0} + E_{K(max)}$ ✓

**NOTE**: If $E_K$ of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.
***LET WEL**: Indien Ek van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord*

$(6{,}63 \times 10^{-34})(5{,}45 \times 10^{14})$ ✓✓ = $(6{,}63 \times 10^{-34})(5{,}07 \times 10^{14}) + E_{k(max)}$ ✓
$E_K = 2{,}52 \times 10^{-20}$ J ✓ (Range/*Gebied*: $2{,}52 \times 10^{-20} – 2{,}6 \times 10^{-20}$ J) (5)

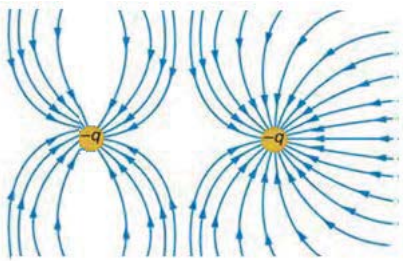
11.5 Remains the same/*Bly dieselfde* ✓ (1)
**[13]**

**TOTAL/*TOTAAL*: 150**

**ADDENDUM**

**QUESTION 7.2**

Accept the following electric field diagram which would be formed if the effect of the third charge is considered.
*Aanvaar die volgende elektrieseveld diagram wat gevorm sal word indien die effek van die derde lading in ag geneem is.*

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Province of the
EASTERN CAPE
EDUCATION

**NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT***

**GRADE/*GRAAD* 12**

**SEPTEMBER 2018**

# PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MARKING GUIDELINE/*NASIENRIGLYN*

**MARKS/*PUNTE*:** **150**

This marking guideline consists of 20 pages./
*Hierdie nasienriglyn bestaan uit 20 bladsye.*

## QUESTION/*VRAAG* 1: MULTIPLE-CHOICE QUESTIONS/ *MEERVOUDIGEKEUSE-VRAE*

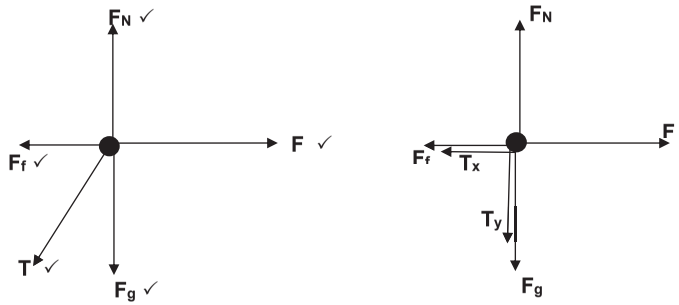
| | | |
|---|---|---|
| 1.1 | C ✓✓ | (2) |
| 1.2 | A ✓✓ | (2) |
| 1.3 | D ✓✓ | (2) |
| 1.4 | A ✓✓ | (2) |
| 1.5 | D ✓✓ | (2) |
| 1.6 | C ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | D ✓✓ | (2) |
| | | **[20]** |





## QUESTION/*VRAAG* 2

2.1.1




Mark awarded for arrow and label./*Punt toegeken vir pyl en byskrif*
Do not penalise for length of arrows since drawing is not drawn to scale/ *Moenie penaliseer vir lengte van pyle want skets nie volgens skaal nie.*
Any other additional force(s)/*Enige addisonele krag(te)* $^4/_5$
If force(s) do not make contact with body./*Indien krag(te) nie kontak maak met liggaam nie* Max/*Maks.* $^4/_5$ (5)

2.1.2 If the resultant/net force acts on an object, the object will accelerate in the direction of the resultant/net force with <u>an acceleration that is directly proportional to the resultant/net force</u> ✓ and <u>inversely proportional to the mass</u> ✓ <u>of the object</u>.
*Indien 'n resulterende/netto krag op 'n voorwerp uitgeoefen word sal die voorwerp versnel in die rigting van die resulterende/netto krag met 'n <u>versnelling wat direk eweredig is aan die resulterende/netto krag</u> ✓en <u>omgekeerd eweredig aan die massa van die voorwerp</u>.* ✓ (2)

2.1.3

**<u>OPTION/OPSIE 1</u>**

$F_{net}$ = ma ✓
$F_{net}$ = $F_{app}$ - $T_x$ - f
ma = $F_{app}$ - $T_x$ - f
any one / *enige een*
5,2a = 46,5 - $T_x$ - 12 ✓
5,2a = 34,5 - $T_x$ . . . . . (1)
2a = $T_x$ - 5,1 ✓ . . . . . .(2)
a = 4,08m.s$^{-2}$
2 x (4,08) ✓ = $T_x$ - 5,1
$T_x$ = 13,26
T = $\frac{T_x}{cos25^o}$
T = $\frac{13,26}{cos25^o}$ ✓
T = 14,63 N ✓

**<u>OPTION/OPSIE 2</u>**

-5,2a = - 46,5 + $T_x$ + 12 ✓
-5,2a = -34,5 + $T_x$ . . . . . (1)
-2a = $T_x$ + 51 ✓ . . . . . (2)
a = -4,08m.s$^{-2}$
a = 4,08 m.s$^{-2}$

(6)

2.2 $g = \frac{GM}{R^2}$ ✓

$g = \frac{6,67\ 10^{-11} x\ 6,39\ 10^{23}}{(3,39\ 10^6)^2}$ ✓

$g = 3,71\ m.s^{-2}$ ✓ (3)

**[16]**





**QUESTION/*VRAAG* 3**

3.1.1

| **UPWARD POSITIVE/ *OPWAARTS POSITIEF*** | **DOWNWARD POSITIVE / *AFWAARTS POSITIEF*** |
|---|---|
| $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ | $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ |
| $-(48)$ ✓ $= v_i \times 2,8 + \frac{1}{2} \times (-9,8) \times 2,8^2$ ✓ | $(48)$ ✓ $= v_i \times 2,8 + \frac{1}{2} \times 9,8 \times 2,8^2$ ✓ |
| $V_i = -3,42$ | $V_i = 3,42\ m.s^{-1}$ ✓ |

$V_i = 3,42\ m.s^{-1}$ ✓ (4)

**OPTION/*OPSIE* 1**

3.1.2

| **UPWARD POSITIVE/ *OPWAARTS POSITIEF*** | **DOWNWARD POSITIVE / *AFWAARTS POSITIEF*** |
|---|---|
| $V_f = V_i + a\Delta t$ ✓ | $V_f = V_i + a\Delta t$ ✓ |
| $V_f = -3,42 + (-9,8)(2,8)$ ✓ | $V_f = 3,42 + (9,8)(2,8)$ ✓ |
| $V_f = -30,86\ m.s^{-1}$ | |
| $V_f = 30,86\ m.s^{-1}$ ✓ | $V_f = 30,86\ m.s^{-1}$ ✓ |

(3)

**OPTION/*OPSIE* 2**

| **UPWARD POSITIVE/ *OPWAARTS POSITIEF*** | **DOWNWARD POSITIVE / *AFWAARTS POSITIEF*** |
|---|---|
| $V_f^2 = V_i^2 + 2a\Delta x$ ✓ | $V_f^2 = V_i^2 + 2a\Delta x$ ✓ |
| $V_f^2 = -3,42^2 + 2(-9,8)(-48)$ ✓ | $V_f^2 = 3,42^2 + 2(9,8)(48)$ ✓ |
| $V_f = 30,86\ m.s^{-1}$ ✓ | $V_f = 30,86\ m.s^{-1}$ ✓ |

**OPTION/*OPSIE* 3**

| **UPWARD POSITIVE/ *OPWAARTS POSITIEF*** | **DOWNWARD POSITIVE / *AFWAARTS POSITIEF*** |
|---|---|
| $\Delta x = \frac{V_f + V_i}{2} \Delta t$ ✓ | $\Delta x = \frac{V_f + V_i}{2} \Delta t$ ✓ |
| $-(48) = \frac{V_f - 3,42}{2} \times 2,8$ ✓ | $48 = \frac{V_f + 3,42}{2} \times 2,8$ ✓ |
| $V_f = -30,87$ | $V_f = 30,87\ m.s^{-1}$ ✓ |
| $V_f = 30,87\ m.s^{-1}$ ✓ | |

**OPTION/*OPSIE* 4**

$E_{Mi} = E_{Mi}$
$mgh_1 + \frac{1}{2} mv_i^2 = mgh + \frac{1}{2} mv_f^2$
$gh_1 + \frac{1}{2} v_i^2 = gh_2 + \frac{1}{2} v_i^2$
} Any one ✓ *Enige een*

$9,8 \times 48 + \frac{1}{2} \times 3,42^2 = 0 + \frac{1}{2} v_i^2$ ✓

$V_f = 30,86\ m.s^{-1}$ ✓

**OPTION/*OPSIE* 5**

$F_{net}\ \Delta t = \Delta p$
$F_{net}\ \Delta t = m(v_f - v_i)$
$mg\Delta t = m(v_f - v_i)$
$g\ \Delta t = v_f - v_i$
} Any one *Enige een* ✓

$9,8 \times 2,8 = v_f - 3,42$ ✓

$V_f = 30,86\ m.s^{-1}$ ✓

3.1.3

**UPWARD POSITIVE/ *OPWAARTS POSITIEF***

$V_f^2 = V_i^2 + 2a\Delta X$ ✓

$0 = V_i^2 + 2(-9,8)(8)$ ✓

$V_i = 12,52\ m.s^{-1}$ upwards. ✓

**DOWNWARD POSITIVE / *AFWAARTS POSITIEF***

$V_f^2 = V_i^2 + 2a\Delta x$ ✓

$0 = V_i^2 + 2(9,8)(--8)$ ✓

$V_i = 12,52\ m.s^{-1}$

$V_i = 12,52\ m.s^{-1}$ upwards. ✓

(3)

3.2 **Positive marking from/*Positiewe merk vanaf* 3.1.1, 3.1.2, 3.1.3**

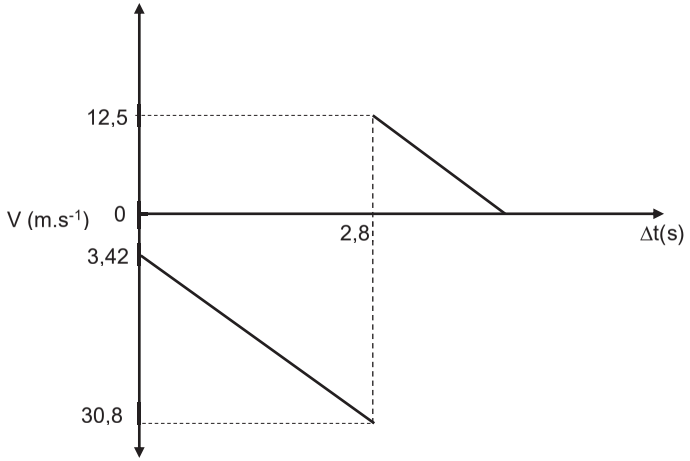
**CRITERIA FOR MARKING/*KRITERIA VIR MERK***

(i) Initial velocity with which the ball was thrown. ✓
*Beginsnelheid waarmee bal gegooi is.*

(ii) Final velocity with which the ball hit the ground ✓
*Eindsnelheid waarmee die bal die grond tref.*

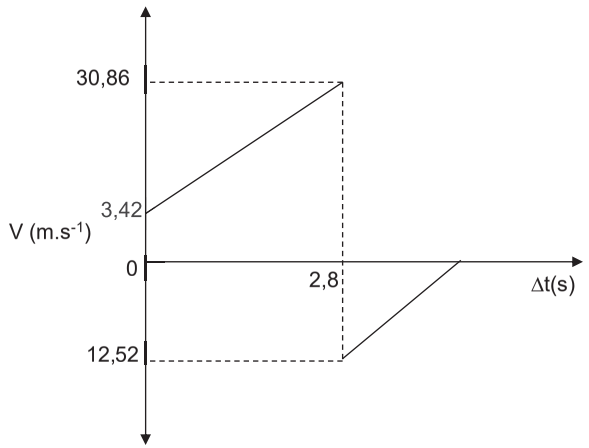
(iii) Time taken to hit the ground. ✓
*Tyd om die grond te tref.*

(iv) The velocity with which the ball bounces off the ground. ✓
*Die snelheid waarmee die bal van die grond af bons.*








(4)
**[14]**

**QUESTION/*VRAAG* 4**

4.1 $(m_A + m_B)\ v_i = m_A\ v_{fA} + m_B\ v_{fB}$ ✓

$(1100 + 800) \times (\frac{45 \times 1000}{3600})$ ✓ $= 1100\ v_{fA} + 800 \times 9,06$ ✓

$v_{fA} = 15,00\ m.s^{-1}$ ✓ (4)

4.2 4.2.1 The product of the net force acting on an object and the time the net force acts on the object. ✓✓
*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 4.1 / *Positiewe merk vanaf VRAAG* 4.1**

4.2.2 **OPTION/*OPSIE* 1**

$F_{net}\Delta t = m(v_f - v_i)$ ✓

$F_{net} \times 0,2$ ✓ $= 1100(0 - (-15))$ ✓

$F_{net} = 1,65 \times 10^4$ N left/*links* ✓

**OPTION/*OPSIE* 2**

$F_{net}\Delta t = m(v_f - v_i)$ ✓

$F_{net} \times 0,2$ ✓ $= 1100(0 - (15))$ ✓

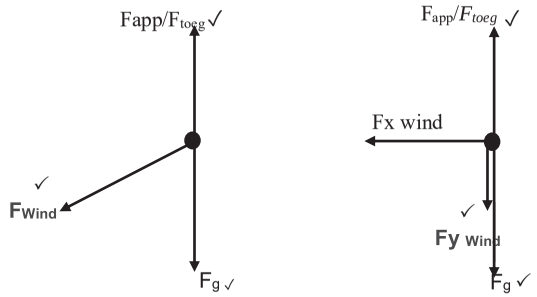
$F_{net} = -1,65 \times 10^4$

$F_{net} = 1,65 \times 10^4$ N left/*links* ✓ (4)

**[10]**

**QUESTION/*VRAAG* 5**

5.1




(3)

Mark awarded for arrow and label./*Punt toegeken vir pyl en byskrif*
Do not penalise for length of arrows since drawing is not drawn to scale/
*Moenie penaliseer vir lengte van pyle nie want skets is nie volgens skaal nie.*
Any other additional force(s)/*Enige addisonele krag(te)* $^{2}/_{3}$
If force(s) do not make contact with body./*Indien krag(te) nie kontak maak met liggaam nie* Max/*Maks.* $^{2}/_{3}$

5.2 5.2.1

**OPTION/*OPSIE* 1**

$W_{Fg} = F_g \Delta X \cos\theta$ ✓

$W_{Fg} = 245 \times 9{,}8 \times 12 \cos 180^\circ$ ✓

$W_{Fg} = -28812$ J ✓

**OPTION 2/*OPSIE* 2**

$W_{Fg} = -\Delta E_p$
$W_{Fg} = -mg(h_2 - h_1)$
Any one ✓/ *Enige een*

$W_{Fg} = -245 \times 9{,}8(12 - 0)$ ✓
$W_{Fg} = -28812$ J ✓

(3)

5.2.2 **OPTION/*OPSIE* 1**

$F_{net} = F_{windY} + F_g + F_{app}$

$F_{net} = -(1870 \cos 50^\circ) - (245 \times 9{,}8) + 3000$ ✓

$F_{net} = -603{,}01$ N

$W_{net} = F_{net} . \Delta x \cos\theta$

$W_{net} = 603{,}01 \times 12 \cos 180^\circ$ ✓

$W_{net} = -7236{,}12$ J ✓

Any one ✓/ *Enige een*

**Positive marking from QUESTION 5.2.1/**
***Positiewe merk vanaf VRAAG 5.2.1***

**OPTION/*OPSIE* 2**

$W_{nc} = \Delta E_k + \Delta E_p$
$W_F + W_{wind} = \Delta E_k + \Delta E_p$
Any one ✓/ *Enige een*

$\underline{3000 \times 12 \cos 0^\circ + 1870 \times 12 \cos 130^\circ)}$ ✓ = $\underline{28812}$ ✓ + $\Delta E_k$
$\Delta E_k = -7236{,}15$ J
$W_{net} = -7236{,}12$ J ✓





**Positive marking from QUESTION 5.2.1/**
***Positiewe merk vanaf VRAAG 5.2.1***

**OPTION/*OPSIE* 3**

$W_{net} = W_{windY} + W_{Fg} + W_{app}$ ✓
$W_{net} = \underline{(1870 \times 12 \cos 130^\circ)}$ ✓ - $\underline{28812 + (3000 \times 12 \cos 0^\circ)}$ ✓
$W_{net} = -7236{,}15$ J ✓

(4)

5.3 The net work done on an object is equal to the change in kinetic energy ✓✓
*Die netto arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie* ✓✓

(2)

5.4 $W_{net} = \Delta E_k$
$W_{net} = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2$
Any one/*Enige een* ✓

$-7236{,}15 = \frac{1}{2} \times 245 V_f^2 - \frac{1}{2} \times 245 \times 15^2$ ✓
$V_f = 12{,}88$ m.s$^{-1}$ ✓

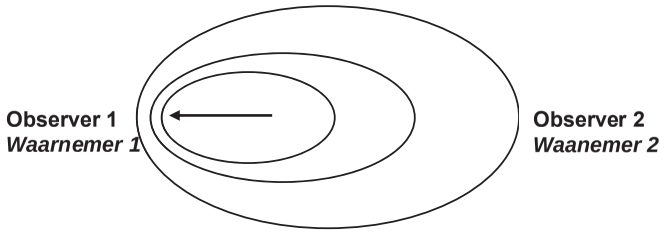
(3)
**[15]**

**QUESTION/*VRAAG* 6**

6.1 6.1.1 EQUAL TO. ✓ There is no relative motion between the observers and the source of sound. ✓
*GELYK AAN.* ✓ *Daar is geen relatiewe beweging tussen die waarnemers en die bron van die klank nie.* ✓ (2)

6.1.2 GREATER THAN / *GROTER AS* ✓ (1)

6.1.3




| Criteria/*Kriteria* | Mark/*Punt* |
|---|---|
| Wave compressed towards observer 1<br>*Golf saamgepers na waarnemer 1* | ✓ |
| Wave stretched away from observer 2<br>*Golf saamgepers weg van waarnemer 2* | ✓ |
| Direction of motion indicated<br>*Rigting van beweging aangedui* | ✓ |

(3)

6.1.4 Doppler effect / *Doppler effek* ✓ (1)

6.1.5 $f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ ✓

1730 ✓ $= \frac{340}{340-25}$ ✓ ✓ $f_S$

$f_S$ = 1602,79 Hz ✓ (5)

6.1.6 Star C, ✓ it shows a greater red shift. ✓
*Ster C,* ✓ *dit toon 'n groter rooi verskuiwing* ✓ (2)
**[14]**





**QUESTION/*VRAAG* 7**

7.1 The electrostatic force between two point charges is directly proportional to the product of the charges ✓and inversely proportional to the square of the distance between them. ✓
*Die elektrostatiese krag tussen twee puntladings is direk eweredig aan die produk van die ladings* ✓ *en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.* ✓ (2)

7.2.1 **OPTION/*OPSIE* 1**

Factor/*Faktor* = $\frac{1920}{120}$ ✓ = 16

**OR/*OF***

Factor/*Faktor* = $\frac{120}{1920} = \frac{1}{16}$

Factor decreases by 16. /*Faktor verminder met 16* ✓

Factor by which r increased/*Faktor waarmee r toeneem* = $\sqrt{16}$ = 4 ✓

X + 6 = 4X ✓

X = 2 m ✓

**OPTION/*OPSIE* 2**

F = $\frac{kQ_1Q_2}{r^2}$ ✓

1920 ✓ $= \frac{9\,x10^9\,x\,Q^2}{X^2}$ ✓

$Q^2 = \frac{1920\,x\,X^2}{9\,x\,10^9}$ . . . . . (1)

120 = $\frac{9\,x\,10^9\,x\,Q^2}{(X+6)^2}$ ✓

$Q^2 = \frac{120\,x\,(X+6)^2}{9\,x\,10^9}$ . . . . . (2)

$\frac{1920\,x\,X^2}{9\,x\,10^9} = \frac{120\,x\,(X+6)^2}{9\,x\,10^9}$

x = 2 m ✓ (5)

**Positive marking from QUESTION 7.2.1/**
***Positiewe merk vanaf VRAAG 7.2.1***

7.2.2 **OPTION/*OPSIE* 1**

F = $\frac{kQ_1Q_2}{r^2}$ ✓

1920 ✓ = $\frac{9\,x\,10^9\,x\,Q^2}{2^2}$ ✓

Q = 9,24 x$10^{-4}$ C ✓

**OPTION/*OPSIE* 2**

F = $\frac{kQ_1Q_2}{r^2}$ ✓

120 ✓ = $\frac{9\,x\,10^9\,x\,Q^2}{8^2}$ ✓

Q = 9,24 x$10^{-4}$ C ✓ (4)

**Positive marking from QUESTION 7.2.1/**
***Positiewe merk vanaf VRAAG 7.2.1***

7.3.1 $E = \frac{kQ}{r^2}$ ✓

$E_1 = \frac{9 \times 10^2 \times 9{,}24 \times 10^{-4}}{2.2^2}$ ✓

$E_1$ = 1718181,818 N.C$^{-1}$ (1,72 X 10$^6$ N.C$^{-1}$) Right/*Regs*

$E_2 = \frac{9 \times 10^2 \times 9{,}24 \times 10^{-4}}{0.2^2}$ ✓

$E_2$ = 207900000 NC$^{-1}$ (2,08 X 10$^8$ N.C$^{-1}$) Right/*Regs*

$E_{net}$ = 1718181,818 + 207900000
(1,72 X 10$^6$ N.C$^{-1}$ + 2,08 X 10$^8$ N.C$^{-1}$) ✓

$E_{net}$ = 2,10 x 10$^8$ N.C$^{-1}$ ✓ (5)

**Positive marking from QUESTION 7.3.1/**
***Positiewe merk vanaf VRAAG 7.3.1***

7.3.2 **OPTION/*OPSIE* 1**

$E = \frac{F}{q}$ ✓

2,10 x 10$^8$ = $\frac{F}{1{,}6 \times 10^{-19}}$ ✓

F = 3,36 x 10$^{-11}$ N ✓

**OPTION/*OPSIE* 2**

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{9 \times 10^9 \times 9{,}24 \times 10^{-4} \times 1{,}6 \times 10^{-19}}{2.2^2} + \frac{9 \times 10^9 \times 9{,}24 \times 10^{-4} \times 1{,}6 \times 10^{-19}}{0.2^2}$ ✓

F = 3,35 x 10$^{-11}$ N ✓ (3)

**[19]**





**QUESTION/*VRAAG* 8**

8.1.1 Diagram **A** represents **Exp 2**/*Diagram **A** verteenwoordig **Eksp 2***. ✓ (1)

8.1.2 ε = I(R+r) ✓
= 14,4 + 4,8r✓ . . . . . (1)
= 20,58 + 1,71r ✓.. . . . . .(2)
3,09 r = 6,18
∴r = 2 Ω✓ (4)

8.1.3 **OPTION/*OPSIE* 1**

ε = I(R+r)
= 4,8 x 2 + 14,4 ✓
= 24 V ✓

**OPTION/*OPSIE* 2**

ε = I(R+r)
= 1,71 x 2 + 20,5 ✓
= 24 V ✓ (2)

**Positive marking from QUESTION 8.2.1 and 8.2.2 /**
***Positiewe merk vanaf VRAAG 8.2.1 en 8.2.2***

8.1.4 **OPTION/*OPSIE* 1**

$R = \frac{V}{I}$✓

$R = \frac{20{,}58}{1{,}71}$ ✓
R = 12
R = R$_1$ + R$_2$
12 = 2R$_1$ ✓
R = 6 Ω ✓

**OPTION/*OPSIE* 2**

$R = \frac{V}{I}$ ✓
$R = \frac{14{,}4}{4{,}8}$ ✓
R = 3 Ω
$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{3} = \frac{1}{R} + \frac{1}{R}$✓ (R$_1$=R$_2$ = R)
R = 6 Ω ✓

**OPTION/*OPSIE* 3**

ε = I (R + r) ✓
24 = 4,8 (R + 2) ✓
R = 3 Ω
$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{3} = \frac{1}{R} + \frac{1}{R}$✓ (R$_1$ = R$_2$ = R)
R = 6 Ω ✓

**OPTION/*OPSIE* 4**

ε = I (R + r) ✓
24 = 1,71(R + 2) ✓
R = 12,04 Ω
R = R$_1$ + R$_2$
12,04 = 2R✓
R = 6,02 Ω ✓

(4)

8.1.5 **OPTION/*OPSIE* 1**

DECREASE, ✓ total external resistance will increase, the current will decrease ✓
$P \propto I^2$ ✓ therefore power decreases.
*AFNEEM, totale eksterne weerstand sal afneem, die stroom sal afneem*
*$P \propto I^2$ ✓ dus sal drywing verminder.*

**OPTION/*OPSIE* 2**

DECREASE, ✓ total external resistance will increase, the current will decrease, the lost volt will decrease. ✓
$P \propto V_{lost}^2$ ✓ therefore power decreases.
*AFNEEM, totale eksterne weerstand sal afneem, die stroom sal afneem, die verlore volt sal verminder.*
$P \propto V_{verlore}^2$ ✓ *dus sal drywing verminder.* (3)

8.2 $P = I^2R$ ✓

$P = 16^5 \times 52$ ✓

$P = 13\,312$ W

kWh = 13,312 x 6

kWh = 79,872

Cost/*Koste* = 79,872 x 1,20 ✓

= R95,85 ✓ (4)

**[18]**





**QUESTION/*VRAAG* 9**

9.1 9.1.1 Mechanical energy to Electrical energy. ✓✓
*Meganiese energie na Elektriese energie* (2)

9.1.2 P to Q. / *P na Q* ✓ (1)

9.2 9.2.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $V_{wgk} = \frac{Vmaks}{\sqrt{2}}$ ✓

✓ $230 = \frac{V_{max}}{\sqrt{2}}$

$V_{max}/_{maks}$ = 325,27 V ✓ (3)

9.2.2 $\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_{//}} = \frac{1}{12} + \frac{1}{24}$ ✓

$R_{//} = 8\ \Omega$

**OPTION/*OPSIE* 1**

$P_{average} = \frac{V^2_{rms}}{R}$ ✓ / $P_{gem} = V^2_{wgk}/R$

$P_{average} = \frac{(230)^2}{8}$ ✓

$P_{average}$ / $P_{gem}$ = 6612,5 W (6,61 kW) ✓ (5)

**OPTION/*OPSIE* 2**

$I_{rms} = \frac{V_{rms}}{R}$ / $I_{wgk} = \frac{Vwgk}{R}$

$V_{rms} = I_{rms}R$

✓Any one/ *Enige een*

$I_{rms} = \frac{230}{8}$

= 28,75 A

$P_{avg} = V_{rms}.I_{rms}$ ✓/$P_{gem} = V_{wgk}.I_{wgk}$

= (230)(28,75) ✓

= 6612,5 W (6,61 kW) ✓

**OPTION/*OPSIE* 3**

$I_{rms} = \frac{V_{rms}}{R}$

$V_{rms} = I_{rms}R$

✓ Any one/ *Enige een*

$I_{rms} = \frac{230}{8}$

= 28,75 A

$P_{average} = I^2_{rms}R$ / $P_{gem} = I^2_{wgk}.R$

$= (28,75)^2(8)$ ✓

= 6612,5 W (6,61 kW) ✓

(5)

**[11]**

**QUESTION/*VRAAG* 10**

10.1 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 (oppervlakte)* ✓✓ (2)

10.2 $W_o = 3,51 \times 10^{-19}$ J ✓ (1)

10.3 EQUAL to ✓ The gradient is Plank's constant. ✓
*GELYK AAN* ✓ *Die gradiënt (helling) is Plank se konstante* ✓ (2)

**Positive marking from QUESTION 10.1.2/**
***Positiewe merk vanaf VRAAG 10.1.2***

10.4 $W_o = hf_o$ ✓
$3,51 \times 10^{-19} = 6,63 \times 10^{-34} f_o$ ✓
$f_o = 5,29 \times 10^{14}$ Hz ✓ (3)

**Positive marking from QUESTION 10.1.2/**
***Positiewe merk vanaf VRAAG 10.1.2***

10.5 $E = W_o + E_k$
$\frac{hc}{\lambda} = W_o + \frac{1}{2} mv^2$ ] Any one ✓/ *Enige een*

$\frac{6,63x\ 10^{-34}\ x\ 3\ 10^{8}}{\lambda}$ ✓ = $3,51 \times 10^{-19}$ ✓ + $\frac{1}{2} \times 3,83 \times 10^{-19}$ ✓

$\lambda = 2,71 \times 10^{-7}$m ✓ (5)
**[13]**

**TOTAL/*TOTAAL*: 150**

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**GRADE/*GRAAD* 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**
***FISIESE WETENSKAPPE: FISIKA (V1)***

**FEBRUARY/MARCH/*FEBRUARIE/MAART* 2018**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 13 pages.**
***Hierdie nasienriglyne bestaan uit 13 bladsye.***

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## QUESTION 1/*VRAAG 1*

| | | |
|---|---|---|
| 1.1 | A✓✓ | (2) |
| 1.2 | B✓✓ | (2) |
| 1.3 | C✓✓ | (2) |
| 1.4 | B✓✓ | (2) |
| 1.5 | A✓✓ | (2) |
| 1.6 | B✓✓ | (2) |
| 1.7 | C✓✓ | (2) |
| 1.8 | C✓✓ | (2) |
| 1.9 | D✓✓ | (2) |
| 1.10 | B✓✓ | (2) |
| | | **[20]** |



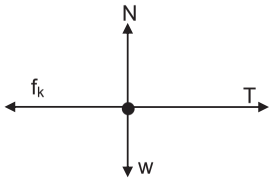


## QUESTION 2/*VRAAG 2*

2.1. A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force acts on it. ✓✓
*'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid in 'n reguitlyn volhard tensy 'n nie-nul resulterende/netto krag daarop inwerk.* (2)

2.2

| **Accepted labels/*Aanvaarde benoemings*** | |
|---|---|
| w | $F_g$ / $F_w$/weight / mg / gravitation force<br>*$F_g$ / $F_w$ / gewig / mg / gravitasiekrag* |
| T | $F_T$/tension<br>$F_s$/*spanning* |
| $f_k$ | (Kinetic) Friction / $F_f$ / 4 N / f / *wrywing* / $F_w$ |
| N | $F_{Normal}$ / Normal / $F_N$ |




(4)

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 force(s) do not make contact with body/*Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{3}{4}$

2. 3 Object Q/*Voorwerp Q*

$F_{net} = ma$
$F_{net} = 0$ } ✓
$T + (f_k) = ma$
$T - 3$ ✓ $= 0$ ✓
$T = 3$ N

Object P/*Voorwerp Q*
$F_{net} = ma$
$F_{hor} - (f_k + T) = ma$✓
$(F\cos 30^o) - 5 - 3 = 0$ ✓
$F = 9{,}24$ N✓ (9,238 N) (6)

2.4 3 s✓ (1)

2.5 **Y**✓
Graph **Y** represents the motion of Q after the string breaks.
The graph Y shows a decreasing velocity ✓with a negative acceleration. ✓
This is because the net force (friction) acting on Q is in the opposite direction to its motion, ✓ (accept: only frictional force acts on Q).

*Grafiek Y verteenwoordig die beweging van Q na die toutjie breek*
*Die versnelling is negatief vir grafiek Y en toon 'n afnemende snelheid*
*Dit is omdat wrywing op Q inwerk* (4)
**[17]**

**QUESTION 3/*VRAAG 3***

3.1 10 m·s$^{-1}$✓ (1)

3.2 The gradient represents the acceleration due to gravity *(g) which is constant* for free fall. ✓
*Die helling verteenwordig die versnelling as gevolg van gravitasie (g) wat konstant vir vry-val is.*

[The graphs represent free fall/*Die grafieke verteenwoordig vryval*] (1)

3.3.1

| **POSITIVE MARKING FROM QUESTION 3.1**<br>***POSITIEWE NASIEN VANAF VRAAG 3.1*** | |
|---|---|
| **OPTION 1/*OPSIE 1*** | |
| $\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$= (10)(2) + ½ (9,8)(2^2)$ ✓<br>$= 39,6$ m<br>Height/*Hoogte*= 39,6 m ✓ | $\Delta y = v_i\Delta t + ½ a\Delta t^2$✓<br>$= (-10)(2) + ½ (-9,8)(2^2)$ ✓<br>$= -39,6$ m<br>Height/*Hoogte* = 39,6 m ✓ |
| **OPTION 2/*OPSIE 2*** | **OPTION 3/*OPSIE 3*** |
| $\Delta x = \frac{(v_i + v_f)}{2}\Delta t$ ✓<br>$\Delta x = \left(\frac{10 + 29,6}{2}\right)(2)$ ✓<br>$\Delta x = 39,6\ m$ ✓ | $v_f^2 = v_i^2 + 2a\Delta x$ ✓<br>$(29,6)^2 = (10)^2 + 2(9,8)a\Delta x$ ✓<br>$\Delta x = 39,6\ m$ ✓ |
| **OPTION 4/*OPSIE 4*** | |
| Height = Area under the graph<br>*Hoogte = Area onder die grafiek* } Any one/*Enige een*✓<br>=Area of/*van* ☐+Area of/*van* △<br>= (10)(2)+(½)(2)(19,6) ✓<br>= 39,6 m ✓ | |
| **OPTION 5/*OPSIE 5*** | |
| Height = Area of trapezium = *Hoogte = Area van trapesium* ✓<br>= ½ (10 +29,6) x 2 ✓= 39,6 m ✓ | |

(3)





3.3.2

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $v_f = v_i + a\Delta t$✓<br>$0 = -25 + (9,8)(\Delta t)$ ✓<br>$\Delta t = 2,55$ s<br>Total time T/*Totale tyd* = 8 +2,55 ✓<br>= 10,55 s✓ | $v_f = v_i + a\Delta t$✓<br>$0 = 25 + (-9,8)(\Delta t)$ ✓<br>$\Delta t = 2,55$ s<br>Total time T/*Totale tyd* = 8 +2,55 ✓<br>= 10,55 s✓ |
| **OPTION 3/*OPSIE 3*** | **OPTION 4/*OPSIE 4*** |
| $v_f^2 = v_i^2 + 2a\Delta x$<br>✓<br>$\Delta x = 31,89\ m$<br>$\Delta x = \frac{(v_i + v_f)}{2}\Delta t$<br>$31,89 = \left(\frac{25 + 0}{2}\right)\Delta t$ ✓<br>$\Delta t = 2,55\ s$<br>Total time T/*Totale tyd* = 8 +2,55 ✓<br>= 10,55 s✓ | $E_{Mi} = E_{Mf}$<br>$W_{nc} = 0$<br>$W_{net} = \Delta E_K$<br>$W_{con} = \Delta E_K$<br>$\Delta E_K + \Delta E_P = 0$<br>$E_{Ki} + E_{Pi} = E_{Kf} + E_{Pf}$ ✓<br>$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$<br>$\frac{1}{2}(25)^2 + 0 = 0 + 9,8h_f$<br>$\Delta x = 31,89\ m$<br>$\Delta x = \frac{(v_i + v_f)}{2}\Delta t$<br>$31,89 = \left(\frac{25 + 0}{2}\right)\Delta t$ ✓<br>$\Delta t = 2,55\ s$<br>Total time T/*Totale tyd* = 8 +2,55 ✓<br>= 10,55 s✓ |
| **OPTION 5/*OPSIE 5*** | |
| Slope of graph = 9,8 ✓<br>$= \frac{0 - (-25)}{T - 8}$ ✓ ✓<br>Total time T/*Totale tyd*<br>= 10,55 s ✓ | If values of $v_i$ and $v_f$ are swopped around,and a negative time is obtained, give 1 mark for formula and 1 mark for adding calculated time to 8 s, (max 2/4). |

(4)

3.4.1 0,2 s✓ (1)

3.4.2 4,955 s✓✓ (2)

3.4.3 - 27 (m·s$^{-1}$) ✓[Must include the negative/*Moet negatief insluit*] (1)

3.5 Inelastic./*Onelasties*✓
The speeds at which it strikes and leaves the ground are not the same/The kinetic energies will not be the same ✓
*Die spoed waarmee dit die grond tref en die grond verlaat is nie dieselfde nie./Die kinetiese energieë sal nie dieselfde wees nie* (2)
**[16]**

## QUESTION 4/*VRAAG 4*

4.1 The total linear momentum of a closed (isolated) system remains constant (is conserved). ✓✓
*Die totale lineêre momentum in 'n geslote sisteem bly konstant (bly behoue)*

**OR/*OF***
In an isolated system, the total linear momentum before collision is equal to the total linear momentum after collision ✓✓
*In 'n geïsoleerde sisteem is die totale lineêre momentum voor botsing gelyk aan die totale lineêre momentum na botsing.*
*(If key words isolated and total missing -1 mark for each.)* (2)

4.2 $\Sigma p_i = \Sigma p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ } Any one/ *Enige een* ✓

For the system cat-skate board **A**/*Vir die sisteem kat-skaatsplank*
$\underline{(3,5)(0) + (2,6)(0)}$ ✓ = $\underline{(3,5)v_{skateboard/skaatsplank} + (2,6)(3)}$ ✓

$v_{skateboard/skaatsplank}$ = 2,23 m·s$^{-1}$✓ to the left/*na links*✓

**ACCEPT/AANVAAR** v = -2,23 m·s$^{-1}$✓✓ (5)

4.3 $F_{net}\,\Delta t = \Delta p = mv_f - mv_i$✓
= (3,5)(1,28 - 0) ✓
= 4,48 N·s (4,48 kg·ms$^{-1}$) ✓

**OR/*OF***
$F_{net}\,\Delta t = \Delta p = mv_f - mv_i$✓
= (2,6)(1,28 - 3) ✓
= -4,48 N·s (4,48 kg·ms$^{-1}$)
∴ Δp = 4,48 N·s✓ (3)
**[10]**





## QUESTION 5/*VRAAG 5*

5.1 The total mechanical energy/sum of kinetic and gravitational potential energy in a closed/isolated system is constant (conserved).✓✓
*Die totale meganiese energie/some van kinetiese en gravitasionele potensiële energie in 'n geslote sisteem bly behoue.*
*(If key words isolated and total missing -1 mark for each.)* (2)

5.2 $E_{MECH\,P} = E_{MECH\,Q}$
$(E_P + E_K)_P = (E_P + E_K)_Q$
$W_{net} = \Delta E_K$
$W_{con} = \Delta E_K$
$\Delta E_K + \Delta E_p = 0$
} ✓1 mark for any of the three/ *1 punt vir enige van die drie*

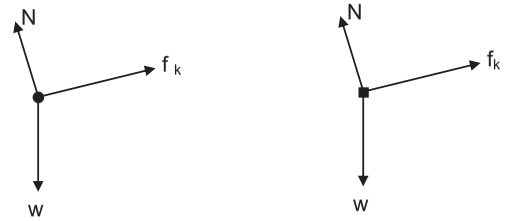
$(mgh + \frac{1}{2}mv^2)_P = (mgh + \frac{1}{2}mv^2)_Q$
50 (9,8)(3) + 0 ✓= 0 + ½ (50)v$^2$✓

v = 7,67 m·s$^{-1}$ ✓ (7,668 m·s$^{-1}$ ) (4)

5.3

| Accepted labels/*Aanvaarde benoemings* | | |
|---|---|---|
| w | $F_g$ / $F_w$ / weight / mg / gravitational force<br>*$F_g$/ $F_w$/ gewig / mg / gravitasiekrag* | ✓ |
| N | $F_N$ | ✓ |
| $f_k$ | $F_f$/friction/f | ✓ |

(3)




**Notes/*Aantekeninge***
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- Any other additional force(s)/*Enige ander addisionele krag(te) Max/Maks* $\frac{2}{3}$
- If force(s) do not make contact with body/*Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{2}{3}$

5.4 $f_k = \mu_k N$
$= \mu_k (mg\cos\theta)$ } ✓ Any one/*Enige een*
= 0,08 (50 x 9,8) cos 30°✓
= 33,95 (33, 948) N ✓ (3)

**NOTE/*LET WEL*:**
**IN ALL THE OPTIONS FOR QUESTION 5.5 BELOW, ACCEPT THE SUBSTITUTION:/*IN AL DIE OPSIES VIR VRAAG 5.5 HIERONDER, AANVAAR DIE VERVANGING***
**5 cos 60° IN PLACE OF/*IN PLAAS VAN* 5 sin 30°**

5.5

**OPTION 1/*OPSIE 1***
**POSITIVE MARKING FROM QUESTION 5.4/*POSITIEWE NASIEN VANAF VRAAG 5.4***

$W = F_{net}\Delta x \cos\theta$

$W_{net} = W_f + W_w + W_N$
$W_{net} = W_f + (-\Delta E_P) + W_N$
$W_{net} = f_k \Delta x \cos 180° + mg\sin\theta \Delta x\cos 0 + 0$

$W_{net} = \Delta E_K/\Delta K$

✓1 mark for any one/
*1 punt vir enige van die drie*

$W_{net} = [33,948)(5)(-1)]$ ✓ $+ [(50)(9,8)(5)\sin 30° + 0]$✓
$= 1055, 26\ (1055,259)$
$1055,259 = ½ (50)(v_f^2 - 7,668^2)$ ✓
$v_f = 10,05\ m\cdot s^{-1}$✓

**OPTION 2/*OPSIE 2***
**POSITIVE MARKING FROM QUESTION 5.2/*POSITIEWE NASIEN VANAF VRAAG 5.3***

$W_{nc} = \Delta E_p + \Delta E_k$
$f\Delta x\cos\theta = (mgh_f - mgh_i) + (½ mv_f^2 - ½ mv_i^2)$

1 mark for any of the two/
*1 punt vir enige van die twee*

$\mu mg\Delta x \cos 180° = [0 - (mg\Delta x \sin 30°] + ½ m(v_f^2 - v_i^2)$
$[33,948)(5)(-1)]$ ✓$= [0 - 50(9,8)(5)\sin 30°]$✓ $+ ½ (50)(v_f^2 - 7,668^2)$✓
$v_f = 10,05\ m\cdot s^{-1}$✓

**OPTION 3/*OPSIE***
**POSITIVE MARKING FROM QUESTION 5.2 AND 5.4/*POSITIEWE NASIEN VANAF VRAAG 5.2 EN 5.4***

$W_{nc} = \Delta E_p + \Delta E_k$
$f\Delta x\cos\theta = (mgh_f - mgh_i) + (½ mv_f^2 - ½ mv_i^2)$

1 mark for any of the two/
*1 punt vir enige van die twee*

$(33,95)(5)\cos 180$ ✓$= [(50)(9,8)\{0 - 5\sin 30°\}]$✓ $+ ½ (50)(v_f^2 - 7,668^2)$ ✓
$v_f = 10,05\ m\cdot s^{-1}$✓

(5)
**[17]**





**QUESTION 6/*VRAAG 6***

6.1 An (apparent) change in the observed frequency (pitch), (wavelength) ✓as a result of the relative motion between a source and an observer ✓(listener).
*'n (Waarskynlike) verandering in die waargenome frekwensie (toonhoogte) (golflengte) aas gevolg van die relatiewe beweging tussen bron en waarnemer (luisteraar)* (2)

6.2 Towards A./*Na A*✓
Recorded frequency higher./*Aangetekende frekwensie is hoër*✓ (2)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

**FOR A/*VIR A***

$690 = \left(\frac{340}{340 - v_s}\right) f_s$ ✓ ✓ (1)

**FOR B/*VIR B*:**

$610 = \left(\frac{340}{340 + v_s}\right) f_s$ ✓ ✓ (2)

$\frac{690}{610} = \frac{340 + v_s}{340 - v_s}$

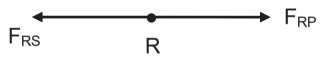
$1,131\ (340 - v_s) = 340 + v_s$
$v_s = 20,90\ m.s^{-1}$✓ (20.90 to 20.92 $m.s^{-1}$) (6)

6.4 **ANY ONE/*ENIGE EEN***
Doppler flow meter/*Doppler-vloeimeter* ✓
Measuring foetal heartbeat/*Meet van fetale hartslag*
*Measure speed of blood flow*
Ultra sound/*Ultraklank*
Sonar
Radar (for speeding/*vir jaag*) (1)
**[11]**

## QUESTION 7/*VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge 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 uitgeoefen deur een puntlading op 'n ander puntlading is direk eweredig aan die produk (van die groottes) van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle* (2)

7.2




**NOTE/*LET WEL*:** (2)
One mark for each force, correctly shown./*Een punt vir elke krag korrek getoon.*

7.3 Taking right as positive/*Neem regs as positief*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{netR} = F_{PR} + F_{SR}$

$F_{net} = \frac{kQ_1Q_2}{r^2} + \frac{kQ_1Q_2}{r^2}$

$-1{,}27\times10^{-6} = \left\{\frac{(9\times10^9)(1{,}5\times10^{-9})(Q)}{(0{,}3)^2} - \frac{(9\times10^9)(2\times10^{-9})(Q)}{(0{,}2)^2}\right\}$ ✓ ✓ ✓ ✓

$-1{,}27\times10^{-6} = 150Q - 450Q$ (for subtraction/*vir aftrekking*)

$Q = 4{,}23\times10^{-9}$ C✓ (7)

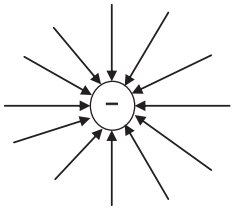
Accept answers where left is taken as positive. **[11]**





## QUESTION 8/*VRAAG 8*

8.1




Shape (radial)/*Vorm (radiaal)*✓
Polarity (sign) of A/*Polariteit (Teken) van A*✓
Do not penalize for incorrect direction/*Moet nie penaliseer vir verkeerde rigting nie*

(2)

8.2 $E = \frac{kQ}{r^2}$ ✓

$3\times10^7 = \frac{(9\times10^9)(Q)}{(0{,}5)^2}$

$Q = 8{,}33\times10^{-4}$ C✓ (3)

8.3 $Q = ne$✓

$= (10^5)(1{,}6\times10^{-19})$ ✓

$= 1{,}6\times10^{-14}$ C

$E = \frac{F}{Q}$ ✓

$3\times10^7 = \frac{F}{1{,}6\times10^{-14}}$ ✓

$F = 4{,}8\times10^{-7}$ N✓ Right/*Regs*✓

**(Positive marking from 8.2 for this option)**

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F = (9\times10^9)\frac{(8{,}33\times10^{-4})(1{,}6\times10^{-14})}{(0{,}5)^2}$ ✓

$= 4{,}8\times10^{-7}$ N✓ Right/*Regs*✓

(6)
**[11]**

**QUESTION 9/*VRAAG 9***

9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.✓✓.
*Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.*

**OR/*OF***
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature. ✓✓
*Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor die geleier by konstante temperatuur* (2)

9.1.2 Graph X./*Grafiek X*✓
Graph X is a straight line (passing through the origin) therefore potential difference is directly proportional to current. ✓
*/Grafiek X is lineêr*
(2)

9.2.1

$$\frac{1}{R_{//}} = \frac{1}{R_{10}} + \frac{1}{R_{15}}$$

$$\frac{1}{R_{//}} = \frac{1}{10} + \frac{1}{15} ✓$$

$R_{//} = 6\ \Omega$

$$R_{//} = \frac{R_{10} \times R_{15}}{R_{10} + R_{15}}$$

$$R_{//} = \frac{10 \times 15}{25} ✓$$

$= 6\ \Omega$

$\therefore R = (10 + 6 + 2)$✓(for the addition/*vir optelling*)
$= 18\ \Omega$

$R_{ext} = (10 + 6) = 16\ \Omega$
$\varepsilon = I(R + r)$
$6 = I(16 + 2)$✓
$I = 0{,}33\ A$✓

$R = \frac{V}{I}$ ✓

$I = \frac{6}{18}$ ✓
$= 0{,}33\ A$✓ (5)

9.2.2 Decrease. ✓
The total resistance of the circuit increases✓.
*Afneem*
*Die totale weerstand van die stroombaan neem toe.* (2)

9.2.3 Increase/*Neem toe* ✓ (1)





9.2.4 The total resistance in the external circuit increases./*Die totale weerstand in die eksterne stroombaan neem toe*✓
Current decreases/*Stroom neem af*✓
"Lost" volts decreases/*"Verlore" volts neem af*✓

**OR/*OF***

The total resistance in the external circuit increases./*Die totale weerstand in die eksterne stroombaan neem toe* ✓
V α R✓ for constant/*vir konstante* I✓
Therefore V increases./*Dus neem V toe* (3)
**[15]**

**QUESTION 10/*VRAAG10***

10.1 **ANY THREE/*ENIGE DRIE***
I. Permanent magnets/*Permanente magnete*
II. coils (armature)/*spoel*
III. commutator/*kommutator*
IV. brushes/*borsels*
V. power supply/battery/*kragbron* (3)

10.2.1 The rms voltage of AC is the potential difference which dissipates the same amount of energy as the equivalent DC potential difference. ✓✓
*Die wgk spanning/potensiaalverskil van WS is die potensiaalverskil wat dieselfde aantal energie verkwis as GS.*
*Accept formula for $V_{rms}$ as 1 mark.* (2)

10.2.2 **OPTION 1/*OPSIE 1***

$V_{rms} = I_{rms}R$ ✓

$I_{rms} = \frac{V_{rms}}{R}$

$I_{rms} = \frac{240}{11}$ ✓
$= 21{,}82\ A$

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

$I_{max} = (21{,}82)\sqrt{2}$ ✓
$I_{max} = 30{,}86\ A$✓

**OPTION 2/*OPSIE 2***

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = (240)\sqrt{2}$ ✓
$= 339{,}41$

$V_{max} = I_{max}R$

$I_{max} = \frac{339{,}41}{11}$ ✓

$I_{max} = 30{,}86\ A$✓

**OPTION 3/*OPSIE 3***

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$P_{ave} = \frac{(240)^2}{11}$ ✓

$P_{ave} = 5236{,}36\ W$

$P_{ave} = I_{rms}V_{rms}$

$5236{,}36 = I_{rms}240$

$I_{rms} = 21{,}82\ A$

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

$21{,}82 = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{max} = 30{,}86\ A$ ✓

$P_{ave} = \frac{I_{max}V_{max}}{2}$

$P_{ave} = \frac{I_{max}V_{rms}\sqrt{2}}{2}$

$5236{,}36 = \frac{I_{max}(240)\sqrt{2}}{2}$ ✓

$I_{max} = 30{,}86\ A$ ✓

(4)
**[9]**

**QUESTION 11/*VRAAG 11***

11.1.1 Greater than/*Groter as*✓

Electrons are ejected from the metal plate./*Elektrone word vrygestel vanaf die metaalplaat* ✓ Accept: a current is registered on the ammeter. (2)

11.1.2 Increase in intensity means that (for the same frequency) the number of photons per second increases (ammeter reading increases)✓but the energy of the photons stays the same ✓(Therefore the statement is incorrect).
OR
An increase in the energy of the photons only increases the kinetic energy of the photoelectrons and not the number of photoelectrons, thus the ammeter reading will not change.
*Toename in intensiteit beteken dat (vir dieselfde frekwensie) die aantal fotone neem toe (ammeterlesing neem toe) maar die energie van die fotone bly dieselfde. (Dus is die stelling verkeerd)* (2)

11.1.3 Light has a particle nature/*Lig het 'n deeltjieaard*
Accept light energy is quantized/*Aanvaar ligenergie is gekwantiseer*✓ (1)

11.2.1 The minimum frequency needed for the emission of electrons (from a metal surface).
*Die minimum energie benodig vir die vrystelling van elektrone (vanaf die metaaloppervlak)* (2)

11.2.2 $W_0 = hf_0$ ✓
$= (6{,}63 \times 10^{-34})(5{,}73 \times 10^{14})$✓
$= 3{,}8 \times 10^{-19}$ J✓ [$3{,}799 \times 10^{-19}$ J] (3)

11.2.3 **POSITIVE MARKING FROM QUESTION 11.2.2**
***POSITIEWE NASIE VANAF VRAAG 11.2.2***
**OPTION 1/*OPSIE 1***

$E = W_0 + E_{k(max/maks)}$
$hf = hf_0 + E_{k(max/maks)}$
$hf = hf_0 + ½ mv^2$
$E = W_0 + ½ mv^2$
✓ Any one/*Enige een*

$(6{,}63 \times 10^{-34})f = 3{,}8 \times 10^{-19} + [½(9{,}11 \times 10^{-31})(4{,}19 \times 10^5)^2]$✓
$f = 6{,}94 \times 10^{14}$ Hz✓ [$7 \times 10^{14}$ Hz]

**OPTION 2/*OPSIE 2***

$E = W_0 + E_{k(max/maks)}$
$hf = hf_0 + E_{k(max/maks)}$
$hf = hf_0 + ½ mv^2$
$E = W_0 + ½ mv^2$
✓ Any one/*Enige een*

$E = 3{,}8 \times 10^{-19} + [½(9{,}11 \times 10^{-31})(4{,}19 \times 10^5)^2]$✓
$hf = 4{,}599 \times 10^{-19}$
$(6{,}63 \times 10^{-34})f = 4{,}599 \times 10^{-19}$
$f = 6{,}94 \times 10^{14}$ Hz✓ [$7 \times 10^{14}$ Hz] (3)

**[13]**

**TOTAL/*TOTAAL*: 150**

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**GRADE/*GRAAD* 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**
***FISIESE WETENSKAPPE: FISIKA (V1)***

**NOVEMBER 2017**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 20pages.**
***Hierdie nasienriglyne bestaan uit 20 bladsye.***

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## QUESTION 1 / *VRAAG 1*

| | | |
|---|---|---|
| 1.1 | B ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | A✓✓ | (2) |
| 1.4 | C✓✓ | (2) |
| 1.5 | B✓✓ | (2) |
| 1.6 | A✓✓ | (2) |
| 1.7 | D✓✓ | (2) |
| 1.8 | B✓✓ | (2) |
| 1.9 | C✓✓ | (2) |
| 1.10 | D✓✓ | (2) |
| | | **[20]** |



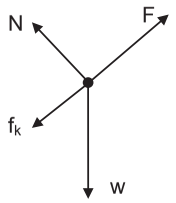


## QUESTION 2 / *VRAAG 2*

2.1.1 An object continues in its state of rest or uniform motion (moving with constant velocity) unless it is acted upon by an unbalanced (resultant/net) force.✓✓
**OR**
A body will remain in its state of rest or motion at constant velocity unless a resultant/net force acts on it.✓✓
**OR**
A body will remain in its state of rest or of uniform motion in a straight line at constant velocity/speed unless a non-zero resultant/net force acts on it.✓✓

*'n Liggaam sal in sy toestand van rus of uniforme beweging (teen konstante snelheid) volhard tensy 'n ongebalanseerde (resulterende/netto) krag daarop inwerk.*
***OF***
*'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid bly tensy 'n resulterende/netto krag daarop inwerk*
***OF***
*'n Liggaam sal in sy toestand van rus of uniforme beweging in 'n reguitlyn teen konstante snelheid/spoed volhard tensy 'n nie-nul resulterende/netto krag daarop inwerk.* (2)

2.1.3




| Accepted Labels/*Aanvaarde benoemings* | |
|---|---|
| w | $F_g$ / $F_w$/weight/mg /78,4 N/gravitational force<br>*$F_g$ / $F_w$ /gewig/mg/78,4 N/gravitasiekrag* |
| F | $F_{app}$/$F_A$ / applied force (Accept T / tension)<br>$F_{toegepas}$/ $F_T$ / toegepaste krag *(Aanvaar T / spanning)* |
| $f_k$ | (kinetic) Friction/$F_f$/f/*(kineties) wrywing*/$F_w$ |
| N | $F_N$/Normal (force)/*Normaal(krag)*/ 67,9 N |

(4)

2.1.3

$F_{net} = ma$ ✓
$F_{net} = 0$
$F + (-f_k) + (-F_{g\parallel}) = ma$
$F - (f_k + F_{g\parallel}) = ma$
$F - 20{,}37$ ✓ $- (8)(9{,}8)\sin 30^{\circ}$ ✓ $= 0$
$F = 59{,}57$ N ✓ (5)

2.1.4

| OPTION 1/*OPSIE 1* | OPTION 2/*OPSIE 2* |
|---|---|
| $F_{net} = ma$<br>$(F_{g\parallel} - f_k) = ma$ ✓<br>$(8)(9{,}8)\sin 30^{\circ} - 20{,}37$ ✓ $= 8a$ ✓<br>∴magnitude/*grootte:* $a = 2{,}35\ m\cdot s^{-2}$ ✓ | $F_{net} = ma$<br>$(f_k - F_{g\parallel}) = ma$ ✓<br>$20{,}37 + [-(8)(9{,}8)\sin 30^{\circ}]$ ✓ $= 8a$ ✓<br>∴$a = -2{,}35\ m\cdot s^{-2}$<br>∴ magnitude/*grootte:* $a = 2{,}35\ m\cdot s^{-2}$ ✓ |

(4)

2.2.1

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. ✓
*Elke liggaam in die heelal trek elke ander liggaam aan met 'n krag wat direk eweredig is aan die produk van hul massas en omgekeerd eweredig is aan die kwadraat van die afstand tussen hul middelpunte.*

**OR/*OF***
Every particle in the universe attracts every other particle with a force along a line joining them. The force is directly proportional to the product of the masses ✓ of the particles and inversely proportional to the square of the distance between them. ✓
*Elke partikel in die heelal trek elke ander partikel aan met 'n krag wat direk eweredig is aan die produk van hul massas en omgekeerd eweredig is aan die kwadraat van die afstand tussen hulle.* (2)

2.2.2

| OPTION 1/*OPSIE 1* | OPTION 2/*OPSIE 2* |
|---|---|
| $g = \frac{GM}{r^2}$ ✓<br>✓ $6 = \frac{(6{,}67 \times 10^{-11})M}{(700 \times 10^3)^2}$ ✓<br>$M = 4{,}41 \times 10^{22}$ kg ✓ | $F = G\frac{m_1m_2}{r^2}$<br>$mg = \frac{GmM}{r^2}$ ✓<br>✓ $(200)(6) = \frac{(6{,}67 \times 10^{-11})(200)M}{(700 \times 10^3)^2}$ ✓<br>$M = 4{,}41 \times 10^{22}$ kg ✓ |

(4)
**[21]**





## QUESTION 3 / *VRAAG 3*

3.1

**OPTION 1/*OPSIE 1***

| Upwards positive<br>*Opwaarts positief:* | Downwards positive<br>*Afwaarts positief:* |
|---|---|
| $v_f = v_i + a\Delta t$ ✓<br>$0 = (12) + (-9{,}8)(\Delta t)$ ✓<br>$\Delta t = 1{,}22$ s ✓ | $v_f = v_i + a\Delta t$ ✓<br>$0 = (-12) + (9{,}8)(\Delta t)$ ✓<br>$\Delta t = 1{,}22$ s ✓ |

**OPTION 2/*OPSIE 2***

| Upwards positive<br>*Opwaarts positief:* | Downwards positive<br>*Afwaarts positief:* |
|---|---|
| $v_f^2 = v_i^2 + 2a\Delta y$<br>$0 = 12^2 + 2(-9{,}8)\Delta y$ ✓<br>$\Delta y = 7{,}35$<br>$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓<br>$7{,}35 = 12\Delta t + ½\ (-9{,}8)\Delta t^2$<br>$\Delta t = 1{,}22$ s ✓ | $v_f^2 = v_i^2 + 2a\Delta y$<br>$0 = (-12)^2 + 2(9{,}8)\Delta y$ ✓<br>$\Delta y = -7{,}35$<br>$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓<br>$-7{,}35 = -12\Delta t + ½\ (9{,}8)\ \Delta t^2$<br>$\Delta t = 1{,}22$ s ✓ |

**OPTION 3/*OPSIE 3***

| Upwards positive<br>*Opwaarts positief:* | Downwards positive<br>*Afwaarts positief:* |
|---|---|
| $v_f^2 = v_i^2 + 2a\Delta y$<br>$0 = 12^2 + 2(-9{,}8)\Delta y$ ✓<br>$\Delta y = 7{,}35$ m<br>$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓<br>$7{,}35 = \frac{(12+0)}{2}\Delta t$<br>$\Delta t = 1{,}22$ s ✓ | $v_f^2 = v_i^2 + 2a\Delta y$<br>$0 = (-12)^2 + 2(9{,}8)\Delta y$ ✓<br>$\Delta y = -7{,}35$ m<br>$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓<br>$-7{,}35 = \frac{(-12+0)}{2}\Delta t$<br>$\Delta t = 1{,}22$ s ✓ |

**OPTION 4/*OPSIE 4***

$(E_{mech})_A = (E_{mech})_{top}$
$(½\ mv^2 + mgh)_A = (½\ mv^2 + mgh)_{top}$
$½m(12)^2 + 0 = 0 + m(9{,}8)(h)$ ✓
∴$h = \Delta y = 7{,}35$ m

**OR/OF**
$W_{net} = \Delta E_k$
$F_{net}\Delta y\cos\theta = ½\ m(v_f^2 - v_i^2)$
$m(9{,}8)\Delta y\cos 180^{\circ} = ½\ m(0^2 - (12)^2)$ ✓
$\Delta y = 7{,}35$ m

**OR/*OF***
$\Delta E_p + \Delta E_k = 0$
$mg(h_f - h_i) + ½\ m(v_f^2 - v_i^2) = 0$
$m(9{,}8)(h - 0) + ½(m)(0 - 12^2) = 0$ ✓
∴$h = \Delta y = 7{,}35$ m

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$7{,}35 = \frac{(12+0)}{2}\Delta t$
$\Delta t = 1{,}22$ s ✓

| OPTION 5/*OPSIE 5* | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief:***<br>$F_{net}\Delta t = m(v_f - v_i)$ ✓<br>$mg\Delta t = m(v_f - v_i)$<br>$(-9,8)\Delta t = (0 - 12)$ ✓<br>$\Delta t = 1,2245$ s ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>$F_{net}\Delta t = m(v_f - v_i)$ ✓<br>$mg\Delta t = m(v_f - v_i)$<br>$(9,8)\Delta t = (0 - (-12))$ ✓<br>$\Delta t = 1,2245$ s ✓ |

| OPTION 6/*OPSIE 6* | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief:***<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$0 = 12\Delta t + ½ (-9,8)\Delta t^2$<br>$\Delta t = 2,4490$ s<br><br>$\Delta t = ½ (2,4490)$✓<br>$= 1,2245$ s ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$0 = -12\Delta t + ½ (9,8)\Delta t^2$<br>$\Delta t = 2,4490$ s<br><br>$\Delta t = ½ (2,4490)$ ✓<br>$= 1,2245$ s ✓ |

(3)

3.2

**OPTION 1/*OPSIE 1***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief:***<br>$v_f = v_i + a\Delta t$✓<br>$-3v = -v$✓ + $(-9,8)(1,22)$ ✓<br>$v = 5,98\ m\cdot s^{-1}$✓$(5,978 – 6,03\ m\cdot s^{-1})$ | **Downwards positive**<br>***Afwaarts positief:***<br>$v_f = v_i + a\Delta t$✓<br>$3v = v$✓ + $(9,8)(1,22)$ ✓<br>$v = 5,98\ m\cdot s^{-1}$✓$(5,978 – 6,03\ m\cdot s^{-1})$ |

**OPTION 2/*OPSIE 2***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief:***<br>$F_{net}\Delta t = m(v_f - v_i)$ ✓<br>$mg\Delta t = m(v_f - v_i)$<br>$(-9,8)(1,2245)$✓ $= -3v - (-v)$✓<br>$v = 6,00\ m\cdot s^{-1}$ ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>$F_{net}\Delta t = m(v_f - v_i)$ ✓<br>$mg\Delta t = m(v_f - v_i)$<br>$(9,8)(1,2245)$✓ $= 3v - v$✓<br>$v = 6,00\ m\cdot s^{-1}$ ✓ |

(4)

3.3

**OPTION 1/*OPSIE 1***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief:***<br>$\Delta y = v_i\Delta t + ½a\Delta t^2$✓<br>$= (-5,98)(2,44) + ½(-9,8)(2,44)^2$✓<br>$= -43,764$<br>$\therefore h = 43,76$ m✓ (43,764 – 44,08 m) | Downwards positive<br>*Afwaarts positief:*<br>$\Delta y = v_i\Delta t + ½a\Delta t^2$✓<br>$= (5,98)(2,44) + ½(9,8)(2,44)^2$ ✓<br>$= 43,764$<br>$\therefore h = 43,76$ m✓(43,764 – 44,08) |





**OPTION 2/*OPSIE 2***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief***<br>$v_f = v_i + a\Delta t$<br>$v_f = -5,98 + (-9,8)(2,44)$<br>$v_f = -29,892\ m\cdot s^{-1}$<br>$v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$(-29,892)^2 = (-5,98)^2 + 2(-9,8)\Delta y$✓<br>$\Delta y = -43,763$ m<br>$\therefore h = 43,76$ m✓(43,764 – 44,08) | **Downwards positive**<br>***Afwaarts positief:***<br>$v_f = v_i + a\Delta t$<br>$v_f = 5,98 + 9,8(2,44)$<br>$= 29,892\ m\cdot s^{-1}$<br>$v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$(29,892)^2 = (5,98)^2 + 2(9,8)\Delta y$✓<br>$\Delta y = 43,76$ m<br>$\therefore h = 43,76$ m✓(43,764 – 44,08) |

**OPTION 3/*OPSIE 3***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief***<br>$v_f = v_i + a\Delta t$<br>$v_f = -5,98 + (-9,8)(2,44)$<br>$v_f = -29,892\ m\cdot s^{-1}$<br>$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓<br>$= \left(\left(\frac{-30 + (-6,00)}{2}\right)(2,4490)\right)$ ✓<br>$\Delta x = -44,082$ m<br>$h = 44,082$ m ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>$v_f = v_i + a\Delta t$<br>$v_f = 5,98 + 9,8(2,44)$<br>$= 29,892\ m\cdot s^{-1}$<br>$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓<br>$= \left(\left(\frac{30 + 6,00}{2}\right)(2,4490)\right)$ ✓<br>$\Delta x = 44,082$ m<br>$h = 44,082$ m ✓ |

**OPTION 4/*OPSIE 4***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief***<br>**For A/ *Vir A***<br>$v_f = v_i + a\Delta t$<br>$-12 = 12 + (-9,8)\Delta t$<br>$\Delta t = 2,45$ s<br>**For B/ *Vir B***<br>$\Delta x = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$= (-5,98)(2,45) + ½ (-9,8)(2,45)^2$ ✓<br>$= -44,06$ m<br>$h = 44,06$ m ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>**For A/ *Vir A***<br>$v_f = v_i + a\Delta t$<br>$12 = -12 + (9,8)\Delta t$<br>$\Delta t = 2,45$ s<br>**For B/ *Vir B***<br>$\Delta x = v_i\Delta t + ½ a\Delta t^2$ ✓<br>$= (5,98)(2,45) + ½ (9,8)(2,45)^2$ ✓<br>$= 44,06$ m<br>$h = 44,06$ m ✓ |

(3)

**OPTION 5/*OPSIE 5***

| | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief***<br>$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓<br>$\Delta y_A = 12\Delta t + ½ a\Delta t^2$<br>$\Delta y_B = -6\Delta t + ½ a\Delta t^2$<br>$\Delta y_A – \Delta y_B = 12\Delta t – (-6\Delta t)$<br>$0 – \Delta y_B = 18\Delta t$ ✓<br>$= 18(2,44)$<br>$= 43,92$ m<br>$h = 43,92$ m ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓<br>$\Delta y_A = -12\Delta t + ½ a\Delta t^2$<br>$\Delta y_B = 6\Delta t + ½ a\Delta t^2$<br>$\Delta y_A – \Delta y_B = 12\Delta t – (-6\Delta t)$<br>$0 – \Delta y_B = -18\Delta t$ ✓<br>$= -18(2,44)$<br>$= 43,92$ m<br>$h = 43,92$ m ✓ |

(3)

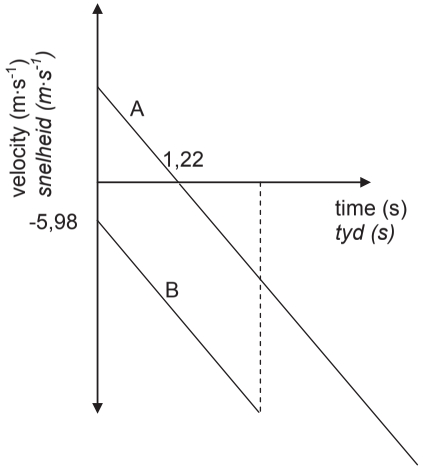
| OPTION 6/*OPSIE 6* | |
|---|---|
| **Upwards positive**<br>***Opwaarts positief***<br>$W_{net} = \Delta E_k$ ✓<br>$mg\Delta y\cos\theta = ½ m(v_f^2 - v_i^2)$<br>$(-9,8)h\cos 0^o = ½ (-20)^2 - ½ (-6)^2$ ✓<br>h = 44,082 m ✓ | **Downwards positive**<br>***Afwaarts positief:***<br>$W_{net} = \Delta E_k$ ✓<br>$mg\Delta y\cos\theta = ½ m(v_f^2 - v_i^2)$<br>$(9,8)h\cos 0^o = ½ (20)^2 - ½ (6)^2$ ✓<br>h = 44,082 m ✓ |

| OPTION 7/*OPSIE 7* |
|---|
| $(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$<br>$mgh_i + ½ mv_i^2 = mgh_f + ½ mv_f^2$ ✓<br>$(9,8)h + ½ (6)^2 = (9,8)(0) + ½ (30)^2$ ✓<br>h = 44,082 m ✓ |

(3)

3.4

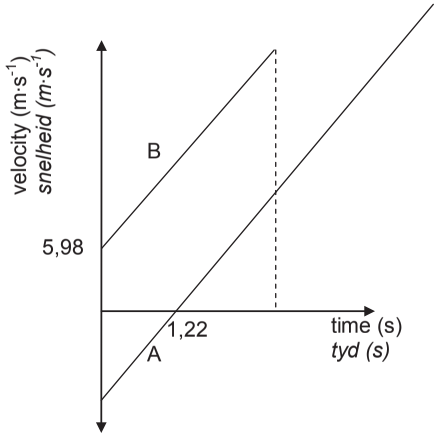
**UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF***








**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***




| Criteria for graph/*Kriteria vir grafiek* | Marks/*Punte* |
|---|---|
| Time 1,22 s shown **correctly**/*Tyd 1,22 s **korrek** getoon* | ✓ |
| Initial velocity for stone B at time t = 0 correctly shown with correct signs / *Aanvanklike snelheid vir klip B korrek met korrekte tekens getoon* | ✓ |
| Two sloping parallel lines with A **crossing** the time axis /*Twee skuins parallelle lyne met A wat die tyd-as **kruis*** | ✓ |
| Straight line graph for A parallel to graph B, extending beyond the time when B hits the ground/ *Reguitlyn grafiek A parallel aan grafiek B verleng verby die tyd wanneer B die grond tref* | ✓ |

(4)
**[14]**

**QUESTION 4 /*VRAAG 4***

4.1 The total linear momentum in an isolated/closed system is constant.✓✓
*Die totale liniêre momentum in 'n geïsoleerde (geslote) sisteem is konstant*

**OR/*OF***
In an isolated/closed system, total linear momentum before collision is equal to total linear momentum after collision. ✓✓
*In 'n geïsoleerde (geslote) sisteem is die totale liniêre momentum voor die botsing gelyk aan die totale momentum na die botsing.* (2)

4.2 $\Sigma p_i = \Sigma p_f$ ✓

$m_B v_{Bi} + m_b v_{bi} = m_B v_{Bf} + m_b v_{bf}$

$\Delta p_{bullet} = -\Delta p_{block}$
$(0,015)(400)$✓ $+ 0 = (0,015)v_{Bf} + 2(0,7)$✓
$V_{Bf} = 306,67\ (306,666) m\cdot s^{-1}$✓ (4)

4.3

**OPTION 1/*OPSIE 1***

$F_{net}\Delta t = \Delta p$
$\Delta p = mv_f - mv_i$ ✓

| **For bullet / *Vir koeël*** | **For block / *Vir blok*** |
|---|---|
| $\Delta p = (0{,}015)(306{,}666 - 400)$✓ | $\Delta p = (2)(0{,}7 - 0)$✓ |
| $= -1{,}4\ kg\cdot m\cdot s^{-1}$ | $= 1{,}4\ kg\cdot m\cdot s^{-1}$ |
| $F_{net}(0{,}002) = -1{,}4$ | $F_{net}(0{,}002) = 1{,}4$ |
| $F_{net} = -700\ N$ | $F_{net} = 700\ N$ |

$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$(700)\Delta x\cos180^o$ ✓$= ½\ (0{,}015)(306{,}67^2 - 400^2)$✓
$\Delta x = 0{,}71\ m$ ✓

| | |
|---|---|
| $F_{net} = ma$<br>$-700 = (0{,}015)a$<br>**OR/*OF***<br>$F_{met} = ma$<br>$700 = (0{,}015)a$<br><br>$a = -46\ 666{,}67$<br>**or/*of*** $46\ 665\ m\cdot s^{-2}$ | $\Delta x = v_i\Delta t + ½\ a\Delta t^2$<br>$= (400)(0{,}002)$✓ $+ ½(-46\ 666{,}67)(0{,}002)^2$✓<br>$= 0{,}71\ m\ (0{,}70667)\ m$✓<br>**OR/OF**<br>$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$<br>$(306{,}67)^2$ ✓$= (400)^2 + 2(-46\ 666{,}67)\Delta x$✓<br>$\Delta x = 0{,}71\ m\ (0{,}70667\ m)$ ✓ |

**OPTION 2/*OPSIE 2***

$v_f = v_i + a\Delta t$✓
$306{,}666 = 400 + a\ (0{,}002)$ ✓
$a = -46\ 667\ m\cdot s^{-2}$

$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$
$(306{,}666)^2$ ✓$= 400^2 + 2(-4667)\ \Delta x$✓
$\Delta x = 0{,}71\ m\ (0{,}706\ m)$ ✓

**OPTION 3/*OPSIE 3***

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{400 + 306{,}666}{2}\right)(0{,}002)$ ✓ ✓
$= 0{,}71\ m\ (0{,}707)\ m$ ✓





**OPTION 4/*OPSIE 4***

$W_{net} = \Delta K/\Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ma\Delta x\cos\theta = \Delta K/\Delta E_k$

$v_f = v_i + a\Delta t$
$306{,}666 = 400 + a\ (0{,}002)$ ✓
$a = -46\ 667\ m\cdot s^{-2}$

$W_{net} = \Delta K/\Delta E_k$
$F_{net}\Delta x\cos\theta = ma\Delta x\cos\theta = \Delta K/\Delta E_k$
$(0{,}015)(46\ 667)\Delta x\cos180^o$✓ $= ½(0{,}015)(306{,}666^2 - 400^2)$✓
$\Delta x = 0{,}71\ m\ (0{,}707)$ ✓

**OR/*OF***
$W_{nc} = \Delta E_p + \Delta E_k$
$(0{,}015)(46\ 667)\Delta x\cos180^o$✓ $= ½(0{,}015)(306{,}666^2 - 400^2)$✓
$\Delta x = 0{,}71\ m\ (0{,}707)$ ✓

(5)
**[11]**

**QUESTION 5/*VRAAG 5***

5.1 The net/total work done (on an object) is equal to the change in the object's kinetic energy.✓✓
*Die netto/totale arbeid wat (op 'n voorwerp) verrig is is gelyk aan die verandering in die voorwerp se kinetiese energie.*

**OR/*OF***
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy.✓✓
*Die arbeid verrig op in voorwerp deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.* (2)

5.2

| | **Accepted labels/*Aanvaarde benoemings*** |
|---|---|
| w | $F_g$ / $F_w$ / weight / mg/ 58,8N / gravitational force / $F_{earth\ on\ block}$<br>*$F_g$ / $F_w$ / gewig / mg /58,8 N/ gravitasiekrag / $F_{aarde\ op\ blok}$* |
| T | $F_T$/ Tension/ *spanning* |

5.3

| | |
|---|---|
| $W_w = w\Delta x\cos\theta$✓<br>$= mg\Delta x\cos\theta$<br>$= (6)(9{,}8)(1{,}6)\cos0^o$✓<br>$\therefore W = 94{,}08\ J$ ✓ | $W_w = -\Delta E_P$ ✓<br>$= -mg(h_f - h_i)$<br>$= -(6)(9{,}8)(0 - 1{,}6)$ ✓<br>$= 94{,}08\ J$✓ |

(3)

5.4

**OPTION 1/*OPSIE 1***

$W_{net} = \Delta E_K / \Delta K$ ✓ $= ½m(v_f^2 - v_i^2)$
$W_{net} = F_{net}\Delta x\cos\theta$
$W_{net} = W_f + W_g + W_N$
$= \mu_k N\Delta x\cos\theta + W_g + W_N$

$W_{net} = (0,4)(4)(9,8)(1,6)\cos180^o$ ✓ + 94,08 + 0
= 68,992 J
$W_{net} = ½m(v_f^2 - v_i^2)$
$68,992$ ✓ $= ½(4)(v_f^2 - 0) + ½(6)(v_f^2 - 0)$ ✓
$v_f = 3,71\ m\cdot s^{-1}$ ✓

**OPTION 2/*OPSIE 2***

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$f\Delta x\cos\theta = (m_1gh_f - m_1gh_i) + (½m_1v_f^2 - ½m_1v_i^2) + (½m_2v_f^2 - ½m_2v_i^2)$
$(0,4)(4)(9,8)(1,6)\cos180^o$ ✓ $= [0 - (6)(9,8)(1,6)]$ ✓ $+ (½(6)v_f^2 + ½(4)v_f^2 - 0)$ ✓
$68,992 = 5v_f^2$
$v_f = 3,71\ m\cdot s^{-1}$ ✓

**OPTION 3/*OPSIE 3***

$f_k = \mu_k N = (0,4)(4)(9,8) = 15,68$ N
$T - f_k = ma$
$w - T = ma$
$T - 15,68 = 4a$ … .(i)
$(6)(9,8) - T = 6a$ ……..(ii)
$\therefore a = 4,312\ m\cdot s^{-2}$
$\therefore T = 32,928$ N

$F_{net} = ma$
$= (6)(4,312)$
$= 25,872$

$W_{net} = F_{net}\Delta x\cos\theta$
$= (25,872)(1,6)\cos0^o$ ✓
$= 41,3952$ J

$W_{net} = \Delta E_k$ ✓
$41,3952 = ½m(v_f^2 - v_i^2$
$41,3952 = ½(6)(v_f^2 - 0)$ ✓
$v_f = 3,7146\ m\cdot s^{-1}$ ✓

Above calculations can be done with 4 kg or 10 kg / *Bostaande berekeninge kan met 4 kg of 10 kg gedoen word*

4 kg block
$W_{net} = \Delta E_K / \Delta K$ ✓
$W_f + W_T = ½m(v_f^2 - v_i^2)$

$f\Delta x\cos180^o + T\Delta x\cos0^o = ½(4)(v_f^2 - 0)$
$(15,68)(1,6)(-1)$ ✓ $+ (32,928)(1,6)(1)$ ✓ $= 2v_f^2$
$v_f = 3,72\ m\cdot s^{-1}$ ✓

6 kg block
$W_{net} = \Delta E_K / \Delta K$ ✓
$W_w + W_T = ½m(v_f^2 - v_i^2)$

$mg\Delta x\cos0^o + T\Delta x\cos180^o = ½(6)(v_f^2 - 0)$
$(6)(9,8)(1,6)(1)$ ✓ $+ (32,928)(1,6)(-1)$ ✓ $= 3v_f^2$
$v_f = 3,72\ m\cdot s^{-1}$ ✓





**OPTION 4/*OPSIE 4***

$W_{net} = \Delta E_K / \Delta K$ ✓
**For the 4 kg mass / *Vir die 4 kg massa***
$T(1,6)\cos0^o + [(0,4)(9,8)(4)](1,6)\cos180^o$ ✓ $= ½(4)v^2 - 0)$
**For the 6 kg mass/*Vir die 6 kg massa***
$(6)(9,8)(1,6)]\cos0^o + T(1,6)\cos180^o$ ✓ $= ½(6)(v^2 - 0)$
Adding the two equations / *Optel van twee vergelykings*
$68,992 = ½(4)v^2 + ½(6)v^2$ ✓
$5v^2 = 68,992$
$v = 3,71\ m\cdot s^{-1}$ ✓

**OPTION 5/*OPSIE 5***

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
$(F_g - f)\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
$[(6)(9,8) - (0,4)(4)(9,8)]$ ✓ $(1,6)\cos0^o$ ✓ $= ½(10)(v_f^2 - 0)$ ✓
$v_f = 3,71 m.s^{-1}$ ✓ (5)

**[12]**

**QUESTION 6 / *VRAAG 6***

6.1 It is the (apparent) 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. ✓
*Dit is 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 van klankvoortplanting 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)

6.2.1 170 Hz✓ (1)

6.2.2 130 Hz✓ (1)

6.3

**POSITIVE MARKING FROM QUESTIONS 6.2.1 and 6.2.2/**
***POSITIEWE NASIEN VANAF VRAAG 6.2.1 en 6.2.2***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$170$ ✓ $= \frac{(340 + 0)}{(340 - v_s)}$ ✓ $\times f_s$ ---------- (1)

$130$ ✓ $= \frac{(340 - 0)}{340 + v_s}$ ✓ $\times f_s$ ---------- (2)

$v_s = 45,33\ m\cdot s^{-1}$ ✓ $(45,33 - 45,45\ m\cdot s^{-1})$ (6)

**[10]**

## QUESTION 7 / *VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge 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 puntlading op 'n ander puntlading is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.*
**OR/*OF***
The force of attraction or repulsion between two point charges is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between them. ✓
*Die aantrekkings- of afstotingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.* (2)

7.2

**OPTION 1/ *OPSIE 1***

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^9)(6\times10^{-6})(8\times10^{-6})}{(0,2)^2}$ ✓ ✓

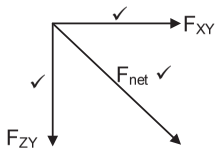
$= 10,8$ N✓

**OPTION 2/ *OPSIE 2***

$E = \frac{kQ}{r^2} = \frac{(9\times10^9)(8\times10^{-6})}{(0,2)^2}$✓ $= 1,8 \times 10^4$ N·C$^{-1}$

$F = Eq = (1,8 \times 10^4)(6 \times 10^{-6})$✓ $= 10,8$ N✓ (4)

7.3




(3)





7.4

**OPTION 1 /*OPSIE 1***

$F_{net}^2 = F_{XY}^2 + F_{ZY}^2$

$15,20^2 = 10,8^2 + F_{ZY}^2$

$F_{ZY} = 10,696$ N

$F_{ZY} = k\frac{Q_ZQ_Y}{r^2}$

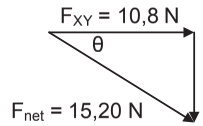
$10,696$✓ $= 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0,30)^2}$ ✓

$Q_Z = 1,34 \times 10^{-5}$ C✓

**OPTION 2 /*OPSIE 2***

$\cos\theta = \frac{10,8}{15,2}$

$\theta = 44,72^o$




$\sin 44,72 = \frac{F_{ZY}}{15,2}$ ✓ **OR/*OF*** $\tan 44,72 = \frac{F_{ZY}}{F_{XY}}$

$F_{ZY} = 10,696$ N

$F_{ZY} = k\frac{Q_ZQ_Y}{r^2}$

$10,696$✓ $= 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0,30)^2}$ ✓

$Q_Z = 1,34 \times 10^{-5}$ C✓ (4)

**[13]**

## QUESTION 8 / *VRAAG 8*

8.1 Electric field at a point is the force per unit positive charge placed at that point. ✓✓
*Elektriese veld by 'n punt is die krag per eenheids positiewe lading geplaas by daardie punt.* (2)

8.2

$E = \frac{kQ}{r^2}$ ✓

$E_{net} = (E_A + E_B)$

$= 9\times10^9 \frac{(1,5\times10^{-6})}{(0,4)^2}$✓ $+ 9\times10^9 \frac{(2,0\times10^{-6})}{(0,3)^2}$ ✓

$= 2,84 \times 10^5$ N·C$^{-1}$ ✓ (4)

8.3

**OPTION 1/*OPSIE 1***

$F_E = qE$ ✓

$= (3,0 \times 10^{-9})(2,84 \times 10^5)$ ✓

$= 8,52 \times 10^{-4}$ N ✓

**OPTION 2/*OPSIE 2***

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = (F_A + F_B)$

$= \left(\frac{(9\times10^9)(3\times10^{-6})(1{,}5\times10^{-6})}{(0{,}4)^2} + \frac{(9\times10^9)(3\times10^{-6})(2{,}0\times10^{-6})}{(0{,}3)^2}\right)$ ✓

$= 8{,}53 \times 10^{-4}$ N ✓ (3)

**[9]**

**QUESTION 9 / *VRAAG 9***

9.1.1 The potential difference (voltage) across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓
*Die potensiaalverskil (spanning) oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.*
**OR/*OF***
The current in a conductor is directly proportional to the potential difference (voltage) across the conductor if temperature is constant✓✓
*Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil (spanning) oor die geleier indien die temperatuur konstant is.* (2)

9.1.2 (Equivalent) resistance/ (*Ekwivalente) weerstand*✓ (1)

9.1.3

Gradient/*Helling* = $\frac{\Delta V}{\Delta I}$

$= \frac{2-0}{0{,}5-0}$ ✓ = 4 (Ω)✓ (2)

9.1.4 **OPTION 1/*OPSIE 1***

In series $R_1 + R_2 = 4\ \Omega$ ✓.....(1)

In parallel $\frac{R_1R_2}{R_1+R_2} = 1\ \Omega$ ✓✓.....(2)

$R_1R_2 = 4\ \Omega$

$\therefore R_1 = R_2 = 2\ \Omega$ ✓

**OPTION 2/*OPSIE 2***

For graph X/*Vir grafiek X*:
$R_1 + R_2 = 4$.....(1) ✓
For graph Y/*Vir grafiek Y*

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\left\{\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \left(\frac{1}{1}\right)\right\}$ ✓✓ .....(2)

$R_1^2 - 4R_1 + 4 = 0$

$R_1 = 2\ \Omega$✓ (4)





9.2.1

$I = \frac{V}{R}$

$= \frac{5}{(R_M + R_N)}$

$= \frac{5}{(6)}$ ✓

$= 0{,}83$ A✓ (3)

9.2.2

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $\varepsilon = I(R + r)$ ✓<br>$= 0{,}83[(6 + 1{,}5)$ ✓$+ 0{,}9$✓$]$<br>$= 6{,}997$ V<br>$= 7(,00)$ V✓ (6,972 – 7,00 V) | $\varepsilon = (V_s + V_{//} + V_r)$✓ / $V_{ext/eks} + V_{int}$<br>$= [5 + (0{,}833 \times 1{,}5)$ ✓$+ (0{,}9 \times 0{,}833)]$ ✓<br>$= 6{,}999$ V<br>$= 7(,00)$ V✓ (6,972 – 7,00 V) |

9.2.3 The resistance $R_N$ will be 3 Ω ✓
The voltage divides (proportionately) in a series circuit. Since the voltage across **M** is half the total voltage, it means the resistances of **M** and **N** are equal.✓

*Die weerstand $R_N$ sal 3 Ω wees.*
*Die potensiaalverskil verdeel (eweredig) in 'n serie stroombaan. Aangesien die potensiaalverskil oor **M** die helfte is van die totale potensiaalverskil, beteken dit dat die weerstande van **M** en **N** gelyk is.* (2)

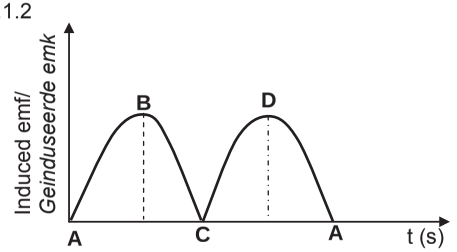
**[18]**

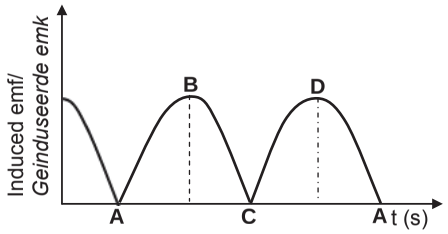
## QUESTION 10 / *VRAAG10*

10.1

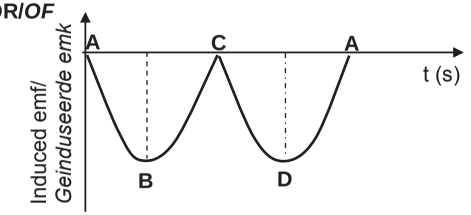
10.1.1 Mechanical to electrical / Meganies na elektries ✓ (1)

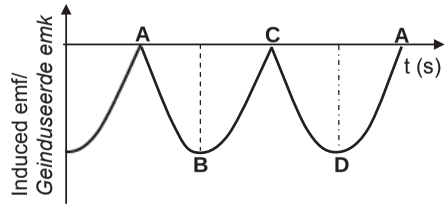
10.1.2




**OR/*OF***




| **Criteria for graph/*Kriteria vir grafiek*** | **Marks/*Punte*** |
|---|---|
| Correct DC shape, starting from zero/*Korrekte GS vorm wat by nul begin* | ✓ |
| Positions ABCDA correctly indicated on the graph/*Posisies ABCDA of grafiek aangedui* | ✓ |

(2)

10.2.1 20,5 Ω✓ (1)





10.2.2

**OPTION 1/*OPSIE 1***

$I_{rms} = \frac{V_{rms}}{R}$✓ $= \frac{25}{20,5}$✓

$= 1,22\ (1,2195)$ A

| | | |
|---|---|---|
| $P_{ave} = I_{rms}^2 R$<br>$=(1,22)^2(0,5)$<br>$= 0,74$ W<br><br>$P_{ave} = \frac{V_{rms}^2}{R}$ ✓<br>$P_{ave} = \frac{(25)^2}{20,5}$ ✓<br>$P_{ave} = 30,49$ W<br>Actual energy delivered per second(power) / *Energie aan toestel gelewer per sekonde (drywing)*<br>$= (30,49 – 0,74)$<br>$= 29,75$ W✓ | $P_{ave} = I_{rms}^2 R$✓<br>$= (1,22)^2(20)$ ✓<br>$= 29,77$ W✓<br><br>**OR/OF**<br><br>$V_{rms/wgk\ device/toestel} = \frac{20}{20,5}$ ✓ $\times 25 = 24,39$ V<br><br>$P_{ave} = V_{rms}I_{rms}$ ✓<br>$= (24,39)(1,22)$<br>$= 29,76$ W ✓ | $W = I^2_{rms} R\Delta t$<br>$= (1,22)^2 (0,5)(1)$<br>$= 0,74$ J<br><br>$P_{ave} = \frac{V_{rms}^2}{R}$ ✓<br>$P_{ave} = \frac{(25)^2}{20,5}$ ✓<br>$P_{ave} = 30,49$ W<br>Actual energy delivered per second(power) / *Energie aan toestel gelewer per sekonde (drywing)*<br>$= (30,49 – 0,74)$<br>$= 29,75$ W✓ |

**OPTION 2/*OPSIE 2***

$V_{rms/wgk\ device/toestel} = \frac{20}{20,5}$ ✓ $\times 25 = 24,39$ V

$P_{ave} = \frac{V_{rms}^2}{R}$✓ $= \frac{(24,39)^2}{20}$✓ $= 29,74$ W✓

(5)
**[9]**

## QUESTION 11 / *VRAAG 11*

11.1.1 (Line) emission (spectrum) / *(Lyn) emissiespektrum* ✓ (1)

11.1.2 (Line) absorption (spectrum ) / *(Lyn) absorpsiespektrum* ✓ (1)

11.2.1 Emission ✓/ *Emissie* (1)

11.2.2 Energy released in the transition from $E_4$ to $E_2 = E_4 – E_2$
*Energie vrygestel in die oorgang vanaf $E_4$ na $E_2 = E_4 – E_2$*
$E_4 – E_2 = (2,044 \times 10^{-18} – 1,635 \times 10^{-18})$✓ $= 4,09 \times 10^{-19}$ J

$E = hf$✓
$4,09 \times 10^{-19} = (6,63 \times 10^{-34})f$✓
$f = 6,17 \times 10^{14}$ Hz✓ (4)

11.2.3

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$
$hf = hf_0 + ½ m v^2_{max}$
$E = W_0 + ½ m v^2_{max}$
✓ Any one/*Enige een*

$4,09 \times 10^{-19}$ ✓ $= (6,63 \times 10^{-34})(4,4 \times 10^{14})$✓ $+ E_{k(max)}$

$E_{k(max)} = 1,17 \times 10^{-19}$ J✓

**OR/OF**

$E_{k(max)} = E_{light/lig} - W_o$
$= hf_{light/lig} - hf_o$
✓ Any one/*Enige een*

$= (6,63 \times 10^{-34})(6,17 \times 10^{14})$ ✓ $- (6,63 \times 10^{-34})(4,4 \times 10^{14})$✓
$= 1,17 \times 10^{-19}$ J ✓ (4)

11.2.4

No✓ / *Nee*
The threshold frequency is greater than the frequency of the photon. ✓
*Die drumpelfrekwensie is groter as die frekwensie van die foton*
**OR/*OF***
The frequency of the photon is less than the threshold frequency✓
*Die frekwensie van die foton is minder as die drumpelfrekwensie*
**OR/*OF***
Energy of the photon is less than the work function of the metal✓
*Energie van foton is minder as die van die arbeidsfunksie van die metaal* (2)
**[13]**

**TOTAL/*TOTAAL*: 150**



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**GRADE/*GRAAD* 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**
***FISIESE WETENSKAPPE: FISIKA (V1)***

**NOVEMBER 2016**

**MEMORANDUM**

**MARKS/*PUNTE*: 150**

**This memorandum consists of 19 pages.**
***Hierdie memorandum bestaan uit 19 bladsye.***

## QUESTION 1/*VRAAG 1*

| | | |
|---|---|---|
| 1.1 | A ✓✓ | (2) |
| 1.2 | C ✓✓ | (2) |
| 1.3 | C ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | C ✓✓ | (2) |
| 1.8 | A ✓✓ | (2) |
| 1.9 | B ✓✓ | (2) |
| 1.10 | B ✓✓ | (2) |
| | | **[20]** |

## QUESTION 2/*VRAAG 2*

2.1 When a resultant/net force acts on an object, the object will accelerate in the (direction of the net/resultant force). The acceleration is directly proportional to the net force ✓and inversely proportional to the mass ✓of the object.
*Wanneer 'n netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die netto krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.*

**OR/*OF***
The resultant/net force acting on the object is equal (is directly proportional to) to the rate of change of momentum of an object (in the direction of the force). ✓✓
*Die resulterende/netto krag wat op 'n voorwerp inwerk, is gelyk aan (is direk eweredig aan) die tempo van verandering van momentum van die voorwerp (in die rigting van die netto krag).* (2)

2.2
$f_k = \mu_k N$✓ $= \mu_k mg$
$= (0,15)(3)(9,8)$✓
$= 4,41$ N✓ (3)

2.3

| Accepted Labels/*Aanvaarde benoemings* | |
|---|---|
| w | $F_g/F_w$/force of Earth on block/weight/14,7 N/mg/gravitational force<br>*$F_g/F_w$/krag van Aarde op blok/gewig/14,7 N/mg/gravitasiekrag* |
| N | $F_N/F_{normal}$/normal force<br>$F_N/F_{normaal}$/normalekrag |
| T | Tension/$F_T$<br>*Spanning*/$F_T$ |
| $f_k$ | $f_{kinetic\ friction}$/*kinetiesewrywing*/$f_{f/w}$/f//$F_{f/w}$ kinetic friction/*kinetiesewrywing* |
| 25 N | $F_{applied}/F_A$/F<br>$F_{toegepas}/F_A$/F |

2.4.1

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $f_k = \mu_k N = \mu_k(25\sin 30^o + mg)$<br>$= 0,15[(25\sin 30^o)$✓ $+ (1,5)(9,8)$✓$]$<br>$= 4,08$ N✓ | $f_k = \mu_k N = \mu_k(25\cos 60^o + mg)$<br>$= 0,15[(25\cos 60^o)$✓ $+ (1,5)(9,8)$✓$]$<br>$= 4,08$ N✓ |

(3)

2.4.2

**POSITIVE MARKING FROM**
**QUESTION 2.2 AND QUESTION 2.4.1**
***POSITIEWE NASIEN VANAF VRAAG 2.2 EN VRAAG 2.4.1***
**OPTION 1/*OPSIE 1***
For the 1,5 kg block/*Vir die 1,5 kg blok*
$F_{net} = ma$
$F_x + (-T) + (-f_k) = ma$ ✓
$25\cos 30^o - T - f_k = 1,5a$
$(25\cos 30^o - T) - 4,08$ ✓$= 1,5a$
$17,571 - T = 1,5a$ …….(1)
✓either one
*enigeen*
For the 3 kg block
*Vir die 3 kg blok*
$T - f_k = 3a$
$T - 4,41$✓ $= 3a$ ……(2)
$13,161 = 4,5\ a$
$a = 2,925\ m{\cdot}s^{-2}$
$T = 13,19$ N ✓ (13,17 N – 13,19 N)

| **OPTION 2/*OPSIE 2*** | **OPTION 3/*OPSIE 3*** |
|---|---|
| For the 1,5 kg block/*Vir die 1,5 kg blok*<br>$F_{net} = ma$<br>$F_x + (-T) + (-f_k) = ma$ ✓<br>$25\cos 30^o - T - f_k = 1,5a$<br>$(25\cos 30^o - T) - 4,08$ ✓ $= 1,5a$<br>$17,571 - T = 1,5a$ …….(1)<br>✓either one *enigeen*<br>For the 3 kg block<br>*Vir die 3 kg blok*<br>$T - f_k = 3a$<br>$T - 4,41$ ✓ $= 3a$ ……(2)<br><br>$35,142 - 2T = T - 4,41$<br>$T = 13,18$ N ✓ | For the 1,5 kg block/*Vir die 1,5 kg blok*<br>$F_{net} = ma$<br>$F_x + (-T) + (-f_k) = ma$ ✓<br>$25\cos 30^o - T - f_k = 1,5a$<br>$(25\cos 30^o - T) - 4,08$ ✓ $= 1,5a$<br>$17,571 - T = 1,5a$ …….(1)<br>✓either one *enigeen*<br>$a = \frac{17,571 - T}{1,5}$<br>For the 3 kg block<br>*Vir die 3 kg blok*<br>$T - f_k = 3a$<br>$T - 4,41$ ✓ $= 3a$ ……(2)<br>$a = \frac{T - 4,41}{3}$<br>$\frac{17,571 - T}{1,5} = \frac{T - 4,41}{3}$<br>$T = 13,18$ N✓ |

(5)
**[18]**

**QUESTION 3/*VRAAG 3***

3.1 The motion of an object under the influence of gravity/weight/gravitational force only / Motion in which the only force acting is the gravitational force.✓✓
*Die beweging van 'n voorwerp slegs onder die invloed van swaartekrag/gewig gravitasiekrag.*
*Beweging waarin die enigste krag wat op die liggaam inwerk, die gravitasiekrag is.* (2)

3.2.1

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| **Upwards positive/*Opwaarts positief:***<br>$v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$= 0^2 + (2)(-9,8)$✓$(-20)$✓<br>$v_f = 19,80\ m\cdot s^{-1}$ ✓<br><br>**Downwards positive**<br>***Afwaarts positief***<br>$v_f^2 = v_i^2 + 2a\Delta y$ ✓<br>$= 0^2 + (2)(9,8)$✓$(20)$✓<br>$v_f = 19,80\ m\cdot s^{-1}$✓ | **Upwards positive/*Opwaarts positief:***<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$<br>$-20 = 0 + ½ (-9,8)\Delta t^2$✓<br>$\Delta t = 2,02$ s<br>✓either one *enigeen*<br>$v_f = v_i + a\Delta t$<br>$= 0 + (-9,8)(2,02)$ ✓<br>$= -19,80\ m\cdot s^{-1}$<br>$= 19,80\ m\cdot s^{-1}$ ✓<br>**Downwards positive**<br>***Afwaarts positief***<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$<br>$20 = 0 + ½ (9,8)\Delta t^2$✓<br>$\Delta t = 2,02$ s<br>✓either one *enigeen*<br>$v_f = v_i + a\Delta t$<br>$= 0 + (9,8)(2,02)$✓<br>$= 19,80\ m\cdot s^{-1}$✓ |





| |
|---|
| **OPTION 3/*OPSIE 3***<br>$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$<br>$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$<br>$(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{Bottom/Onder}$<br>$(9,8)(20) + 0$✓ $= (0 + ½v_f^2)$✓<br>$v_f = 19,80\ m\cdot s^{-1}$✓<br>✓1 mark for any *1 punt vir enige* |
| **OPTION 4/*OPSIE 4***<br>$W_{nc} = \Delta E_p + \Delta E_k$ ✓<br>$0 = mg\Delta h + ½ m\Delta v^2$<br>$0$✓ $= m(9,8)(0 - 20) + ½ m(v_f^2 - 0)$ ✓<br>$v_f = 19,80\ m\cdot s^{-1}$✓ |
| **OPTION 5/*OPSIE 5***<br>$W_{net} = \Delta E_k$ ✓<br>$mg\Delta x\cos 0^o = ½ m(v_f^2 - 0)$<br>$m(9,8)(20)(1)$✓ $= ½ mv_f^2$ ✓<br>$v_f = 19,80\ m\cdot s^{-1}$✓ |

(4)

3.2.2

**POSITIVE MARKING FROM QUESTION 3.2.1/*POSITIEWE NASIEN VANAF VRAAG 3.2.1***

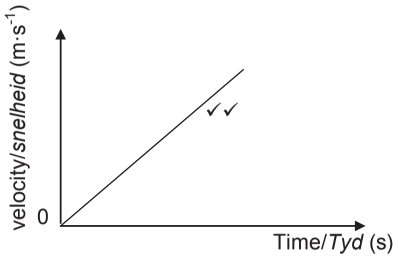
**OPTION 1/*OPSIE 1***
**Downwards positive/*Afwaarts positief***
$v_f = v_i + a\Delta t$ ✓
$19,80 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 2,02$ s ✓
**Upwards positive/*Opwaarts positief***
$v_f = v_i + a\Delta t$ ✓
$-19,80 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 2,02$ s ✓

| **OPTION 2/*OPSIE 2*** | |
|---|---|
| **Upwards positive/*Opwaarts positief:***<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓<br>$-20 = 0 + ½ (-9,8)\Delta t^2$✓<br>$\Delta t = 2,02$ s✓ | **Downwards Positive/*Afwaarts positief***<br>$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓<br>$20 = 0 + ½ (9,8)\Delta t^2$✓<br>$\Delta t = 2,02$ s✓ |

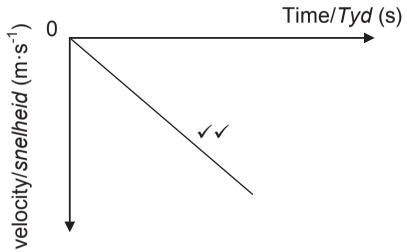
**OPTION 3/*OPSIE 3***
**Downwards positive/*Afwaarts positief:***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$20 = \left(\frac{0 + 19,80}{2}\right)(\Delta t)$✓
$\Delta t = 2,02$ s✓
**Upwards positive/*Opwaarts positief:***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-20 = \left(\frac{0 - 19,80}{2}\right)(\Delta t)$ ✓
$\Delta t = 2,02$ s✓

(3)

3.3 **Downward positive/*Afwaarts positief***




**Upward positive/*Opwaarts positief***




**Notes/*Aantekeninge***

| | |
|---|---|
| ✓✓ | Straight line through the origin.<br>*Reguitlyn deur die oorsprong* |

(2)
**[11]**





**QUESTION 4/*VRAAG 4***

4.1 A system on which the resultant/net external force is zero/*'n Sisteem waarop die resulterende krag/netto eksternekrag nul is* ✓
A system which excludes external forces /*'n Sisteem wat eksterne kragte uitlaat.* (1)

4.2.1

**OPTION 1/*OPSIE 1***
$p = mv$ ✓
$30\,000 = (1\,500)v$ ✓
$v = 20\ m\cdot s^{-1}$ ✓

**OPTION 2/*OPSIE 2***
$\Delta p = mv_f - mv_i$ ✓
$0 = (1\,500)v_f - 30\,000$ ✓
$v = 20\ m\cdot s^{-1}$ ✓

(3)

4.2.2 **POSITIVE MARKING FROM QUESTION 4.2.1/*POSITIEWE NASIEN VANAF VRAAG 4.2.1***

**OPTION 1/*OPSIE 1***
$\sum p_i = \sum p_f$
$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ ✓ (1 mark for any/*1 punt vir enige*)
$30\,000 + (900)(-15)$ ✓ $= 14\,000 + 900v_B$ ✓
$\therefore v_B = 2{,}78\ m\cdot s^{-1}$ ✓east/*oos* ✓ (Accept/*Aanvaar:* to the right/*na regs*)

**OPTION 2/*OPSIE 2***
$\Delta p_A = -\Delta p_B$
$p_f - p_i = -(mv_f - mv_i)$ (1 mark for any/*1 punt vir enige*)
$14\,000 - 30\,000$ ✓ $= 900v_f - 900(-15)$ ✓
$v_f = 2{,}78\ m\cdot s^{-1}$ ✓ east/*oos* ✓ (Accept/*Aanvaar:* to the right/*na regs*)

(5)

4.2.3

**OPTION 1/*OPSIE 1***
$$\text{Slope/}\textit{Helling} = \frac{\Delta p}{\Delta t} = F_{net} \checkmark$$
$$= \frac{(14\,000 - 30\,000)}{(20{,}2 - 20{,}1)} \checkmark \checkmark$$
$$= -160\,000$$
$$F_{net} = 160\,000\ N \checkmark$$

**OPTION 2/*OPSIE 2***
$F_{net}\Delta t = \Delta p$ ✓
$F_{net}(0{,}1)$ ✓ $= 14\,000 - 30\,000$ ✓
$F_{net} = -160\,000\ N$
$F_{net} = 160\,000\ N$ ✓

**POSITIVE MARKING FROM QUESTION 4.2.2/POSITIEWE NASIEN VANAF VRAAG 4.2.2**
**OPTION 3/*OPSIE 3***
$F_{net}\Delta t = \Delta p$ ✓
$F_{net}(0{,}1)$ ✓ $= 900[(2{,}78) - (-15)]$ ✓
$F_{net} = 160\,020\ N$
$F_A = -F_B$
$F_{net} = 160\,020\ N$ ✓

**OPTION 4/*OPSIE 4***

$p = mv$
$14\,000 = 1\,500v_f$ ✓
$v_f = 9{,}33\ m\cdot s^{-1}$

$F_{net} = \frac{m(v_f - v_i)}{\Delta t}$ ✓ $= \frac{1500(9{,}33 - 20)}{0{,}1}$ ✓
$= -160\,050$
$= 160\,050$ N ✓

$v_f = v_i + a\Delta t$
$9{,}33 = 20 + a(0{,}1)$
$a = -106{,}7\ m\cdot s^{-2}$

$F_{net} = ma$ ✓
$= 1\,500(-106{,}7)$ ✓
$F_{net} = -160\,050$ N
$F_{net} = 160\,050$ N ✓

(4)
**[13]**

**QUESTION 5/*VRAAG 5***

5.1.1 $E_k/K = ½ mv^2$ ✓
$= ½ (2)(4{,}95)^2$ ✓
$= 24{,}50$ J ✓ (3)

5.1.2 **POSITIVE MARKING FROM QUESTION 5.1.1/*POSITIEWE NASIEN VANAF 5.1.1***

**OPTION 1/*OPSIE 1***
$E_{mech\ before} = E_{mech\ after}$
$[(E_{mech})_{bob} + (E_{mech})_{block}]_{before/voor} = [(E_{mech})_{Block} + (E_{mech})_{bob}]_{after/na}$
$(mgh + ½ mv^2)_{before/voor} = (mgh + ½ mv^2)_{after/na}$
$(5)(9{,}8)h + 0 + 0$ ✓ $= 5(9{,}8)¼h + 0 + 24{,}50$ ✓
$h = 0{,}67$ m✓

Any one/ *Enige een*✓

**OPTION 2/*OPSIE 2***
$W_{nc} = \Delta E_p + \Delta E_k$
$0 = \Delta E_p + \Delta E_k$
$-\Delta E_p = \Delta E_k$
$-[(5)(9{,}8)(¼h) - (5)(9{,}8)h]$✓ $= 24{,}50$✓
$h = 0{,}67$ m ✓

Any one/ *Enige een*✓

**OPTION 3/*OPSIE 3***
Loss Ep bob = Gain in Ek of block ✓
$mg(¾h) = 24{,}5$
$(5)(9{,}8)(¾h)$✓ $= 24{,}5$ ✓
$h = 0{,}67$ m ✓

(4)

**OPTION 4 /*OPSIE 4***
Before/*Voor*
$(mgh + ½ mv^2)_{top/bo} = (mgh + ½ mv^2)_{bottom/onder}$
$(5)(9{,}8)h + 0 = (5)(9{,}8)h_o + ½ (5)v^2$
$v_i^2 = 19{,}6h - 19{,}6h_o$

After/*Na*
$(mgh + ½ mv^2)_{bottom/onder} = (mgh + ½ mv^2)_{top/bo}$
$(5)(9{,}8)h_o + ½(5)v_f^2 = (5)(9{,}8)(¼h) + 0$
$v_f^2 = 4{,}9h - 19{,}6h_o$

$E_{mech/meg}$ before collision/*voor botsing* = $E_{mech/meg}$ after collision/*na botsing*✓
$½ mv_i^2$(bob/skietlood) + 0 = $½ mv_f^2$(bob/skietlood)+ $½ mv^2$(block/blok)
$½ (5)(19{,}6h - 19{,}6h_o)$ ✓ $= ½ (5)(4{,}9h - 19{,}6h_o) + 24{,}5$ ✓
$h = 0{,}67$ m✓





5.2 The net/total work done on an object is equal ✓to the change in the object's kinetic energy ✓
*Die netto/totale arbeid op 'n voorwerp verrig is gelyk aan die verandering in die kinetiese energie van die voorwerp.*

**OR/*OF***
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy.
*Die arbeid verrig op 'n voorwerp deur 'n resulterende/netto krag is gelyk aan die voorwerp se verandering in kinetiese energie.* (2)

5.3

**OPTION 1/*OPSIE 1***
$W_{net} = \Delta E_K$✓
$W_f + mg\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$
$W_f + (2)(9{,}8)(0{,}5)\cos180^o$ ✓ $= ½ (2)(2^2 - 4{,}95^2)$ ✓
$W_f = -10{,}7$ J✓

**OPTION 2/*OPSIE 2***
$W_{nc} = \Delta E_K + \Delta U$
$W_{nc} = \Delta E_K + \Delta E_P$ ✓
$W_f = ½ (2)(2^2 - 4{,}95^2)$ ✓ $+ (2)(9{,}8)(0{,}5-0)$ ✓
$= -10{,}7$ J✓

(4)
**[13]**

**QUESTION 6/*VRAAG 6***

6.1.1 It is the (apparent) 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. ✓
*Dit is 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 van klankvoortplanting 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)

6.1.2 $v = f\lambda$ ✓
$340 = f(0{,}28)$ ✓
$f_s = 1\,214{,}29$ Hz ✓ (3)

6.1.3 **POSITIVE MARKING FROM QUESTION 6.1.2/*POSITIEWE NASIEN VANAF VRAAG 6.1.2***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v \pm v_L}{v \pm v_s} \times \frac{v}{\lambda_s}$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ **OR/*OF*** $f_L = \frac{f_s}{1 - \frac{v_s}{v}}$ ✓

$f_L = (\frac{340}{340 - 30}) 1214{,}29$ ✓ **OR/*OF*** $f_L = (\frac{340}{340 - 30}) \times \frac{340}{0{,}28}$ **OR/*OF*** $f_L = \frac{1214{,}29}{1 - \frac{30}{340}}$ ✓

= 1 331,80 Hz✓ (1 331,80 Hz – 1 335,72 Hz) (5)

6.1.4 Decreases/*Verlaag*✓ (1)

6.2 The spectral lines of the star are/should be shifted towards the lower frequency ✓ end, which is the red end (red shift) of the spectrum. ✓
*Die spektraallyne van die van die ster is verskuif na die laer frekwensie ent, wat die rooi ent van die spektrum is.* (2)
**[13]**

**QUESTION 7/*VRAAG 7***

7.1.1 The (magnitude of the) electrostatic force exerted by one (point) charge on another is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between their (centres) them. ✓
*Die (grootte) van die elektrostatiese krag wat een (punt) lading op 'n ander uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte.* (2)

7.1.2 $F_E$/Electrostatic force/*Elektrostatiese krag*✓ (1)

7.1.3 The electrostatic force is inversely proportional to the square of the distance between the charges ✓
*Die elektrostatiese krag is omgekeerd eweredig aan die kwadraat van die afstand tussen die ladings*

**OR/OF**
The electrostatic force is directly proportional to the inverse of the square of the distance between the charged spheres (charges). ✓
*Die elektrostatiese krag is direk eweredig aan omgekeerde van die kwadraat van die afstand tussen die gelaaide sfere (ladings).*

**OR/OF**
$F \alpha \frac{1}{r^2}$ ✓

**OR/*OF***
They are inversely proportional to each other /*Hulle is omgekeerd eweredig aan mekaar* (1)





7.1.4

**OPTION 1/OPSIE 1**

1 mark for using slope/
*1 punt vir die gebruik van helling*

Slope/*Helling* = $\frac{\Delta F_E}{\Delta \frac{1}{r^2}}$ ✓ = $\frac{(0{,}027 - 0)}{(5{,}6 - 0)}$ ✓

= 4,82 x $10^{-3}$ N·m$^2$ (4,76 x $10^{-3}$ – 5 x $10^{-3}$)

Slope/*Helling* = $F_E r^2 = kQ_1Q_2 = kQ^2$ ✓
4,82 x $10^{-3}$ ✓ = 9 x $10^9$ $Q^2$ ✓
∴ Q = 7,32 x $10^{-7}$C ✓

**OPTION 2/*OPSIE 2***
Accept any pair of points on the line/*Aanvaar enige paar punte op die lyn*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

( ) ✓ = $\frac{(9 \times 10^9)Q^2}{(\quad)}$ ✓✓

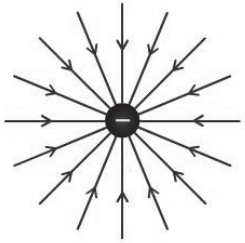
Q = 7,32 x $10^{-7}$C ✓ (7,32 x $10^{-7}$ – 7,45 x $10^{-7}$ C)

**Examples/*Voorbeelde***

(0,005) ✓ = $\frac{(9 \times 10^9)Q^2}{(1)}$ ✓✓
Q = 7,45 x $10^{-7}$ C ✓

(0,027) ✓ = $\frac{(9 \times 10^9)Q^2}{(\frac{1}{5{,}6})}$ ✓✓
Q = 7,32 x $10^{-7}$ C ✓ (6)

7.2.1



| **Criteria for drawing electric field:**<br>***Kriteria vir teken van elektriese veld:*** | **Marks/*Punte*** |
|---|---|
| Direction /*Rigting* | ✓ |
| Field lines radially inward/*Veldlyne radiaal inwaarts* | ✓ |

7.2.2 $E = \frac{kQ}{r^2}$ ✓

**Take right as positive/*Neem regs as positief***

$E_{PA} = \frac{(9\times10^9)(0{,}75\times10^{-6})}{(0{,}09)^2}$ ✓

$= 8{,}33 \times 10^5\ N\cdot C^{-1}$ to the left/*na links*

$E_{PB} = \frac{(9\times10^9)(0{,}8\times10^{-6})}{(0{,}03)^2}$ ✓

$= 8 \times 10^6\ N\cdot C^{-1}$ to the left/*na links*

$E_{net} = E_{PA} + E_{PC}$

$= [-8{,}33 \times 10^5 + (-8 \times 10^6)]$ ✓

$= -8{,}83 \times 10^6$

$= 8{,}83 \times 10^6\ N\cdot C^{-1}$ ✓

1 mark for the addition of same signs/
*1 punt vir optelling van dieselfde tekens*

**Take left as positive/*Neem links as positief***

$E_{PA} = \frac{(9\times10^9)(0{,}75\times10^{-6})}{(0{,}09)^2}$ ✓

$= 8{,}33 \times 10^5\ N\cdot C^{-1}$ to the left/*na links*

$E_{PB} = \frac{(9\times10^9)(0{,}8\times10^{-6})}{(0{,}03)^2}$ ✓

$= 8 \times 10^6\ N\cdot C^{-1}$ to the left/*na links*

$E_{net} = E_{PA} + E_{PC}$

$= \underline{(8{,}33 \times 10^5 + 8 \times 10^6)}$ ✓

$= 8{,}83 \times 10^6\ N\cdot C^{-1}$ ✓

1 mark for the addition of same signs/
*1 punt vir optelling van dieselfde tekens*

(5)
**[17]**





**QUESTION 8/*VRAAG 8***

8.1.1 (Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it ✓✓ / *Energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheid lading wat daardeur vloei.* (2)

8.1.2 12 (V)✓ (1)

8.1.3 0 (V) / Zero/*nul* ✓ (1)

8.1.4 $\varepsilon = I(R + r)$
$\varepsilon = V_{ext} + V_{int}$ ✓
$12 = 11{,}7 + Ir$
$\underline{0{,}3 = I_{tot}(0{,}2)}$ ✓
$I_{tot} = 1{,}5$ A ✓

**OR/*OF***
$V = IR$ ✓ (Accept/Aanvaar: $V_{"lost"} = Ir$)
$\underline{0{,}3 = I_{tot}(0{,}2)}$ ✓
$I_{tot} = 1{,}5$ A✓ (3)

8.1.5

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$<br>$\frac{1}{R} = \frac{1}{10} + \frac{1}{15}$ ✓Any one *Enigeen*<br>$R = 6\ \Omega$ ✓ | $R_{\parallel} = \frac{R_1R_2}{R_1+R_2}$<br>$= \frac{(10)(15)}{10+15}$ ✓Any one *Enigeen*<br>$= 6\ \Omega$ ✓ |

(2)

8.1.6

**POSITIVE MARKING FROM QUESTIONS 8.1.4 AND 8.1.5/*POSITIEWE NASIEN VANAF VRAE 8.1.4 EN 8.1.5***

**OPTION 1/*OPSIE 1***

| | |
|---|---|
| $V = IR$ ✓<br>$11{,}7$✓ $= \underline{1{,}5(6 + R)}$ ✓<br>$R = 1{,}8\ \Omega$ ✓ | **OR/OF**<br>$V = IR$ ✓<br>$\underline{11{,}7 = 1{,}5R}$ ✓<br>$R = 7{,}8\ \Omega$<br>$R_R = 7{,}8 - 6$ ✓<br>$= 1{,}8\ \Omega$ ✓ |

**OPTION 2/*OPSIE 2***

$\varepsilon = I(R + r)$ ✓
$12 = 1{,}5(R + 0{,}2)$ ✓
$R = 7{,}8\ \Omega$

$R_R = 7{,}8 - 6$ ✓
$= 1{,}8\ \Omega$ ✓

**OPTION 3/*OPSIE 3***

$V_{||} = IR_{||}$
$= (6)(1{,}5)$ ✓
$= 9\ V$

$V_R = IR$ ✓
$(11{,}7 - 9) = (1{,}5)R$ ✓
$R = 1{,}8\ \Omega$ ✓

(4)

8.2.1

$P_{ave/gemid} = Fv_{ave/gemid}$ ✓ $= mg(v_{ave/gemid})$
$= (0{,}35)(9{,}8)(0{,}4)$ ✓
$= 1{,}37\ W$ ✓

**OR/*OF***

$P = \frac{W_{nc}}{\Delta t}$ ✓ $= \frac{\Delta E_k + \Delta E_p}{\Delta t} = \frac{0 + (0{,}35)(9{,}8)(0{,}4 - 0)}{1}$ ✓ $= 1{,}37\ W$ ✓

**OR/*OF***

$P = \frac{W}{\Delta t}$ ✓ $= \frac{E_p}{\Delta t} = \frac{(0{,}35)(9{,}8)(0{,}4)}{1}$ ✓ $= 1{,}37\ W$ ✓

(3)

8.2.2

**POSITIVE MARKING FROM QUESTION 8.2.1/*POSITIEWE NASIEN VANAF VRAAG 8.2.1***

**OPTION 1/*OPSIE 1***

$P = VI$
$1{,}37 = (3)I$ ✓
$I = 0{,}46\ A$

$\varepsilon = V_{ext} + V_{int}$
$= V_T + V_X + V_{int}$
$12 = V_T + 3 + (0{,}2)(0{,}46)$ ✓
$V_T = 8{,}91\ V$

$V_T = IR_T$
$8{,}91 = (0{,}46)R_T$ ✓
$R_T = 19{,}37\ \Omega$ ✓

✓Any one *Enigeen*

**OPTION 2/*OPSIE 2***

$P = \frac{V^2}{R}$
$1{,}37 = \frac{3^2}{R}$ ✓
$R = 6{,}57\ \Omega$

$P = VI$
$1{,}37 = (3)I$ ✓
$I = 0{,}46\ A$

$\varepsilon = I(R + r)$
$12 = 0{,}46(6{,}57 + R_T + 0{,}2)$ ✓
$R_T = 19{,}38\ \Omega$ ✓

✓Any one *Enigeen*





**OPTION 3/*OPSIE 3***

$P = VI$ ✓
$1{,}37 = (3)I$ ✓
$I = 0{,}46\ A$

$P_{tot} = P_r + P_{motor} + P_T$
$(12)(0{,}46)$ ✓ $= (0{,}46)^2(0{,}2) + 1{,}37 + (0{,}46)^2R_T$ ✓
$R_T = 19{,}41\ \Omega$ ✓

**OR/*OF***

$P = VI$ ✓
$1{,}37 = (3)I$ ✓
$I = 0{,}46\ A$

$P_{tot} = P_r + P_{motor} + P_T$
$(12)(0{,}46) = (0{,}46)^2(0{,}2) + 1{,}37 + P_T$ ✓
$P_T = 4{,}07\ W$

$P = I^2R$
$4{,}07 = (0{,}46)^2R_T$ ✓
$R_T = 19{,}49\ \Omega$ ✓

**OPTION 4/*OPSIE 4***

$P = VI$
$1{,}37 = (3)I$ ✓
$I = 0{,}46\ A$

$\varepsilon = I(R + r)$
$12 = (0{,}46)(R + 0{,}2)$ ✓
$R = 25{,}87\ \Omega$

✓Any one *Enigeen*

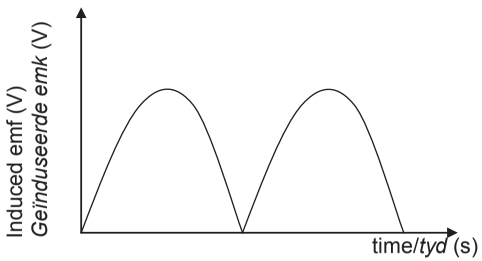
| | | |
|---|---|---|
| $V = IR$<br>$3 = (0{,}46)R$ ✓<br>$R = 6{,}52\ \Omega$<br><br>$R_T = 25{,}87 - 6{,}52$<br>$= 19{,}35\ \Omega$ ✓ | $P = I^2R$<br>$1{,}37 = (0{,}46)^2R$ ✓<br>$R = 6{,}47\ \Omega$<br><br>$R_T = 25{,}87 - 6{,}47$<br>$= 19{,}4\ \Omega$ ✓ | $P_{motor} = \frac{V^2}{R}$<br>$1{,}37 = \frac{3^2}{R}$ ✓<br>$R = 6{,}56\ \Omega$<br><br>$R_T = 25{,}87 - 6{,}56$<br>$= 19{,}31\ \Omega$ ✓ |

(5)
**[21]**

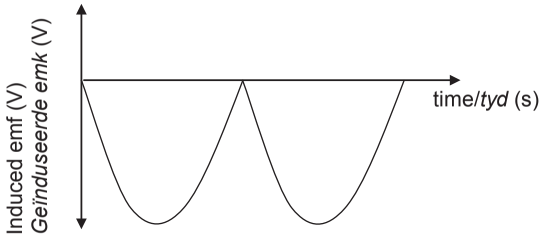
**QUESTION 9/*VRAAG 9***

9.1.1 DC/*GS*-generator✓
Uses split ring/commutator/*Gebruik spleetring/kommutator*✓ (2)

9.1.2




**OR/*OF***




(2)

9.2.1

| **OPTION 1/*OPSIE 1*** | **OR/*OF*** |
|---|---|
| $V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$<br>$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓<br>$800 = \frac{340}{\sqrt{2}}(I_{rms/wgk})$ ✓<br>$I_{rms/wgk} = 3{,}33$ A ✓ | $V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}} = \frac{340}{\sqrt{2}} = 240{,}416$<br>$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓<br>$800 = I_{rms/wgk}(240{,}416)$ ✓<br>$I_{rms/wgk} = 3{,}33$ A ✓ |





**OPTION 2/*OPSIE 2***

✓
$P_{ave/gem} = \left(\frac{V^2_{rms/wgk}}{R}\right) = \frac{(V^2_{max/maks})}{(2)(R)}$

$800 = \frac{(340)^2}{(\sqrt{2})^2(R)}$

$R = 72{,}25\ \Omega$

$P_{ave/gem} = I_{rms/wgk}^2 R$
$800 = I_{rms/wgk}^2 (72{,}25)$ ✓
$I_{rms/wgk} = 3{,}33$ A ✓

$V_{rms/wgk} = I_{rms/wgk} R$

$I_{rms/wgk} = \frac{240{,}416}{72{,}25}$ ✓

$= 3{,}33$ A✓ (3)

9.2.2

**POSITIVE MARKING FROM QUESTION 9.2.1**
***POSITIEWE NASIEN VANAF VRAAG 9.2.1***
**OPTION 1/*OPSIE 1***

$P_{ave/gemid} = V_{rms/wgk} I_{rms/wgk}$ ✓

for the kettle/*vir die ketel*:

$2000 = \frac{340}{\sqrt{2}}(I_{rms/wgk})$✓

$I_{rms/wgk} = 8{,}32$ A
$I_{tot} = (8{,}32 + 3{,}33)$ ✓
$= 11{,}65$ A ✓

**OPTION 2/*OPSIE 2***

$P_{ave/gemid} = \left(\frac{V^2_{rms/wgk}}{R}\right)$✓ $= \frac{(V^2_{max/maks})}{(2)(R)}$

$800 = \frac{(340)^2}{(\sqrt{2})^2(R)}$ ✓

$R = 72{,}25\ \Omega$

$2\,000 = \frac{(340)^2}{(\sqrt{2})^2(R_{2000})}$

$R = 28{,}9\ \Omega$

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ → $R = \frac{(28{,}9)(72{,}25)}{(28{,}9 + 72{,}25)} = 20{,}64\ \Omega$

$V_{rms/wgk} = I_{rms/wgk} R$
$240{,}42 = I_{rms/wgk}(20{,}64)$ ✓
$I_{rms/wgk} = 11{,}65$ A✓

| |
|---|
| **OPTION 3/*OPSIE 3*** |
| $P_{ave/gemid} = V_{rms/wgk}\ I_{rms/wgk}$ ✓ $= \frac{V_{max/maks} I_{max/maks}}{2}$ |
| $2\ 800$✓ $= \frac{(340)\ I_{max/maks}}{2}$ ✓ |
| $I_{max/maks} = 16{,}47$ A |
| $I_{rms} = \frac{I_{max/maks}}{\sqrt{2}} = \frac{16{,}47}{\sqrt{2}}$ |
| $I_{rms/wgk} = 11{,}65$ A✓ |
| **OPTION 4/*OPSIE 4*** |
| $P_{ave/gemid} = V_{rms/wgk}\ I_{rms/wgk}$✓ |
| $2\ 800$ ✓$= \frac{340}{\sqrt{2}}\ I_{rms/wgk}$✓ |
| $I_{rms/wgk} = 11{,}65$ A ✓ |
| **OPTION 5/*OPSIE 5*** |
| $P_T : P_K$ |
| 800 : 2 000 ✓ |
| 1 : 2,5 |
| $I_T : I_K$ |
| 3,33 : 8,325 ✓ |
| $I_{rms} = 3{,}33 + 8{,}325$ ✓ |
| $= 11{,}66$ A ✓ |

(4)
**[11]**

**QUESTION 10/*VRAAG 10***

10.1.1 The minimum frequency (of a photon/light) needed✓ to emit electrons from (the surface of) a metal. (substance) ✓
*Die minimum frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) vry te stel*

**OR/OF**
The frequency (of a photon/light) needed✓ to emit electrons from (the surface of) a metal. (substance) with zero kinetic energy✓
*Die frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) met nul/geen kinetiese energie vry te stel* (2)





10.1.2 Silver/*Silwer*✓

Threshold/cutoff frequency (of Ag) is higher/*Drumpel/afsnyfrekwensie (van Ag) is hoër*✓
$W_o$ α $f_o$ / $W_o = hf_o$ ✓
**OR/*OF***
To eject electrons with the same kinetic energy from each metal, light of a higher frequency/energy is required for silver. ✓ Since $E = W_o + E_{k(max)}$ (and $E_k$ is constant), the higher the frequency/energy of the photon/light required, the greater is the work function/$W_o$.✓
*Om elektrone met dieselfde kinetiese energie van elke metal vry te stel,is lig van hoër frekwensie benodig vir silwer. Aangesien $E = W_o + E_{k(maks)}$ (en $E_{k(maks)}$ is konstant) word fotone/lig van hoër frekwensie/energie benodig, dus is arbeidsfunksie hoër* (3)

10.1.3 Planck's constant /*Planck se konstante* ✓ (1)

10.1.4 Sodium/*Natrium*✓ (1)

10.2.1 Energy radiated per second by the blue light /*Energie per sekonde uitgestraal deur die bloulig* $= (\frac{5}{100})(60 \times 10^{-3})$ ✓ $= 3 \times 10^{-3}\ J{\cdot}s^{-1}$

$E_{photon/foton} = \frac{hc}{\lambda}$ ✓

$= \frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{470 \times 10^{-9}}$ ✓

$= 4{,}232 \times 10^{-19}$ J

Total number of photons incident per second/*Totale aantal fotone wat per sekonde inval* $= \frac{3 \times 10^{-3}}{4{,}232 \times 10^{-19}}$ ✓

$= 7{,}09 \times 10^{15}$ ✓ (5)

10.2.2 **POSITIVE MARKING FROM QUESTION 10.2.1**
***POSITIEWE NASIEN VANAF VRAAG 10.2.1***

$7{,}09 \times 10^{15}$ (electrons per second/*elektron per sekonde*) ✓

**OR/*OF***
Same number as that calculated in Question 10.2.1 above/*Dieselfde as die in Vraag 10.2.1 hierbo bereken* (1)
**[13]**

**TOTAL/*TOTAAL*: 150**

Province of the
EASTERN CAPE
EDUCATION

**NATIONAL SENIOR CERTIFICATE**

**GRADE/*GRAAD 12***

**SEPTEMBER 2014**

# PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MEMORANDUM

**MARKS/PUNT:** **150**

This memorandum consists of 16 pages./
*Hierdie memorandum bestaan uit 16 bladsye.*



**QUESTION 1/*VRAAG 1***

| | | |
|---|---|---|
| 1.1 | D ✓✓ | (2) |
| 1.2 | B ✓✓ | (2) |
| 1.3 | B ✓✓ | (2) |
| 1.4 | A ✓✓ | (2) |
| 1.5 | D ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | B ✓✓ | (2) |
| 1.8 | C ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | B ✓✓ | (2) |
| | | **[20]** |

**QUESTION 2/*VRAAG 2***

2.1

| **OPTION 1/*OPSIE 1*** | **NOTES/*AANTEKENINGE*** |
|---|---|
| **DOWNWARDS AS POSITIVE**<br>$v_f^2 = v_i^2 + 2g\Delta y$ ✓<br>$= 0^2 + 2(9,8)(15)$ ✓<br>$v_f = 17,15\ m\cdot s^{-1}$ ✓ (3)<br><br>**OR/*OF***<br><br>**DOWNWARDS AS NEGATIVE**<br>$v_f^2 = v_i^2 + 2g\Delta y$ ✓<br>$= 0^2 + 2(-9,8)(-15)$ ✓<br>$v_f = 17,15\ m\cdot s^{-1}$ ✓ (3) | **Accept/Aanvaar**<br>***g*** or/of ***a***<br>$v^2 = u^2 + 2a\Delta x$<br>$v^2 = u^2 + 2as$ |
| **OPTION 2/*OPSIE 2*** | **NOTES/*AANTEKENINGE*** |
| **DOWNWARDS AS POSITIVE**<br>$W_{net} = \Delta K$ ✓<br>$F_{net}\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$<br>$m(9,8)(15)\cos 0^0 = ½m(v_f^2 - 0^2)$ ✓<br>$\therefore v_f = 17,15\ m\cdot s^{-1}$ ✓ (3)<br><br>**OR/OF**<br><br>**DOWNWARDS AS NEGATIVE**<br>$W_{net} = \Delta K$ ✓<br>$F_{net}\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$<br>$m(-9,8)(-15)\cos 0 = ½m(vf^2 - 0^2)$ ✓<br>$\therefore v_f = 17,15\ m\cdot s^{-1}$ ✓ (3)<br><br>**OR/OF** | **Accept/Aanvaar:**<br><br>$F_{net}\Delta x\cos\theta$<br>$W_{net} = \Delta E_k$ |
| **OPTION 4/*OPSIE 4*** | **NOTES/*AANTEKENINGE*:** |
| $F_{net} = ma$ ✓<br>$mg = \frac{m(v_f^2 - v_i^2)}{2\Delta x}$<br>$(0,156)(9,8) = \frac{0,156(v_f^2 - 0)}{15}$ ✓<br>$v_f = 17,15\ m\cdot s^{-1}$ ✓ (3)<br><br>**OR/OF**<br><br>**DOWNWARDS AS NEGATIVE**<br>$F_{net} = ma$ ✓<br>$mg = \frac{m(v_f^2 - v_i^2)}{2\Delta x}$<br>$(0,156)(-9,8) = \frac{0,156(v_f^2 - 0)}{-15}$ ✓<br>$v_f = 17,15\ m\cdot s^{-1}$ ✓ (3) | **Accept/*Aanvaar*:**<br><br>***g*** or/of ***a***<br>$v^2 = u^2 + 2a\Delta x$<br>$v^2 = u^2 + 2as$ |
| **OPTION 5/OPSIE 5** | **NOTES/ *AANTEKENINGE*:** |
| $\Delta y = vi\Delta t + ½g\Delta t^2$<br>$15 = 0(\Delta t) + ½(9,8)\Delta t^2$<br>$\Delta t = 1,75\ s$ ✓<br><br>$v_f = v_i + g\Delta t$<br>$= 0 + 9,8(1,75)$ ✓<br>$= 17,15\ m.s^{-1}$ ✓ | **Accept/Aanvaar:**<br><br>***g*** or/of ***a***<br>$s = ut + ½a\Delta t^2$<br>$v = u + at$ |

(3)





2.2 Lower/*Laer* ✓ (1)

2.3 **POSITIVE MARKING FROM QUESTION 2.1/**
***POSITIEWE NASIEN VAN VRAAG 2.1***

**IF/INDIEN:**
Downwards taken as negative in any one of QUESTION 2.3 and deduct only ONE mark at the first infringement.
Indicate at which question the mark is deducted by cancelling one tick and draw an upward arrow with positive sign next to it.

*Afwaarts as negatief geneem in enige van VRAAG 2.3 en trek slegs EEN punt by die eerste oortreding af.*
*Dui aan by watter vraag die punt afgetrek is deur een reg merkie te kanselleer en trek 'n opwaartse pyl met 'n positiewe teken langsaan.* ↑ +

2.3.1

| **DOWNWARDS AS POSITIVE** | **NOTES/ *AANTEKENINGE*** |
|---|---|
| $v_f^2 = v_i^2 + 2g\Delta y$ ✓<br>$0^2$ ✓ $= v_i^2 + 2(9,8)(-4)$ ✓<br>$v_i = 8,85\ m\cdot s^{-1}$ ✓<br><br>$F_{net}\Delta t = \Delta p$ } ✓<br>$F_{net}\Delta t = m(v_f - v_i)$ } Any **ONE**/Enige **EEN**<br>$\Delta p = (0,156)$ ✓ $(-8,85 - 17,15)$ ✓<br>$= -4,056\ kg\cdot m\cdot s^{-1}$<br>$= 4,06\ N\cdot s$ upwards/opwaarts ✓ (8)<br><br>**DOWNWARDS AS NEGATIVE**<br>$v_f^2 = v_i^2 + 2g\Delta y$ ✓<br>$0^2$ ✓ $= v_i^2 + 2(-9,8)(4)$ ✓<br>$v_i = 8,85\ m\cdot s^{-1}$ ✓<br><br>$F_{net}\Delta t = \Delta p$ } ✓<br>$F_{net}\Delta t = m(v_f - v_i)$ } Any **ONE**/Enige **EEN**<br>$\Delta p = (0,156)$ ✓ $(8,85 - (-17,15)$ ✓<br>$= 4,056\ kg\cdot m\cdot s^{-1}$<br>$= 4,06\ N\cdot s$ upwards/opwaarts ✓ (8) | **Accept/Aanvaar**<br>***g*** or/of ***a***<br>$v^2 = u^2 + 2a\Delta x$<br>$v^2 = u^2 + 2as$ |

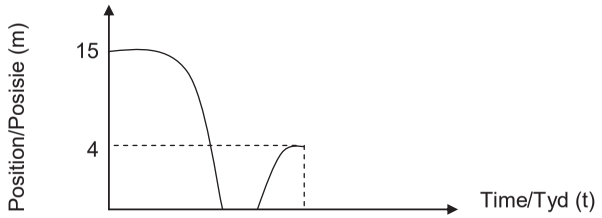
(8)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.3.1/**
***POSITIEWE NASIEN VAN VRAAG 2.3.1***

**DOWNWARDS AS POSITIVE**
$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= -\frac{4,056}{0,80}$ ✓ $= -5,07\ N = 5,07\ N$ upwards/opwaarts ✓ (4)

**DOWNWARDS AS NEGATIVE**
$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= \frac{4,056}{0,80}$ ✓ $= 5,07\ N$ upwards/opwaarts ✓ (4)

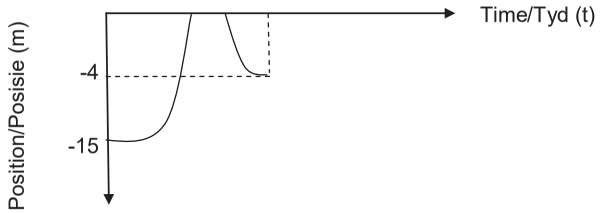
2.4 **DOWNWARD POSITIVE/AFWAARTS POSITIEF:**




| Criteria for graph/Kriteria vir grafiek | Marks/ Punte |
|---|---|
| Correct shape (Both curves)/ *Korrekte vorm (Beide kurwes)* | ✓ |
| Graph starts at y = 15 m at t = 0 s<br>*Grafiek begin by y= 15 m by t = 0 s* | ✓ |
| Second maximum height at y = 4 m<br>*Tweede maksimum by y = 4 m* | ✓ |
| Contact time shown as space on x-axis between two curves<br>*Kontak tyd aangetoon as spasie op x-as tussen twee krommes* | ✓ |

(4)

**DOWNWARD NEGATIVE/AFWAARTS POSITIEF:**




| Criteria for graph/Kriteria vir grafiek | Marks/ Punte |
|---|---|
| Correct shape (Both curves)/ *Korrekte vorm (Beide kurwes)* | ✓ |
| Graph starts at y = -15 m at t = 0 s<br>*Grafiek begin by y= -15 m by t = 0 s* | ✓ |
| Second maximum height at y = -4 m<br>*Tweede maksimum by y = -4 m* | ✓ |
| Contact time shown as space on x-axis between two curves<br>*Kontak tyd aangetoon as spasie op x-as tussen twee krommes* | ✓ |

(4)

2.5 SMALLER/KLEINER ✓

$F_{net} = \frac{\Delta p}{\Delta t}$

OR/OF

$F_{net} \propto \frac{1}{\Delta t}$ ($\Delta p$ constant)

$\Delta t$ increases/*neem toe* ✓

$\therefore F_{net}$ decreases/*neem af*

(3)

**[23]**





**QUESTION 3/VRAAG 3**

3.1 The total linear momentum of a closed system remains constant (is conserved) ✓✓ or ✓
Total linear momentum before a collision = total linear momentum after a collision in a closed system. ✓
*Die totale linieêre momentum in 'n geslote sisteem bly konstant (behoue).*✓✓
*Totale linieêre momentum voor 'n botsing = totale linieêre momentum na 'n botsing* ✓ *in 'n geslote sisteem.* ✓ (2)

3.2 **Consider LEFT as positive/*Beskou LINKS as positief***

$\sum p_i = \sum p_f$ ✓
$m_M v_{iM} + m_C v_{iC} = m_M v_{fM} + m_C v_{fC}$

$\underline{(2000)(20)} + (1\,500)(0)$ ✓ $= \underline{(2000)(12) + 1500 v_{fC}}$✓
$V_{f\,M} = 11\ m\cdot s^{-1}$✓ (4)

Other formulae/*Ander formules:*
$m_M v_{iM} + m_C v_{iC} = m_M v_{fM} + m_C v_{fC}$
or/of
$m_M u_M + m_C u_C = m_M v_M + m_C v_C$
or/of
$m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$
or/of
$m_1 u_{i1} + m_2 u_{i2} = m_1 v_{f1} + m_2 v_{f2}$
$p_{total\ before} = p_{total\ after}$

Accept/Aanvaar: $p_{before} = p_{after}$ or/of $p_i = p_f$

3.3 The <u>driver will continue moving foward at the same velocity</u> until the driver <u>strikes the dashboard or windscreen</u>. ✓

*Die <u>bestuurder hou aan vorentoe beweeg teen dieselfde snelheid</u> totdat die bestuurder die <u>paneel of voorruit tref</u>.* ✓ (1)

3.4 A body will remain in its state of rest or motion at constant velocity✓ unless a non-zero resultant force acts on it. ✓

*'n Liggaam sal in sy toestand van rus of beweging teen 'n konstante snelheid volhard,*✓ *tensy 'n nie-nul resulterende krag daarop inwerk.*✓ (2)

**[9]**

**QUESTION 4/*VRAAG 4***

4.1 $W = \Delta K + \Delta U$ ✓
$= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_2 - h_1)$
$= \frac{1}{2}(90)(2^2 - 0^2)$ ✓ $+ (90)(9,8)(37)$ ✓
$= 32\ 814$ J ✓ (4)

4.2 **POSITIVE MARKING FROM QUESTION 4.1/**
***POSITIEWE NASIEN VAN VRAAG 4.1***

$P = \frac{W}{t}$ ✓
$= \frac{32\ 814}{1 \times 60}$ ✓
$= 546,9$ W ✓ (3)

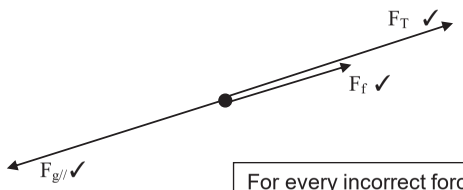
4.3 4.3.1 No/*Nee* ✓ (1)

4.3.2 Windmill is more environmental friendly. ✓ (Or similar)
*Windpomp is meer omgewingsvriendelik.* ✓ *(Of soortgelyk)* (1)
**[9]**

**QUESTION 5/*VRAAG 5***

| **Accepted Labels/*Aanvaarbare Benoemings*** | |
|---|---|
| $F_{applied}$<br>$F_{toegepas}$ | $F_T$/T/Force on crate/$F_A$/Tension/300 N<br>$F_T$/T/Krag op krat/$F_A$/Spanning/300 N |
| Friction<br>*Wrywing* | $F_f$/$F_{friction}$/friction<br>$F_f$/$F_{wrywing}$/*wrywing* |
| $F_{g//}$ | $F_{//}$/mg sin 30°/$F_g$ sin 30°/$F_{W//}$ |

5.1




For every incorrect force shown (-1 mark)
*Vir enige verkeerde krag getoon (-1 punt)*

(3)

5.2 The net (total) work done (on an object) ✓ is equal to the change in kinetic energy (of the object). ✓ **OR**
The work done (on an object) by a net (resultant) force ✓ is equal to the change in (the object's) kinetic energy. ✓

*Die netto (totale) arbeid (verrig op 'n voorwerp)* ✓ *is gelyk aan die verandering in kinetiese energie (van die voorwerp)* ✓ **OF**
*Die arbeid verrig (op 'n voorwerp) deur 'n netto (resulterende) krag* ✓ *is gelyk aan die verandering in kinetiese energie (van die voorwerp).* ✓ (2)





5.3 **OPTION 1/*OPSIE 1***

$W_{NET} = \Delta K$
$W_{Fg} + W_{FT} + W_{Ff} + W_{FN} = \Delta K$ } ✓Any one/*Enige een*
$F_g\Delta x\cos\theta + F_f\Delta x\cos\theta + F_T\Delta x\cos\theta + 0 = 450$
$(50)(9,8)\Delta x\cos 60°$ ✓ $+ 50\Delta x\cos 180° + 300\Delta x\cos 180°$ ✓ $= 450$ ✓
$(245 - 50 - 300)\Delta x = 450$
$\Delta x = 4,29$ m ✓ (5)

**OPTION 2/*OPSIE 2***

$W_{NET} = \Delta K$
$W_{Fg//} + W_{Ff} + W_{FT} + W_{FN} + W_{Fg\perp} = \Delta K$ } ✓ Any one/*Enige een*
$F_{g//}\Delta x\cos\theta + F_f\Delta x\cos\theta + F_T\Delta x\cos\theta + 0 + 0 = 450$
$(50)(9,8)\sin 30°\Delta x\cos 0°$ ✓ $+ 50\Delta x\cos 180° + 300\Delta x\cos 180°$ ✓ $= 450$ ✓
$(245 - 50 - 300)\Delta x = 450$
$\Delta x = 4,29$ m ✓ (5)

**OPTION 3/*OPSIE 3***

$F_{net} = F_T + F_f + W_{//}$
$= 300 + 50 - mg\sin 30°$
$= 300 + 50 - (50)(9,8)\sin 30°$ ✓
$= 105$
✓Both formulae/Albei formules

$F_{net}\Delta x\cos\theta = \Delta K$
$105\ \Delta x\cos 0°$ ✓ $= 450$ ✓
$\Delta x = 4,29$ m ✓ (5)

5.4 $f_k = \mu_k N$
$= \mu_k(mg\cos\theta)$ } ✓ Any ONE/Enige EEN
$50$ ✓ $= \mu_k(50)(9,8)\cos 30°$ ✓
$\mu_k = 0,12$ ✓ (4)
**[14]**

**QUESTION 6/*VRAAG 6***

6.1 The Doppler Effect is the perceived change in frequency of sound caused by either the listener or the source moving relative to each other. ✓✓

*Die Dopplereffek is die waargenome verandering in frekwensie van 'n klank wat veroorsaak deurdat óf die luisteraar óf die bron met betrekking tot mekaar beweeg.* ✓✓ (2)

6.2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$1,07\ f_s$ ✓ $= \frac{340}{340 - v_s}$ ✓ $f_s$ ✓

$v_s = 22,24\ m\cdot s^{-1}$ ✓ (5)

6.3 Ambulance moves towards detector, with constant velocity (speed) of sound. ✓
$\lambda$ decreases and the frequency increases. ✓

*Ambulans beweeg na die detektor met konstante snelheid (spoed) van klank.* ✓
*$\lambda$ neem af en frekwensie neem toe.* ✓ (2)

6.4
- Determine whether arteries are clogged/narrowed ✓
- Determine heartbeat of fetus ✓

- *Bepaal of are verstop/vernou is.* ✓
- *Bepaal die hartklop van 'n fetus* ✓ (2)

6.5 AWAY/*WEG* ✓
Light from a star is shifted towards a lower frequency (red light has the lowest frequency). ✓
*Die ster se lig word verskuif na 'n laer frekwensie (rooi lig besit die laagste frekwensie.)* ✓ (2)
**[13]**

**QUESTION 7/*VRAAG 7***

7.1 (Electrostatic) force experienced per unit positive charge placed at a point. ✓✓

*(Elektrostatiese) krag wat per eenheidspositiewe-lading by daardie punt geplaas is, ondervind word.* ✓✓ (2)

7.2 $E = \frac{kQ_M}{r^2}$ ✓ $= \frac{(9 \times 10^9)(-4 \times 10^{-9})}{(15 \times 10^{-3})^2}$ ✓ $= 1,6 \times 10^5 N \cdot C^{-1}$ ✓ east/*oos* ✓ (5)

7.3 $E_{net} = E_M + E_N$
$2 \times 10^5$ ✓ $= 1,6 \times 10^5 + E_N$ ✓
$E_N = 4,5 \times 10^5 N \cdot C^{-1}$ east/*oos* ✓

| **NOTES/AANTEKENINGE** |
|---|
| Mark direction independently./*Merk rigting onafhanklik.* |

$E_N = \frac{kQ_N}{r^2}$

$4,5 \times 10^5 = \frac{(9 \times 10^9)Q_N}{(45 \times 10^{-3})^2}$ ✓

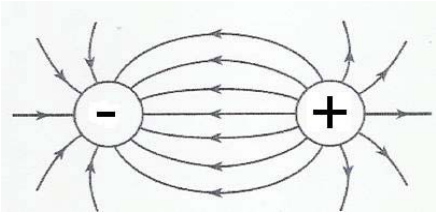
$Q_N = 9 \times 10^{-9}$ C east/*oos* ✓ (5)

7.4 Positive/*Positief* ✓ (1)





7.5 **POSITIVE MARKING FROM QUESTION 7.4**
***POSITIEWE NASIEN VANAF VRAAG 7.4***




| **Criteria for sketch:/*Kriteria vir skets*:** | **Marks/Punte** |
|---|---|
| Correct shape<br>*Korrekte vorm* | ✓ |
| Correct direction<br>*Korrekte rigting* | ✓ |
| Field lines not touching each other or entering the spheres.<br>*Veldlyne raak nie mekaar nie of wat die sfere binnegaan.* | ✓ |

(3)

7.6 $E = \frac{F}{q}$ ✓
$2 \times 10^5 = \frac{F}{1,6 \times 10^{-19}}$ ✓
$F = 3,2 \times 10^{-4}$ N ✓ (3)
**[19]**

**QUESTION 8/VRAAG 8**

8.1 Motor effect/*Motor-effek* ✓ (1)

8.2 Electrical (energy) to mechanical (energy) ✓
*Elektriese (energie) na meganiese (energie)* ✓ (1)

8.3 Current in section BC is parallel ✓ to the magnetic field. ✓
*Stroom in gedeelte BC is parallel* ✓ *aan die magneetveld.* ✓ (2)

8.4 ANTI-CLOCKWISE/ANTI-*KLOKSGEWYS* ✓ (1)

8.5 ~~Increase the speed of rotation/~~
Increase the number of turns in the coil.
Increase the strength of the magnetic field } ANY ONE ✓
increase current strength
~~*Verhoog spoed van rotasie.*~~
*Vermeerder die aantal windings van die spoel.* ✓
*Verhoog die magnetiese veldsterkte.* } *ENIGE EEN* ✓ (1)
verhoog stroom sterkte

8.6.1 $T = \frac{0,075 \times 2}{5}$ ✓ **OR/*OF*** $f = \frac{\text{no of cycles}}{\text{time}}$ ✓ $= \frac{2,5}{0,075}$ ✓ = 33,3 Hz ✓

= 0,03 s

$f = \frac{1}{T}$

$= \frac{1}{0,03}$ ✓

= 33,3 Hz ✓

$f = \frac{\textit{aantal siklusse}}{\textit{tyd}}$ ✓ $= \frac{2,5}{0,075}$ ✓ = 33,3 Hz ✓

(3)

8.6.2

**OPTION 1/*OPSIE 1***

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \left(\frac{V_{max}}{\sqrt{2}}\right)\left(\frac{I_{max}}{\sqrt{2}}\right)$ ✓ BOTH formulae/*ALBEI formules*

2 700 ✓ $= \left(\frac{325}{\sqrt{2}}\right)$ ✓ $\left(\frac{I_{max}}{\sqrt{2}}\right)$

$I_m$ $I_{max}$ = 16,62 A ✓

(5)

**OPTION 2/*OPSIE 2***

$P_{ave} = \frac{V_{max}I_{max}}{2}$ ✓✓ ✓

2 700 ✓ $= \frac{(325)I_{max}}{2}$ ✓

$I_{max}$ = 16,62 A ✓ (5)

**OPTION 3/*OPTION 3***

✓ $V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{325}{\sqrt{2}}$ ✓ = 229,80 V

$P_{ave} = V_{rms}\frac{I_{max}}{\sqrt{2}}$

2 700 ✓ $= (229,80)\frac{I_{max}}{\sqrt{2}}$ ✓

$I_{max}$ = 16,62 A ✓

(5)

**[14]**





**QUESTION 9/*VRAAG 9***

9.1 The battery has internal resistance ✓ therefore work per Coulomb charge must be done by charges to move through the battery. ✓

*Die battery het interne weerstand ✓daarom word arbeid per Coulomb lading deur ladings verrig om deur die battery te beweeg.* ✓ (2)

9.2 **OPTION 1/*OPSIE 1***

$P = I^2R$ ✓

$6 = I^2(6)$

I = 1 A

$V_{6\Omega} = IR = 1(6) = 6V$ ✓

$V_{3\Omega} = 12 - 6 = 6\,V$ ✓

$I_{3\Omega} = \frac{V}{R} = \frac{6}{3}$ ✓ = 2 A ✓

$\varepsilon = IR + Ir$ ✓

13 = 12 + 2r ✓

r = 0,5 Ω ✓ (9)

**OPTION 2/*OPSIE 2***

$P = \frac{V^2}{R}$ ✓

$6 = \frac{V^2}{6}$ ✓

V = 6V ✓

6V + Ir + 3I = 13 ✓

6 + 1 + 3I = 13 ✓

3I = 6

I = 2A ✓

Lost/*Verlore volt*: Ir = 1 ✓

2r = 1 ✓

r = ½ Ω ✓ (9)

9.3 $R = \frac{V}{I}$ ✓ $= \frac{6}{1}$ ✓ = 6 Ω ✓ (3)

9.4 Increases/*Vermeerder* ✓

Total Resistance decreases/*Totale Weerstand verminder* ✓

Current increases/*Stroom vermeerder* ✓

Ir increases/*Ir vermeerder* ✓ (4)

**[18]**

**QUESTION 10/*VRAAG 10***

10.1 What is the relationship between the frequency of the incident light and the number of photo electrons emitted?
*Wat is die verwantskap tussen die frekwensie van die invallende lig en die aantal foto-elektrone wat vrygestel word?*

| **CRITERIA for investigation question:**<br>***KRITERIA vir ondersoekende vraag*:** | **Mark/*Punt*** |
|---|---|
| The dependent and independent variables are stated.<br>*Die afhanklike en onafhanklike veranderlikes is genoem.* | ✓ |
| Asks a question about the relationship between dependent and independent variables.<br>*Vra 'n vraag oor die verwantskap tussen afhanklike en onafhanklike veranderlikes.* | ✓ |

(2)

**NOTES/*AANTEKENINGE***

A question that results in a "YES" or "NO" answer MAX. ½
*'n Vraag wat "JA" of "NEE" as antwoord het MAKS. ½*

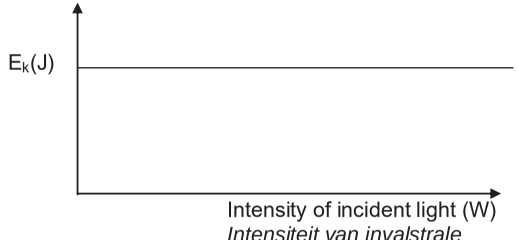
10.2 Cut-off frequency/Threshold frequency ✓
*Afsnyfrekwensie/Drumpelfrekwensie* ✓ (1)

10.3 $hf_x = W_o + E_K$
$hf_x = hf_0 + E_K$ } ✓ ANY one/*ENIGE een*

$(6{,}63 \times 10^{-34})\ f_x$ ✓ $= (6{,}63 \times 10^{-34})(4{,}29 \times 10^{14})$ ✓ $+ (2{,}18 \times 10^{-19})$ ✓

$f_x = \dfrac{5{,}02 \times 10^{-19}}{6{,}63 \times 10^{-34}}$
$= 7{,}58 \times 10^{14}$ Hz ✓ (5)

10.4




| **CRITERIA/KRITERIA** | **MARK/*PUNT*** |
|---|---|
| Correct unit and labels/*Korrekte beskrywings en eenhede* | ✓ |
| Correct shape/*Korrekte vorm* | ✓✓ |

(3)
**[11]**

**TOTAL/TOTAAL: 150**

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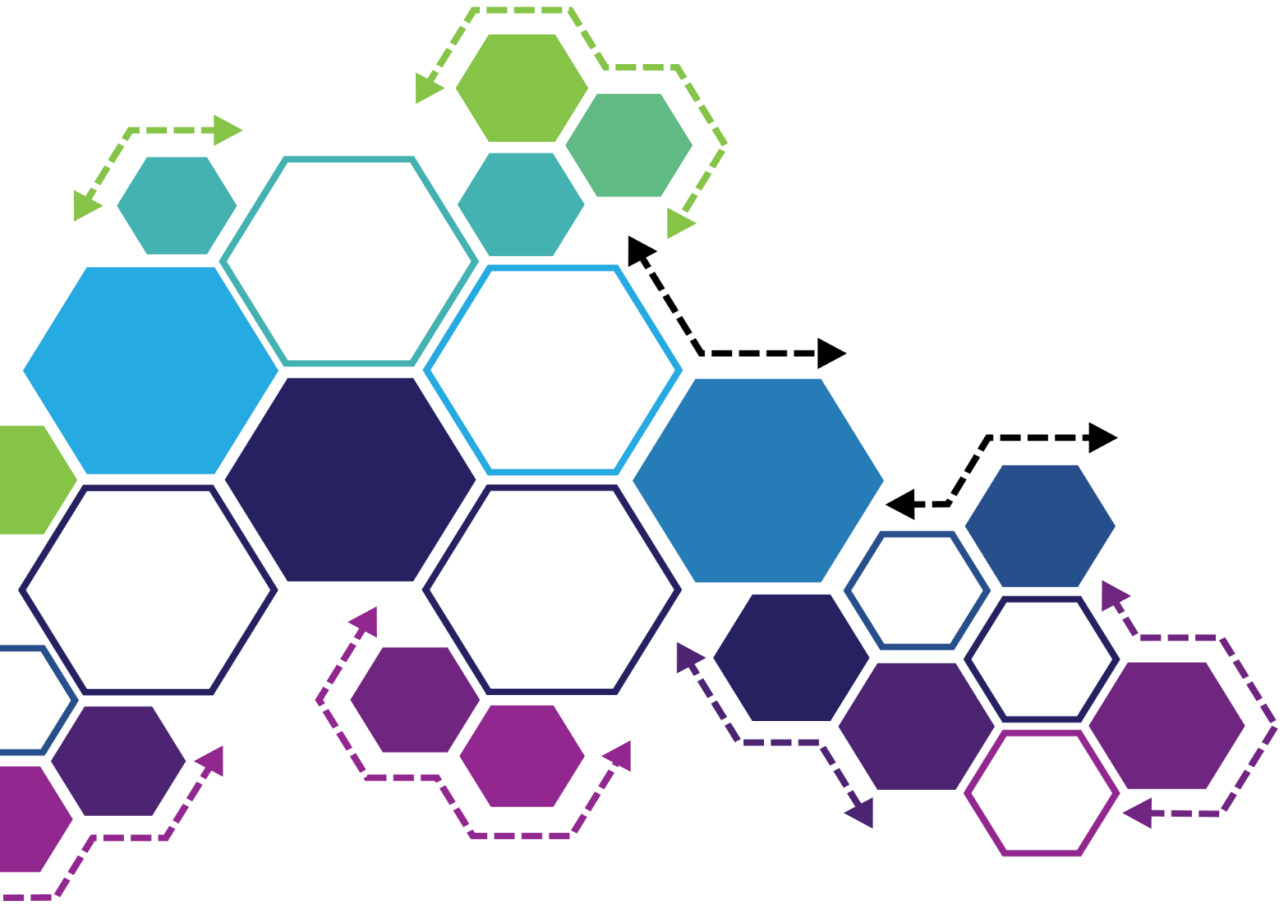
# Chemistry Paper 2 - Memoranda



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* ✓✓

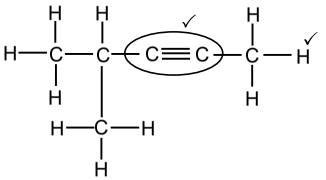
**ACCEPT/*AANVAAR***
2,2-dimethylpropanal/*2,2-dimethylpropanaal*
2-methylbutanal/*2-metielbutanaal*
3-methylbutanal/*3-metielbutanaal* (2)

**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]**

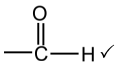
**QUESTION 3/*VRAAG 3***

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]**

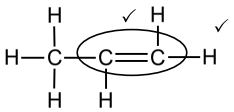
**QUESTION 4/*VRAAG 4***

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

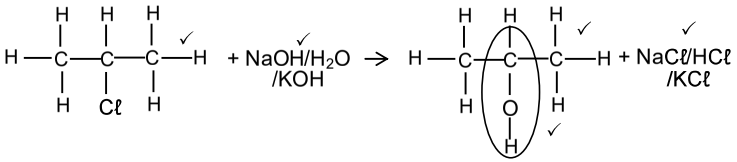
(2)

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 vit 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*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $n(CO_2) = \frac{V}{V_m} = \frac{0,5}{25,7}$ ✓<br>= 0,0195 mol<br>$n(CaCO_3) = n(CO_2) = 0,0195$ mol ✓<br>$m(CaCO_3) = nM$<br>= 0,0195(100)<br>= 1,95 g ✓ | $25,7\ dm^3$ .....1 mol<br>$0,5\ dm^3$ .....0,0195 mol ✓<br>100 g ✓.....1 mol<br>x .....0,0195 mol ✓<br>$x = m(CaCO_3) = 1,95$ 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***

$K_c = \frac{[I]^2}{[I_2]}$ ✓

$3,76 \times 10^{-3}$ ✓ $= \frac{(4,79 \times 10^{-3})^2}{[I_2]}$ ✓

∴ $[I_2] = 6,102 \times 10^{-3}$ mol·dm$^{-3}$

| | $I_2$ | I | |
|---|---|---|---|
| Initial mass (g)<br>*Aanvangsmassa (g)* | (0,1045)(254) ✓<br>= 26,543 g ✓ | | |
| Initial quantity (mol)<br>*Aanvangshoeveelheid (mol)* | 0,1045 | 0 | |
| Change (mol)<br>*Verandering (mol)* | ✓ 0,0295 | 0,0589 ✓ | Using ratio ✓ |
| Quantity at equilibrium (mol)/<br>*Hoeveelheid by ewewig (mol)* | 0,0751 | 0,0589 | |
| Equilibrium concentration (mol·dm$^{-3}$)<br>*Ewewigskonsentrasie (mol·dm$^{-3}$)* | $6,102 \times 10^{-3}$ | $4,79 \times 10^{-3}$ | x12,3 ✓ |

| | |
|---|---|
| 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 | |

**OPTION 2/*OPSIE 2***

| | $I_2$ | I | |
|---|---|---|---|
| Initial amount (moles)<br>*Aanvangshoeveelheid (mol)* | x | 0 | |
| Change in amount (moles)<br>*Verandering in hoeveelheid* (mol) | 0,0295 ✓ | 0,0589 | ratio ✓<br>*verhouding* |
| Equilibrium amount (moles)<br>*hoeveelheid* (mol) | x - 0,0295 | 0,0589 ✓ | |
| Equilibrium concentration (mol·dm$^{-3}$)<br>*Ewewigskonsentrasie (mol·dm$^{-3}$)* | $\frac{x - 0,0295}{12,3}$ | $4,79 \times 10^{-3}$ | 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

∴ 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$^{-3}$)<br>*Aanvangskonsentrasie (mol·dm$^{-3}$)* | $8,497 \times 10^{-3}$ | 0 | |
| Change (mol·dm$^{-3}$)<br>*Verandering* (mol·dm$^{-3}$) | ✓ $2,395 \times 10^{-3}$ | $4,79 \times 10^{-3}$ ✓ | Using ratio ✓ |
| Equilibrium concentration (mol·dm$^{-3}$)<br>*Ewewigskonsentrasie (mol·dm$^{-3}$)* | $6,102 \times 10^{-3}$ | $4,79 \times 10^{-3}$ | |

$c = \frac{m}{MV}$

$8,497 \times 10^{-3} = \frac{m}{(254)(12,3)}$ ✓ ✓

∴ 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 = $-\log[H_3O^+]$ ✓<br>3,85 ✓ = $-\log[H_3O^+]$<br>$[H_3O^+]$ = 1,41 x $10^{-4}$ mol·dm$^{-3}$ ✓ | $[H_3O^+] = 10^{-pH}$ ✓<br>= $10^{-3,85}$ ✓<br>= 1,41 x $10^{-4}$ mol·dm$^{-3}$ ✓ |

(3)

7.1.3 Greater than/*Groter as* ✓ (1)

7.1.4 $CH_3COO^-(aq) + H_2O(\ell)$ ✓ $\rightleftharpoons$ $CH_3COOH(aq) + OH^-(aq)$ ✓

**OR/*OF***

$CH_3COONa(aq) + H_2O(\ell)$ ✓ $\rightleftharpoons$ $CH_3COOH(aq) + NaOH(aq)$ ✓

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***

| | |
|---|---|
| $H_2 \leftarrow 2H^+ + 2e^-$ ($\frac{2}{2}$) | $2H^+ + 2e^- \rightleftharpoons H_2$ ($\frac{1}{2}$) |
| $H_2 \rightleftharpoons 2H^+ + 2e^-$ ($\frac{0}{2}$) | $2H^+ + 2e \leftarrow H_2$ ($\frac{0}{2}$) |

- 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:* $\frac{1}{2}$

(2)

8.4.2 Magnesium/Mg ✓ (1)

8.5

| **OPTION 1/*OPSIE 1*** | **Notes/*Aantekeninge*** |
|---|---|
| $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓<br>$= 0$ ✓ $- (-2,36)$ ✓<br>$E^\theta_{cell} = 2,36$ V ✓ | • Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*<br>• 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***

| | |
|---|---|
| ✓ $2H^+ + 2e^- \rightarrow H_2$ | $E^\theta = 0$ 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/$CH_3COOAg$ / Silwerfloried / 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***

| | |
|---|---|
| $Ag^+ + e^- \leftarrow Ag$ ($\frac{2}{2}$) | $Ag \rightleftharpoons Ag^+ + e^-$ ($\frac{1}{2}$) |
| $Ag \leftarrow Ag^+ + e^-$ ($\frac{0}{2}$) | $Ag^+ + e^- \rightleftharpoons Ag$ ($\frac{0}{2}$) |

- 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 $NH_3 + HNO_3$ ✓ $\rightarrow NH_4NO_3$ ✓ 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<br>X = 26 ✓ (26,04) | m(P) = 2,315 kg<br>Mass of 1 part P = $\frac{2,315}{4}$ = 0,57575<br>Mass of N = (0,57575)(2) = 1,1575 kg<br>Mass of K = (0,57575)(3) = 1,73625 kg<br><br>Total mass of fertiliser:<br>1,1575 + 2,315 + 1,73625 = 5,20875 kg ✓<br>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)

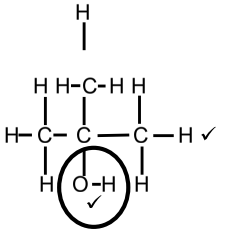
2.3.2 4-ethyl ✓-2,2-dimethyl ✓hexane ✓

*4-etiel-2,2-dimetielheksaan* (3)

**Marking criteria/*Nasienkriteria***
- Hexane/*Heksaan* ✓
- Methyl/*Metiel* and/*en* ethyl *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

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]**



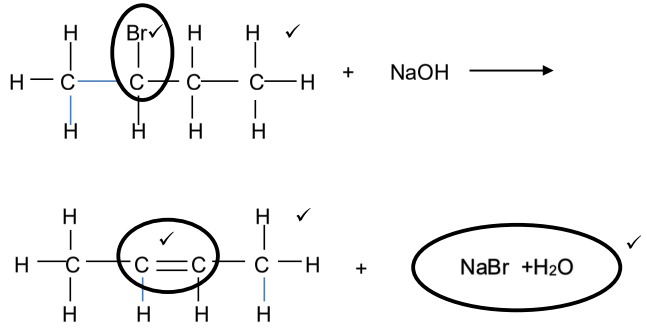


**QUESTION 4/*VRAAG 4***

4.1.1 Substitution ✓/Hydrolysis
*Substitusie/ Hidroliese* (1)

4.1.2 Butan-2-ol ✓✓ OR/*OF* 2-butanol (2)

4.2




Balancing /*Balansering* ✓

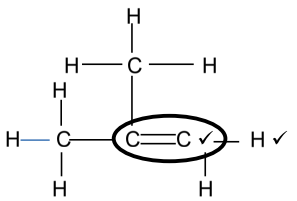
**Marking criteria/*Nasienkriteria***
For organic reagents/*vir organiese reagense*
- Whole structure correct(2/2)
- *Hele struktuur korrek (2/2)*
- Functional group correct (1/2)
- *Funksionele groep korrek (1/2)*

(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)*

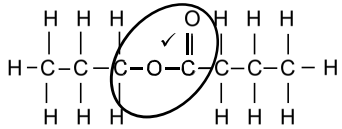
(2)

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



**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)*

Propyl ✓butanoate ✓

*Propielbutanoaat* (4)

**[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 |
| $\Delta n$ | 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 |
| $\Delta c$ | 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 ✓

$m_{oxalic\ acid\ in\ original\ solution\ /\ oksaalsuur\ in\ oorspronklike\ oplossing}$ = nM = 0,06 x 90 ✓
= 5,4 g

$m_{H2O\ of\ crystallisation\ in\ original\ solution\ /\ kristallisasie\ in\ oorspronklike\ oplossing}$ = 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

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 2019**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 20 pages.**
***Hierdie nasienriglyne bestaan uit 20 bladsye.***

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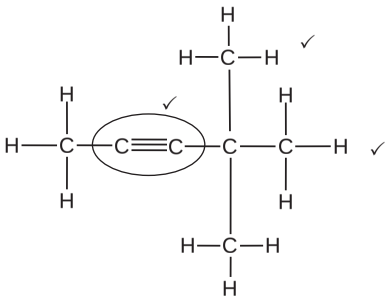
**QUESTION 1/*VRAAG 1***

| | | |
|---|---|---|
| 1.1 | D ✓✓ | (2) |
| 1.2 | C ✓✓ | (2) |
| 1.3 | B ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | C ✓✓ | (2) |
| 1.6 | B ✓✓ | (2) |
| 1.7 | B ✓✓ | (2) |
| 1.8 | A ✓✓ | (2) |
| 1.9 | A ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | **[20]** |

**QUESTION 2/*VRAAG 2***

2.1
2.1.1 $C_nH_{2n-2}$ ✓ (1)

2.1.2



**Marking criteria/*Nasienriglyne***
- Functional group correct. ✓
  *Funksionele groep korrek.*
- 2 methyl substituents. ✓
  *2 metielsubstituente.*
- Whole structure correct:/*Hele struktuur korrek:* 3/3

(3)

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2.2

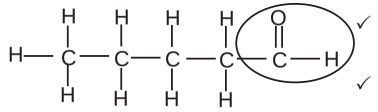
2.2.1 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups ✓on the parent chain.
*Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituente/funksionele groepe op die stamketting.* (2)

2.2.2 Pentan-3-one/3-pentanone ✓✓
*Pentan-3-oon/3-pentanoon*

**Marking criteria/*Nasienriglyne***
- Functional group and correct position i.e. 3 /*Funksionele groep en korrekte posisie nl. 3.* ✓
- Whole name correct/*Hele naam korrek.* ✓

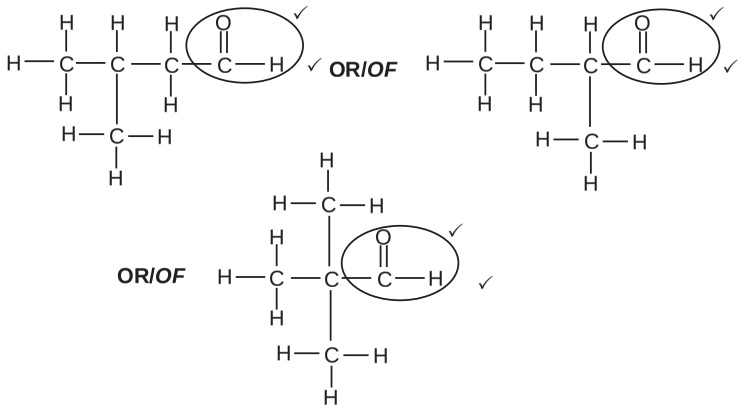
**Accept for ONE mark/Aanvaar vir EEN punt**
Pentanone with the 3 in incorrect place, e.g. penta-3-none.
*Pentanoon met die 3 in foutiewe plek, bv. penta-3-noon.* (2)

2.2.3



**Marking criteria/*Nasienriglyne***
- Whole structure correct:/*Hele struktuur korrek:* 2/2
- Only functional group correct/*Slegs funksionele groep korrek* Max: 1/2

**OR: Any correct structure of an aldehyde with five carbon atoms.**
***OF:Enige korrekte struktuur van 'n aldehied met vyf koolstofatome.***




(2)





2.3

2.3.1 Tertiary (alcohol)/*Tersiêre (alkohol)* ✓

The C atom bonded to the functional group/hydroxyl (group)/-OH is bonded to three other C atoms. /The C-atom bonded to the hydroxyl (group) has no hydrogen atoms. ✓
*Die C-atoom gebind aan die funksionele groep/hidroksiel(groep)/-OH is gebind aan drie ander C-atome./ Die C-atoom gebind aan die hidroksiel (groep) het geen waterstofatome nie.* (2)

2.3.2 2-methylbutan-2-ol/2-methyl-2-butanol/*2-metielbutan-2-ol/2-metiel-2-butanol*

**Marking criteria/*Nasienriglyne***
- 2-methyl/*2-metiel* ✓
- Butan-2-ol/2-butanol ✓
- Any error e.g. hyphens omitted and/or incorrect sequence:
  *Enige fout, bv. koppeltekens weggelaat en/of verkeerde volgorde:* Max./*Maks*: 1/2

(2)

2.3.3 2-methylbut-2- ene/2-methyl-2-butene/*2-metielbut-2-een/2-metiel-2-buteen*

**Marking criteria/*Nasienriglyne***
- 2-methyl/*2-metiel* ✓
- But-2-ene/2-butene/*But-2-een/2-buteen* ✓
- Any error e.g. hyphens omitted and/or incorrect sequence:
  *Enige fout, bv. koppeltekens weggelaat en/of verkeerde volgorde:* Max./*Maks*: 1/2

(2)
**[16]**

**QUESTION 3/*VRAAG 3***

3.1

**Marking guidelines/*Nasienriglyne***
The underlined key phrases must be used in the **CORRECT CONTEXT (pressure/boiling)**. /*Die onderstreepte frases moet gebruik word in die **KORREKTE KONTEKS (druk/kook)**.*

The temperature ✓ at which the vapour pressure of a substance equals atmospheric/external pressure. ✓
*Die temperatuur waar die dampdruk van 'n stof gelyk is aan atmosferiese/ eksterne druk.* (2)

3.2 (**Q**, **R** and **S**) have same molecular mass/formulae/number of carbon and hydrogen atoms/are (chain) isomers. ✓
*(**Q**, **R** en **S**) het dieselfde molekulêre massa/formule/aantal koolstof en waterstofatome/ is (ketting)isomere.*

**OR/*OF***
The compounds are all alkanes /same homologous series and have the same number of carbon atoms.
*Die verbindings is almal alkane /dieselfde homoloë reeks en het die dieselfde aantal koolstofatome.* (1)

**Marking guidelines/*Nasienriglyne***
- 55 (°C) ✓
- Compare all three compounds or Q and S in terms of branches/chain lengths / surface area. ✓
  *Vergelyk al drie verbindings of Q en S in terme van vertakkings/kettinglengte/ oppervlakarea.*
- Compare strengths of all three or Q and S's IMF's / *Vergelyk sterkte van al drie of Q en S se IMK'e.*✓
- Compare energy of all three /*Vergelyk energie van al drie.* ✓

3.3 55 (°C) ✓

**Compare compound R with compounds Q and S:**
- Compound **R** is less branched/compact/spherical/surface area than compound **Q** and more branched/compact/spherical/surface area than compound **S**. ✓
  **OR**
  **Q** is the most branched/compact /spherical/surface area and **S** is least branched/compact/spherical/surface area.
- Intermolecular forces in compound **R** are stronger than in compound **Q** and weaker than in compound **S**. ✓
- More energy needed to overcome intermolecular forces in compound **R** than in compound **Q** and less energy needed to overcome (break) intermolecular forces in compound **R** than in compound **S**. ✓

**OR**
- Compound **R** has a longer chain length than compound **Q** and a shorter chain length than compound **S**. ✓
  **OR**
  **S** has the longest chain length and **Q** the shortest.
- Intermolecular forces increase with increase in chain length. ✓
- More energy needed to overcome intermolecular forces as chain length increases. ✓

***Vergelyk verbinding R met verbindings Q en S:***.
- *Verbinding **R** is minder vertak/kompak/sferieseoppervlak as verbinding **Q** en meer vertak as verbinding **S**.*
  **OF**
  **Q** is die meeste vertak/kompak en **S** is die minste vertak/kompak/series/oppervlak.
- *Intermolekulêre kragte in verbinding **R** is sterker as in verbinding **Q** en swakker as in verbinding **S**.*
- *Meer energie word benodig om intermolekulêre kragte in verbinding **R** te oorkom as in verbinding **Q**, en minder energie word benodig om intermolekulêre kragte in verbinding **R** te oorkom / breek as in verbinding **S**.*

***OF***
- *Verbinding **R** het 'n langer kettinglengte as verbinding **Q** en 'n korter kettinglengte as **S**.*
  **OF**
  **S** het die langste ketting en **Q** die kortste.
- *Intermolekulêre kragte neem toe met toename in kettinglengte.*
- *Meer energie word benodig om intermolekulêre kragte te oorkom wanneer kettinglengte toeneem.* (4)





3.4

3.4.1 P ✓✓ (2)

3.4.2

**Marking guidelines/*Nasienriglyne***
- Name type of IMFs in **P/pentanal**. ✓
  *Noem tipe IMK'e in **P/pentanaal**.*
- Name type of IMFs in/*Noem tipe IMK'e in* **T/pentan-1-ol**.✓
- Compare strength of IMFs. /*Vergelyk sterkte van IMK'e.* ✓
  **OR/*OF***
  Compare energy needed to overcome IMFs./*Vergelyk energie benodig om IMK'e te oorkom.*

- In **P**/ pentanal/aldehydes: dipole-dipole forces ✓(in addition to London forces/dispersion forces/induced dipole forces).
- In **T**/pentan-1-ol: Hydrogen bonding.✓ (in addition to London forces/dispersion forces/induced dipole forces).
- Intermolecular forces in **P**/pentanal are weaker ✓than in **T**/pentan-1-ol **OR** dipole-dipole forces are weaker than hydrogen bonds **OR** intermolecular forces in **T**/pentan-1-ol are stronger than in **P**/pentanal.
  **OR**
  More energy needed to overcome/break intermolecular forces in **T**.
- *In **P**/pentanaal/aldehiede: dipool-dipoolkragte (tesame met Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte).*
- *In **T**/pentan-1-ol: Waterstofbinding. (tesame met Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte).*
- *Intermolekulêre kragte in **P** swakker as in **T**/pentan-1-ol **OF** intermolekulêre kragte in **T**/pentan-1-ol sterker as in **P**/pentanaal **OF** dipool-dipoolkragte is swakker as waterstofbindings.*
  ***OF***
  *Meer energie benodig om intermolekulêre kragte te oorkom/breek in **T**.* (3)

**[12]**

## QUESTION 4/*VRAAG 4*

4.1 Haloalkane/alkyl halide ✓
*Haloalkaan/alkielhalied* (1)

4.2
4.2.1 Elimination/dehydrohalogenation ✓
*Eliminasie/dehidrohalogenering* (1)

4.2.2 Substitution/hydrolysis ✓
*Substitusie/hidrolise* (1)

4.2.3 Esterification/condensation ✓
*Esterifikasie/kondensasie/verestering* (1)

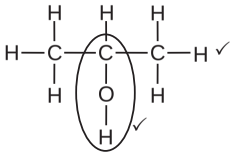
4.3
4.3.1
- (Mild) heat/Heating/*(matige) hitte/ verhitting* ✓
- Dilute (strong base)/*Verdunde (sterk basis)*/(NaOH/KOH/LiOH) ✓

**OR/*OR***
Add water/$H_2O$/*Voeg water/$H_2O$ by* (2)

4.3.2 Propan-1-ol/1-propanol ✓✓

**Marking criteria/*Nasienriglyne:***
- Correct stem and functional group i.e. propanol/*Korrekte stam en funksionele groep, d.i. propanol.* ✓
- Whole name correct:/*Hele naam korrek*: propan-1-ol ✓ (2)

4.4



**Marking criteria/*Nasienriglyne***
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* $\frac{1}{2}$

**Notes/*Aantekeninge***
- Accept –OH as condensed. /*Aanvaar –OH as gekondenseerd.*
- Condensed or semi-structural formula:
  *Gekondenseerde of semi-struktuurformule*: Max./*Maks.* $\frac{1}{2}$
- Molecular formula/*Molekulêre formule*: $\frac{0}{2}$
- If functional group is incorrect/*Indien funksionele groep verkeerd is:* $\frac{0}{2}$
- If more than one functional group:
  *Indien meer as een funksionele groep:* $\frac{0}{2}$ (2)

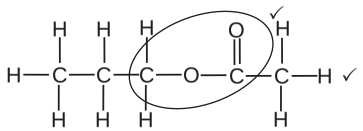




4.5

**POSITIVE MARKING FROM Q4.3.2 ONLY IF THE COMPOUND IN Q4.3.2 IS AN ALCOHOL. /*POSITIEWE NASIEN VANAF V4.3.2 SLEGS INDIEN DIE VERBINDING IN Q4.3.2 'N ALKOHOL IS.***

4.5.1



**Marking criteria/*Nasienriglyne***
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* $\frac{1}{2}$

**Notes/*Aantekeninge***
- Condensed or semi-structural formula:
  *Gekondenseerde of semistruktuurformule*: Max./*Maks.* $\frac{1}{2}$
- Molecular formula/*Molekulêre formule*: $\frac{0}{2}$
- If functional group is incorrect/*Indien funksionele groep verkeerd is:* $\frac{0}{2}$ (2)

4.5.2 (Concentrated) sulphuric acid/*(Gekonsentreerde) swawelsuur*/$H_2SO_4$ ✓ (1)
**[13]**

## QUESTION 5/*VRAAG 5*

5.1 Exothermic/*Eksotermies* ✓
$\Delta H$ < 0/Energy is released/*Energie word vrygestel* ✓ (2)

5.2

| | |
|---|---|
| rate/*tempo* = $-\frac{\Delta m}{\Delta t}$<br>$= -\frac{0{,}25 - 2}{30}$ ✓✓<br>= 0,06 (g· s$^{-1}$) ✓<br>(0,0583 g· s$^{-1}$) | **OR/*OF***<br>rate/*tempo* = $-\frac{\Delta m}{\Delta t}$<br>$= -\frac{-1{,}75}{30}$ ✓✓<br>= 0,06 (g· s$^{-1}$) ✓<br>(0,0583 g· s$^{-1}$) |

(3)

**Notes/*Aantekeninge***
**Accept** negative answer i.e./***Aanvaar*** *negatiewe antwoord d.i.* - 0,06 g· s$^{-1}$.

5.3

**Marking guidelines**

- Calculate/*Bereken*: $m(CaCO_3)$ reacted/*reageer* or / *of* $V(CO_2)$ produced/*gevorm.* ✓
- Substitute/*Vervang*: 100 $g \cdot mol^{-1}$. ✓
- USE mol ratio/*GEBRUIK molverhouding*: $n(CO_2) : n(CaCO_3) = 1 : 1$ ✓
- Use of/ /*Gebruik van* 22,4 $dm^{-3} \cdot mol^{-1}$.✓
- Final answer/*Final antwoord*: 0,18 $dm^3$ (0,1792 $dm^3$) ✓

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $m(CaCO_3) = \frac{40}{100} \times 2$ ✓<br>$= 0,8$ g<br>$n(CaCO_3)_{reacted} = \frac{m}{M}$<br>$= \frac{0,8}{100}$ ✓<br>$= 8 \times 10^{-3}$ mol<br>$n(CO_2) = n(CaCO_3)$ ✓<br>$= 8 \times 10^{-3}$ mol<br>$V(CO_2) = 8 \times 10^{-3} \times 22,4$ ✓<br>$= 0,18\ dm^3$ ✓ | For 2 g antacid/*teensuurtablet*:<br>100 g ✓$CaCO_3$ .....22,4 $dm^3$ ✓ $CO_2$<br>2 g $CaCO_3$ .....0,448 $dm^3$ ✓<br><br>100% $CO_2$ ..... 0,448 $dm^3$ ✓<br>40% $CO_2$ ..... 0,18 $dm^3$ ✓<br><br>**OPTION 3/*OPSIE 3***<br>100% $CaCO_3$ .....2 g<br>40% .....0,8 g ✓<br><br>100 g ✓..... 1 mol<br>0,8 g ..... $8 \times 10^{-3}$ mol ✓<br><br>1 mol .....22,4 $dm^3$ ✓<br>$8 \times 10^{-3}$ mol .....0,18 $dm^3$ ✓ |

(5)

5.4 **ANY ONE/*ENIGE EEN*:**

- Concentration (of acid)/*Konsenterasie (van suur)* ✓
- Size/mass of tablet/Identical tablet /Type of tablet.
  *Grootte/massa van tablet/Identiese tablet./Tipe tablet.*
- State of division / Surface area / *Toestand van verdeeldheid / reaksieoppervlak.*

(1)

5.5

| **Criteria for conclusion/*Riglyne vir gevolgtrekking*:** | |
|---|---|
| Dependent [(reaction) rate/time] and independent (temperature) variables correctly identified.<br>*Afhanklike [(reaksie)tempo/tyd] en onafhanklike (temperatuur) veranderlikes korrek geïdentifiseer.* | ✓ |
| Relationship between the independent and dependent variables correctly stated./*Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.* | ✓ |





**Examples/*Voorbeelde*:**

- Reaction rate ($\frac{1}{time}$) increases with increase in temperature.
  *Reaksietempo* ($\frac{1}{time}$) *neem toe met toename in temperatuur.*
- Reaction rate ($\frac{1}{time}$) decreases with decrease in temperature.
  *Reaksietempo* ($\frac{1}{time}$) *neem af met afname in temperatuur.*
- Time taken for reaction decreases when temperature increases.
  *Tyd vir die reaksie neem af wanneer temperatuur toeneem.*
- Time taken for reaction increases when temperature decreases.
  *Tyd vir die reaksie neem toe as temperatuur afneem.*

**IF/*INDIEN***

Reaction rate is DIRECTLY proportional to temperature: Max. $\frac{1}{2}$

*Reaksietempo is DIREK eweredig aan temperatuur:* *Maks.* $\frac{1}{2}$

(2)

5.6

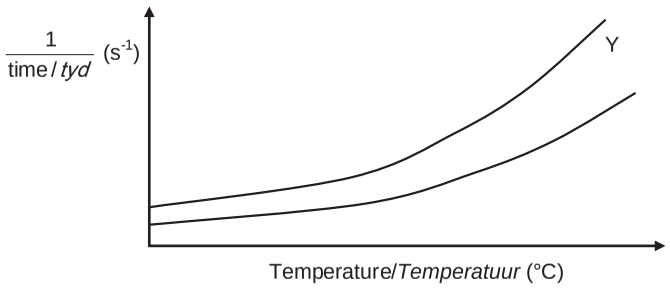
- Increase in temperature increases the average kinetic energy/molecules move faster. /*Toename in temperatuur verhoog die gemiddelde kinetiese energie/molekule beweeg vinniger.* ✓
- More molecules have enough/sufficient kinetic energy/More molecules have $E_k > E_a$. ✓
  *Meer molekule het genoeg/voldoende kinetiese energie/Meer molekule het* $E_k > E_a$.
- More effective collisions per unit time/second. /Frequency of effective collisions increases. ✓
  *Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.*

(3)

5.7

**Marking guidelines/*Nasienriglyne***

- For each value of temperature, the CURVE Y must be above the given CURVE. / *Vir elke waarde van temperatuur, moet kurwe Y bo die gegewe kurwe wees.* ✓
- CURVE Y must have an increasing rate with an increase in temperature. / *KURWE Y moet 'n toenemende tempo het soos die temperatuur toeneem.* ✓




(2)
**[18]**

## 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 **CALCULATIONS USING NUMBER OF MOLES**
***BEREKENINGE WAT AANTAL MOL GEBRUIK***

6.2.1 **Marking guidelines/*Nasienriglyne***

- Substitute/*Vervang*: 44 g·mol$^{-1}$. ✓
- Equilibrium concentration of $CO_2$ multiply by 3 dm$^3$ / *Ewewigskonsentrasie van* $CO_2$ *vermenigvuldig met 3 dm*$^3$ **AND/*EN*** $n(CO)_{eq}$ divide by /*deel* deur 3 dm$^3$ ✓
- Use mole ratio/*Gebruik molverhouding:* 1:2 / n(CO) = 2n($CO_2$). ✓
- $n(CO_2)_{change} = n(CO_2)_{initial} - n(CO_2)_{final}$ / $n(CO)_{eq/ewe} = n(CO)_{initial/begin} + \Delta n(CO)$ ✓
- Correct $K_c$ expression (formulae in square brackets). ✓
  *Korrekte $K_c$-uitdrukking (formules in vierkanthakies).*
- Substitution of concentrations into $K_c$ expression. ✓
  *Vervanging van konsentrasies in $K_c$-uitdrukking.*
- Final answer/*Finale antwoord*: 12,24 (range/*gebied*: 11,85 – 12,66) ✓





**OPTION 1/*OPSIE 1***

$n(CO_2) = \frac{m}{M}$
$= \frac{60,8}{44}$ ✓
$= 1,382$ mol

| | $CO_2$ | CO |
|---|---|---|
| Initial quantity (mol) *Aanvangshoeveelheid (mol)* | 1,382 | 0 |
| Change (mol) ✓ *Verandering (mol)* | 1,22 | 2,44 |
| Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)* | 0,162 | 2,44 |
| Equilibrium concentration (mol·dm$^{-3}$) *Ewewigskonsentrasie (mol·dm$^{-3}$)* | 0,054 | 0,813 |

Use ratio/*Gebruik verhouding* ✓

Divide/multiply by 3/*Deel/ vermenigvuldig met 3* ✓

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓
$= \frac{(0,813)^2}{0,054}$ ✓
$= 12,24$ ✓

No $K_c$ expression, correct substitution/*Geen $K_c$-uitdrukking, korrekte substitusie:* Max./*Maks.* 6/7

Wrong $K_c$ expression/*Verkeerde $K_c$- uitdrukking*: Max./*Maks.* 4/7

**OPTION 2/*OPSIE 2***

$n(CO_2) = \frac{m}{M}$
$= \frac{60,8}{44}$ ✓
$= 1,382$ mol

$n(CO_2)_{change} = n(CO_2)_{initial/begin} - n(CO_2)_{final/finaal}$
$= 1,382 - 0,162$
$= 1,22$ mol

$n(CO)_{change} = 2(CO_2)$
$= 2(1,22)$ ✓
$= 2,44$ mol

✓

$n(CO)_{eq} = n(CO)_{change} = 2,44$ mol

$c(CO) = \frac{n}{V}$
$= \frac{2.44}{3}$ ✓
$= 0,813$ mol·dm$^{-3}$

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓
$= \frac{(0,813)^2}{0,054}$ ✓
$= 12,24$ ✓ (Accept range/*Aanvaar gebied*: 11,85 – 12,66).

## CALCULATIONS USING CONCENTRATION
## *BEREKENINGE WAT KONSENTRASIE GEBRUIK*

**Marking guidelines/*Nasienriglyne***

- Substitute 44 g·mol$^{-1}$. ✓
- Initial $n(CO_2)$divide by 3 dm$^3$. ✓
  *Aanvanklike $n(CO_2)$ gedeel deur 3 dm$^3$.*
- **USE** ratio/***GEBRUIK*** *verhouding:* $c(CO_2) : c(CO) = 1 : 2$ ✓
- $\Delta c(CO_2) = c(CO_2)_{initial/begin} - c(CO_2)_{eq/ewe}$ ✓
  $c(CO)_{eq/ewe} = c(CO)_{initial/begin} + \Delta c(CO)$.
- Correct $K_c$ expression (formulae in square brackets). ✓
  *Korrekte $K_c$ uitdrukking (formules in vierkanthakies).*
- Substitution of concentrations into $K_c$ expression. ✓
  *Vervanging van konsentrasies in $K_c$-uitdrukking.*
- Final answer/*Finale antwoord*: 12,15 (range/*gebied*: 11,85 – 12,66) ✓

**OPTION 3/*OPSIE 3***

$$n(CO_2) = \frac{m}{M}$$
$$= \frac{60,8}{44} ✓$$
$$= 1,382 \text{ mol}$$

| | $CO_2$ | CO |
|---|---|---|
| Initial concentration (mol·dm$^{-3}$) *Aanvanklike konsentrasie (mol·dm$^{-3}$)* | 0,4607 ✓ | 0 |
| Change (mol·dm$^{-3}$) *Verandering (mol·dm$^{-3}$)* | 0,4067 | 0,813 |
| Equilibrium concentration (mol·dm$^{-3}$) *Ewewigskonsentrasie (mol·dm$^{-3}$)* | 0,054 | 0,813 |

Divide by /*Deel deur* 3 dm$^3$ ✓
ratio ✓ *verhouding*

$$K_c = \frac{[CO]^2}{[CO_2]} ✓$$
$$= \frac{(0,813)^2}{0,054} ✓$$
$$= 12,15 ✓$$

No $K_c$ expression, correct substitution/*Geen $K_c$-uitdrukking, korrekte substitusie:* Max./*Maks.* $\frac{6}{7}$

Wrong $K_c$ expression/*Verkeerde $K_c$-uitdrukking*: Max./*Maks.* $\frac{4}{7}$

(7)

6.2.2 **POSITIVE MARKING FROM Q6.2.1/*POSITIEWE NASIEN VANAF V6.2.1***

$n(C)_{reacted/reageer} = n(CO_2)_{reacted/reageer}$
$= 1,22$ mol ✓

$m(C) = nM$ ✓
$= 1,22(12)$
$= 14,64$ g ✓

**Marking guidelines**

- **USE** mol ratio/ ***GEBRUIK*** *molverhouding*: $n(C) = n(CO_2)$. ✓
- Substitute/*Vervang*: 12 g·mol$^{-1}$. ✓
- Final answer/*Finale antwoord*: 14,64 g. ✓

(3)





6.3

6.3.1 Remains the same/*Bly dieselfde* ✓ (1)

6.3.2 Decreases/*Afneem* ✓

- (When pressure is increased) the reaction that leads to the smaller amount/number of moles/volume of gas is favoured. ✓
  *(Wanneer die druk verhoog word,) word die reaksie wat tot die kleiner hoeveelheid/aantal mol/volume gas lei, bevoordeel.*
- The reverse reaction is favoured. / More $CO_2$ is formed. ✓
  *Die terugwaartse reaksie word bevoordeel./ meer $CO_2$ word gevorm.* (3)

6.4

6.4.1 Endothermic/*Endotermies* ✓

- When the temperature increases the mol/percentage CO(g)/product increases/forward reaction is favoured./*Wanneer die temperatuur toeneem, neem die mol/persentasie CO(g)/produk toe/voorwaartse reaksie word bevoordeel.* ✓
- An increase in temperature favours the endothermic reaction/*Toename in temperatuur bevoordeel die endotermiese reaksie*. ✓ (3)

6.4.2 **POSITIVE MARKING FROM Q6.2.1./*POSITIEWE NASIEN VANAF V6.2.1.***

**Marking guidelines/*Nasienriglyne***

- Calculate total volume/mol of gas at equilibrium/*Bereken totale volume/mol gas by ewewig:* 0,162 + 2,44 = 2,606 dm$^3$ /mol ✓
  **OR/*OF***
  Calculate the total concentration at equilibrium/*Bereken die totale konsentrasie by ewewig*: 0,054 + 0,813 = 0,867 mol·dm$^{-3}$
- Calculate percentage of ANY one gas/*Bereken persentasie van ENIGE een gas* ($CO_2$ or/*of* CO). ✓
- Final answer/*Finale antwoord*: T = 827 °C ✓

**OPTION 1/*OPSIE 1***

$V_{total\ eq} = 0,162 + 2,44$ ✓
$= 2,606$ dm$^3$

$\% CO_2 = \frac{0,162}{2,606} \times 100$ ✓
$= 6,225$ %

**OR/*OF***

$\% CO = \frac{2,44}{2,606} \times 100$ ✓
$= 93,63$ %

**OPTION 2/*OPSIE 2***

$c_{total\ eq} = 0,054 + 0,813$
$= 0,867$ mol·dm$^{-3}$

$\% CO_2 = \frac{0,054}{0,867} \times 100$ ✓
$= 6,228$ %

**OR/*OF***

$\% CO = \frac{0,813}{0,867} \times 100$ ✓
$= 93,77$ %

∴ T = 827 °C ✓ (3)

**[22]**

## QUESTION 7/*VRAAG 7*

7.1 Strong (acid)/*Sterk (suur)* ✓

Large/*Groot* $K_a$ value/*waarde*/ $K_a > 1$ / (HBr) ionises completely/*ioniseer volledig* ✓ (2)

7.2 $H_2O$ ✓

$Br^-$ ✓ (2)

7.3

7.3.1

**Marking guidelines/*Nasienriglyne***

- Formula/*Formule:* $c = \frac{n}{V}$ /n = cV / $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓
- Substitution of/*Vervanging van:* (0,5)(0,0165)/(0,5)(16,5) ✓
- Use mol ratio/*Gebruik molverhouding:* 1:1/n(HBr) = n(NaOH) ✓
- Substitute/*Vervang*: V = 0,09 $dm^3$ /90 $cm^3$ ✓
- Formula/*Formule:* pH = -log[$H_3O^+$] ✓
- Substitute [$H_3O^+$] in pH formula. ✓
- Final answer/*Finale antwoord*: pH = 1,04 (range/*gebied*: 1,036 – 1,05) ✓

**OPTION 1/*OPSIE 1***

$n(NaOH)_{reacted/reageer}$ = cV ✓
= 0,5(0,0165) ✓
= 0,00825 mol

$n(HBr)_{excess/oormaat}$ = n(NaOH) = 0,00825 mol ✓

$c(H_3O^+) = \frac{n}{V}$
$= \frac{0,00825}{0,09}$ ✓
= 0,092 mol·$dm^{-3}$

pH = -log[$H_3O^+$] ✓
= -log(0,092) ✓
= 1,04 ✓

**OPTION 2/*OPSIE 2***

$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$ ✓

$\frac{c_a (90)}{(0,5)(16,5)} = \frac{1}{1}$ ✓ ✓

$c_a$ = 0,092 mol·$dm^{-3}$

pH = -log[$H_3O^+$] ✓
= -log(0,092) ✓
= 1,04 ✓

(7)





7.3.2

**Marking guidelines/*Nasienriglyne***

- Calculate/*Bereken* $n(HBr)_{initial/aanvanklik}$: substitute/*vervang* (0,45)(0,09) in n = cV ✓
- Subtraction/*Aftrekking:*
  $n(HBr)_{reacted/reageer}$ = $n(HBr)_{initial/aanvanklik}$ – $n(HBr)_{reacted\ with/reageer\ met\ NaOH}$. ✓✓
  **OR/*OF***: $c(HBr)_{reacted/reageer}$ = $c(HBr)_{initial/aanvanklik}$ – $c(H_3O^+)_{excess/oormaat}$
- Use mol ratio/*Gebruik molverhouding:* $n(Zn(OH)_2)$ : n(HBr) = 1 : 2 ✓
- Substitution of/*Vervanging van:* 99 g·$mol^{-1}$ ✓
- Final answer/*Finale antwoord:* 1,5964 g (range/*gebied:* 1,58 – 1,68) ✓

**POSITIVE MARKING FROM Q7.3.1/*POSITIEWE NASIEN VANAF V7.3.1***

**OPTION 1/*OPSIE 1***

$n(HBr)_{initial/begin}$ = cV
= (0,45)(0,09) ✓
= 0,0405 mol

n(HBr reacted with/*reageer met* $Zn(OH)_2$) = 0,0405 – 0,00825 ✓✓
= 0,03224 mol

$n(Zn(OH)_2)$ = ½n(HBr) = ½(0,03224) ✓= 0,016125 mol

$m(Zn(OH)_2)$ = nM
= (0,016125)(99) ✓
= 1,596 g ✓

**OPTION 2/*OPSIE 2***

c(HBr) = 0,45 – 0,092 ✓✓
= 0,358 mol·$dm^{-3}$

n(HBr reacted/*reageer*) = cV
= 0,358 x 0,09 ✓
= 0,0322 mol

$n(Zn(OH)_2)$ = ½n(HBr) = ½(0,0322) ✓= 0,01611 mol

$m(Zn(OH)_2)$ = nM
= 0,01611 x 99 ✓
= 1,595 g ✓ (1,60 g)

(6)
**[17]**

## QUESTION 8/*VRAAG 8*

8.1 Chemical to electrical/*Chemies na elektries* ✓ (1)

8.2 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)

8.3 **OPTION 1/*OPTION 1***

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓

$1{,}49 = 1{,}36 - E^{\theta}_{anode}$ ✓ ✓

$E^{\theta}_{anode} = 1{,}36 - 1{,}49$

$= -0{,}13$ (V) ✓

X is Pb/Lead/*Lood* ✓

**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*: $\frac{4}{5}$

**OPTION 2/*OPSIE 2***

✓ $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ $E^{\theta} = 1{,}36$ V ✓

$X \rightarrow X^{2+} + 2e^-$ $E^{\theta} = 0{,}13$ V ✓

$C\ell_2 + X \rightarrow X^{2+} + 2C\ell^-$ $E^{\theta} = 1{,}49$ V ✓

X is Pb/Lead/*Lood* ✓ (5)

**POSITIVE MARKING FROM Q8.3/*POSITIEWE NASIEN VANAF V8.3***

8.4 X/Pb/Lead/*Lood* ✓ (1)

8.5

8.5.1 Reaction reached equilibrium./(In each half cell) the rate of oxidation is equal to rate of reduction./Rate of the forward reaction is equal to the rate of the reverse reaction. ✓
*Reaksie bereik ewewig./*(In elke halfsel) die t*empo van oksidasie is gelyk aan tempo van reduksie./Tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie.* (1)

8.5.2 Increases/*Toeneem* ✓ (1)

8.5.3
- [$C\ell^-$] decreases/*neem af.* ✓
- Forward reaction is favoured./*Voorwaartse reaksie word bevoordeel.* ✓ (2)

**[12]**





## QUESTION 9/*VRAAG 9*

9.1

**Marking guidelines/*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 chemical process in which electrical energy is converted to chemical energy. ✓✓
*Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.*
**OR/*OF***
The use of electrical energy to produce a chemical change.
*Die gebruik van elektriese energie om 'n chemiese verandering teweeg te bring.*
**OR/*OF***
The process during which an electrical current passes through a solution/molten ionic compound.
*Die proses waar 'n elektriese stroom deur 'n oplossing/gesmelte ioniese verbinding gestuur word.* (2)

9.2

9.2.1 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓
Ignore phases/*Ignoreer fases*

**Marking guidelines/*Nasienriglyne***
- $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ $(\frac{2}{2})$ $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ $(\frac{1}{2})$
  $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ $(\frac{0}{2})$ $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ $(\frac{0}{2})$
- 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:* $\frac{1}{2}$

(2)

9.2.2 Water/ $H_2O$ ✓ (1)

9.3 $H_2O$ is a stronger oxidising agent ✓ than $Na^+$ ✓ and will be reduced ✓ (to $H_2$).
*$H_2O$ is 'n sterker oksideermiddel as $Na^+$ en sal gereduseer word (na $H_2$).*
**OR/*OF***
$Na^+$ is a weaker oxidizing agent ✓ than $H_2O$ ✓ and therefore $H_2O$ will be reduced ✓ (to $H_2$)
*$Na^+$ is 'n swakker oksideermiddel as $H_2O$ en daarom sal $H_2O$ gereduseer word (na $H_2$)*

**OR/*OF***
The half-reaction that produces $H_2(g)$ has a more positive reduction potential (-0,83 V) ✓ than the half-reaction that produces Na (-2,71 V). ✓
Therefore water/$H_2O$ will be reduced ✓ to $H_2$./$Na^+$ will not be reduced to Na.
*Die halfreaksie wat $H_2(g)$ vorm, het 'n meer positiewe reduksiepotensiaal (-0,83 V) as die halfreaksie wat Na vorm (-2,71 V).*
*Daarom word water/$H_2O$ na $H_2$ gereduseer./$Na^+$ sal nie gereduseer word na* (3)

*Na nie.*

**[8]**





**QUESTION 10/*VRAAG 10***

10.1
10.1.1 Hydrogen/*Waterstof*/$H_2$ ✓ (1)

10.1.2 Nitrogen monoxide/*Stikstofmonoksied*/NO ✓ (1)

10.1.3 Nitric acid/*Salpetersuur*/$HNO_3$ ✓ (1)

10.2
10.2.1 (Catalytic) oxidation/Redox/*(Katalitiese) oksidasie/Redoks* ✓ (1)

10.2.2 $NH_3 + HNO_3$ ✓ → $NH_4NO_3$ ✓ Bal ✓

**Notes/*Aantekeninge***
- Reactants ✓ Products ✓ Balancing ✓
  *Reaktanse* *Produkte* *Balansering*
- Ignore double arrows (⇌) and phases./Ignoreer dubbelpyle (⇌)*en fases.*
- Marking rule 6.3.10./Nasienreël 6.3.10.

(3)

10.3
10.3.1 (Total) percentage of nutrients/fertiliser/N,P,K. ✓
*(Totale) persentasie nutriente/* kunsmis/N,P, K. (1)

10.3.2

**Marking guidelines/*Nasienriglyne***
- Calculate mass fertiliser in A./*Bereken massa kunsmis in A* ✓
- Calculate mass fertiliser in B./ *Bereken massa kunsmis in B* ✓
- Calculate mass P in A and B ./*Bereken massa P in A en B*✓
- Final answer/*Finale antwoord*:
  B has more phosphorous than/*het meer fosfor as* A. ✓

**OPTION 1/*OPSIE 1***

Mass fertiliser in A:
*Massa kunsmis in A*:

$m = \frac{21}{100} \times 50$ ✓ = 10,5 kg

Mass fertiliser in B:
/*Massa kunsmis in B*:

$m = \frac{27}{100} \times 40$ ✓ = 10,8 kg

Mass phosphorous in A/
*Massa fosfor in* A:

$\frac{3}{8} \times 10{,}5 = 3{,}94$ kg

Mass phosphorous in B/
*Massa fosfor in* B:

$\frac{3}{8} \times 10{,}8 = 4{,}05$ kg

✓

Fertiliser B has more phosphorous than fertiliser A. ✓

**OPTION 2/*OPSIE 2***

Mass phosphorous in A/
*Massa fosfor in* A:

$m = \frac{3}{8} \times \frac{21}{100} \times 50$ ✓ = 3,94 kg

Mass(P) in B
*Massa (P) in* B:

$m = \frac{3}{8} \times \frac{27}{100} \times 40$ ✓ = 4,05 kg

✓

Fertiliser B has more phosphorous than fertiliser A. /*Kunsmis B het meer fosfor as kunsmis A.*✓

**OPTION 3/*OPSIE 3***

Mass phosphorous in A/
*Massa fosfor in* A:

$\%P = \frac{3}{8} \times 21 = 7{,}88\%$

$m(P) = \frac{7{,}88}{100} \times 50$ ✓ = 3,94 kg

Mass(P) in B
*Massa (P) in* B:

$\%(P) = \frac{3}{8} \times 27 = 10{,}13\%$

$m = \frac{10{,}13}{100} \times 40$ ✓ = 4,05 kg

✓

Fertiliser B has more phosphorous than fertiliser A. /*Kunsmis B het meer fosfor as kunsmis A* ✓

**OPTION 4/*OPSIE 4***

Mass fertiliser in A:
*Massa kunsmis in A*:

$m = \frac{21}{100} \times 50$ ✓ = 10,5 kg

Mass fertiliser in B:
/*Massa kunsmis in B*:

$m = \frac{27}{100} \times 40$ ✓ = 10,8 kg

For the same NPK ratio ✓
the bag with more fertiliser will have more phosphorous ∴ bag B✓
*Vir dieselfde NPK verhouding, die sake met meer kunsmis sal meer fosfor het ∴ sak B*

(4)
**[12]**

**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 2018**

**MARKING GUIDELINE/*NASIENRIGLYN***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 18 pages.**
***Hierdie nasienriglyne bestaan uit 18 bladsye.***

## QUESTION 1/*VRAAG 1*

1.1 C ✓✓ (2)

1.2 C ✓✓ (2)

1.3 C ✓✓ (2)

1.4 A ✓✓ (2)

1.5 D ✓✓ (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 **ANY ONE/*ENIGE EEN*:**

- (Alcohol/ethanol) is flammable/catches fire easily. ✓
  *(Alkohol/etanol) is vlambaar/slaan maklik aan die brand.*
- To heat it evenly./*Om dit eweredig te verhit.*
- Water bath is used for low heat/low temperature./*Waterbad word gebruik vir lae hitte/lae temperatuur.*
- Alcohol/ethanol will evaporate too quickly./*(Alkohol/etanol) sal te vinnig verdamp.*

**Accept/*Aanvaar*:**
(Alcohol/ethanol) is volatile./*(Alkohol/etanol) is vlugtig.* (1)

2.2

2.2.1 Esterification/condensation ✓
*Verestering/esterifikasie/kondensasie* (1)

2.2.2 $H_2SO_4$ ✓ (1)

2.2.3 Esters ✓ (1)

2.3 $\frac{M(ester)}{M(C_4H_8O)} = \frac{144}{72✓} = 2$

$\therefore$ 2 x $C_4H_8O = C_8H_{16}O_2$ ✓

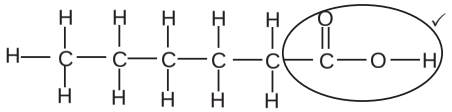
**Marking guidelines/*Nasienriglyne***
- If only answer given, award 2 marks on final answer./*Indien slegs antwoord gegee, ken 2 punte toe vir finale antwoord.*
- If 72 $g \cdot mol^{-1}$ calculated without substituting, no mark is awarded./*Indien 72 $g \cdot mol^{-1}$ bereken is sonder om te vervang word geen punt toegeken nie.*

(2)

2.4 Ethyl ✓ hexanoate ✓
*Etielheksanoaat*

**Note/*Aantekening***
Accept any other ethyl ESTER from QUESTION 2.3.
*Aanvaar enige ander etiel ESTER vanaf VRAAG 2.3.* (2)

2.5 **POSITIVE MARKING FROM QUESTION 2.4.**
***POSITIEWE NASIEN VANAF VRAAG 2.4.***



✓ ✓

**Marking criteria/*Nasienriglyne***
- Whole structure correct/*Hele struktuur korrek:* 2/2
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2
- Accept/*Aanvaar* -OH as condensed/*gekondenseerd.*

**IF/*INDIEN***
- More than one functional group/wrong functional group/*Meer as een funksionele groep/foutiewe funksionele groep:* 0/2
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:* Max/*Maks.*: 1/2

(2)
**[10]**

**QUESTION 3/*VRAAG 3***

3.1 **Marking guidelines/*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 of a substance equals atmospheric/external pressure.
*Die temperatuur waar die dampdruk van 'n stof gelyk is aan atmosferiese/ eksterne druk.* (2)

3.2
3.2.1 Carboxyl (group)/*karboksiel(groep)* ✓

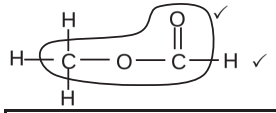
**Accept/*Aanvaar***
Carboxylic/*Karboksiel* (1)

3.2.2 Propanoic acid/*propanoësuur* ✓ (1)





3.2.3

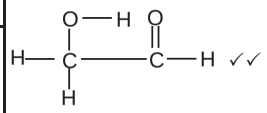


✓ ✓

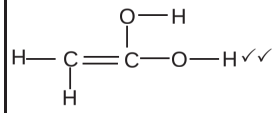
**Marking criteria/*Nasienriglyne***
- Whole structure correct:
  *Hele struktuur korrek:* 2/2
- Only functional group correct:
  *Slegs funksionele groep korrek:* Max/*Maks*: 1/2

**IF/*INDIEN***
- More than one functional group/wrong functional group/*Meer as een funksionele groep/foutiewe funksionele groep:* 0/2
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:* Max/*Maks*: 1/2

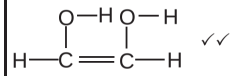
**ACCEPT/*AANVAAR***
***(2 or/of 0)***



✓✓



✓✓



✓✓

(2)

3.3 A ✓
Lowest boiling point./Shortest chain length. ✓
*Laagste kookpunt./Kortste kettinglengte.* (2)

3.4
3.4.1 The same molecular mass/molecular size. ✓
*Dieselfde molekulêre massa/molekulêre grootte.* (1)

3.4.2 Primary/*Primêre* ✓
-OH group is bonded to a C atom bonded to one other C atom. ✓
*-OH-groep is gebind aan 'n C-atoom wat aan een ander C-atoom gebind is.*
**OR/*OF***
-OH group is bonded to a C atom that has two H atoms.
*-OH-groep is gebind aan 'n C-atoom wat twee H-atome bevat.* (2)

3.4.3

**Marking guidelines/Nasienriglyne**
- BOTH have hydrogen bonding./*BEIDE het waterstofbindings*. ✓
- Compare number of sites for hydrogen bonding./*Vergelyk aantal punte vir waterstofbinding.* ✓
- Compare strength of IMFs./*Vergelyk sterkte van IMKe.* ✓
- Compare energy required./*Vergelyk energie benodig.* ✓

- Both compounds/**X** and **B** have (in addition to London forces and dipole-dipole forces) hydrogen bonding./*Beide verbindings/**X** en **B** het waterstofbindings (behalwe Londonkragte en dipool-dipoolkragte).* ✓
- Compound **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alcohol has one site for hydrogen bonding and compound **B/**ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding **OR** **B/**ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding. ✓
  Verbinding **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alkohol *het een punt vir waterstofbindings en verbinding **B**/etanoësuu/karboksielsuur het twee/meer punte vir waterstofbindings **OF** **B**/etanoësuu/karboksielsuur het twee/meer punte vir waterstofbindings.*
- Intermolecular forces in compound **B**/ethanoic acid/carboxylic acid are stronger than intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol. ✓
  *Intermolekulêre kragte in verbinding **B**/etanoësuur/karboksielsuur is sterker as die intermolekulêre kragte in* verbinding **X**/$CH_3CH_2CH_2OH$/ *propan-1-ol/alkohol.*
  **OR/*OF***
  Intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol are weaker than intermolecular forces in compound **B**/ethanoic acid/*carboxylic acid.*/*Intermolekulêre kragte in* verbinding *X/$CH_3CH_2CH_2OH$/propan-1-ol/alkohol is swakker as intermolekulêre kragte in verbinding **B**/etanoësuur/karboksielsuur.*
- More energy is needed to overcome/break intermolecular forces in compound **B**/ethanoic acid/carboxylic acid than in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol. ✓
  *Meer energie word benodig om intermolekulêre kragte in verbinding **B**/etanoësuur as in verbinding **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alkohol te oorkom/breek.*
  **OR/*OF***
  Less energy is needed to overcome/break intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alcohol than in compound **B**/ethanoic acid/*carboxylic acid*.
  *Minder energie word benodig om intermolekulêre kragte in verbinding **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alkohol te oorkom/breek as in verbinding **B**/etanoësuur/karboksielsuur.* (4)

**[15]**





**QUESTION 4/*VRAAG 4***

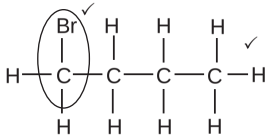
4.1

4.1.1 (A series of organic) compounds that can be described by the same general formula/functional group. ✓✓ **(2 or 0)**
*('n Reeks organiese) verbindings wat deur dieselfde algemene formule/ funksionele groep beskryf kan word.* ***(2 of 0)***
**OR/*OF***
(A series of organic) compounds in which one member differs from the next by a $CH_2$ group./*('n Reeks organiese) verbindings waarin een lid van die volgende verskil met 'n $CH_2$-groep.* **(2 or/*of* 0)** (2)

4.1.2 Substitution/halogenation/bromination ✓
*Substitusie/halogenasie/halogenering/brominasie/brominering* (1)

4.1.3 HBr ✓ (1)

4.1.4



**Marking criteria/*Nasienriglyne***
- Br on first C atom/*Br op eerste C-atoom:* Max/*Maks:* $\frac{1}{2}$
- Whole structure correct/*Hele struktuur korrek:* $\frac{2}{2}$

**IF/INDIEN:**
$Br_2$ but rest of structure correct/$Br_2$ maar res van struktuur korrek: $\frac{1}{2}$ (2)

4.1.5 $C_5H_{12} + 8O_2$ ✓ → $5CO_2 + 6H_2O$ ✓ Bal ✓

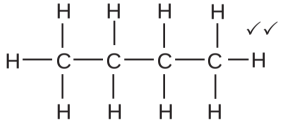
**Marking guidelines/*Nasienriglyne***
- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing ✓ *Balansering*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:* Max/*Maks:* $\frac{2}{3}$ (3)

4.1.6

**Marking guidelines/*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 (chemical) process in which longer chain hydrocarbons/longer chain alkanes are broken down to shorter/more useful hydrocarbons/molecules/ chains/alkanes and alkenes.
*Die (chemiese) proses waarin langketting koolwaterstowwe/langketting-alkane afgebreek word in korter/meer bruikbare koolwaterstowwe/molekule/ kettings/alkane en alkene.* (2)

4.1.7



✓✓

**Marking guidelines/*Nasienriglyne***
- One or more H atoms omitted/*Een of meer H-atome uitgelaat:* Max/*Maks*: $\frac{1}{2}$
- Condensed or semi-structural formula: *Gekondenseerde of semi-struktuur-formule:* Max/*Maks*: $\frac{1}{2}$

(2)

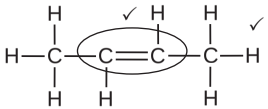
4.2

4.2.1 Butan-2-ol ✓✓ **OR/*OF*** 2-butanol ✓✓

**IF/*INDIEN:***
Butanol or/*of* butan-1-ol $\frac{1}{2}$

(2)

4.2.2



✓ ✓

**Marking criteria/*Nasienriglyne***
- Only functional group correct/*Slegs funksionele groep korrek:* Max/Maks: $\frac{1}{2}$
- Whole structure correct: *Hele struktuur korrek:* $\frac{2}{2}$

(2)

**[17]**

**QUESTION 5/*VRAAG 5***

5.1 Temperature/*Temperatuur* ✓ (1)

5. 2

**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)

5.3 14 (min) ✓✓ (2)





5.4

5.4.1 Graph/*grafiek* **B** ✓
(Experiment **3)** has the highest (acid) concentration/more particles/higher number of moles. ✓
(*Eksperiment **3)** het die hoogste (suur)konsentrasie/meer deeltjies/groter aantal mol.* (2)

5.4.2 (Graph/*grafiek*) **C** ✓
(Experiment 5) is at highest temperature/more particles with sufficient kinetic energy/HCℓ is at 35°C ✓
(*Eksperiment 5) is by die hoogste temperatuur/meer deeltjies met genoeg kinetiese energie/HCℓ is by 35°C.* (2)

5.5

5.5.1 Speeds up the reaction./Increases the reaction rate./Provides alternate pathway./Lowers the (net) activation energy. ✓
*Versnel die reaksie./Verhoog die reaksietempo./Verskaf alternatiewe roete./Verlaag die (netto) aktiveringsenergie.* (1)

5.5.2 Equal to/*Gelyk aan* ✓ (1)

5.6

$$n(Zn) = \frac{m}{M}$$
$$= \frac{1,5}{65} \checkmark$$
$$= 0,023 \text{ mol}$$
$$\text{rate/}tempo = -\frac{\Delta n}{\Delta t} \checkmark$$
$$= -\left(\frac{0 - 0,023}{14 - 0}\right) \checkmark$$
$$= 1,65 \times 10^{-3} \text{ (mol·min}^{-1}\text{)}$$
✓

**Marking guidelines/*Nasienriglyne***
- Substitute/*vervang* 65 g·mol$^{-1}$ in $n = \frac{m}{M}$ ✓
- Substitute change in mol to calculate rate./*Vervang verandering in mol om tempo te bereken.* ✓
- Substitute change in time to calculate rate./*Vervang verandering in tyd om tempo te bereken.* ✓
- Final answer/*Finale antwoord*: 1,65 x 10$^{-3}$ mol·min$^{-1}$ ✓
  **Range/*Gebied:***
  1,43 x 10$^{-3}$ to/*tot* 1,65 x 10$^{-3}$ (mol·min$^{-1}$)

**Notes/*Aantekeninge***
- Ignore if zeros omitted in calculation of reaction rate./*Ignoreer indien nulle uitgelaat in berekening van reaksietempo.*
- Accept negative answer i.e. -1,65 x 10$^{-3}$ mol·min$^{-1}$/*Aanvaar negatiewe antwoord d.i. -1,65 x 10$^{-3}$ mol·min$^{-1}$.*

(4)

**[15]**

**QUESTION 6/*VRAAG 6***

6.1 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 Endothermic/*Endotermies* ✓

- Decrease in temperature favours the exothermic reaction. ✓
  *Afname in temperatuur bevoordeel die eksotermiese reaksie.*
- The reverse reaction is favoured./*Die terugwaartse reaksie word bevoordeel.* ✓
  **OR/*OF***
  Number of moles/amount/concentration of $N_2O_4$/colourless gas increases.
  *Aantal mol/hoeveelheid/konsentrasie van $N_2O_4$/kleurlose gas neem toe.*
  **OR/*OF***
  Number of moles/amount of $NO_2$/brown gas decreases./*Aantal mol/ hoeveelheid $NO_2$ /bruin gas neem af.* (3)

6.3
6.3.1 Increases/*Verhoog* ✓ (1)

6.3.2 Remains the same/*Bly dieselfde* ✓ (1)

6.3.3 Increases/*Verhoog* ✓ (1)





6.4 **CALCULATIONS USING NUMBER OF MOLES**
***BEREKENINGE WAT GETAL MOL GEBRUIK***

**Marking guidelines/*Nasienriglyne***
- $\Delta n(N_2O_4)$ = 20% of/*van* **x**/0,2**x**. ✓
- **USE** ratio/***GEBRUIK*** *verhouding:* $N_2O_4 : NO_2$ : = 1 : 2. ✓
- $n(N_2O_4)_{eq/ewe} = n(N_2O_4)_{initial/begin} - \Delta n(N_2O_4)$.
  $n(NO_2)_{eq/ewe} = n(NO_2)_{initial/begin} + \Delta n(NO_2)$. ✓
- Divide equilibrium moles by 2 $dm^3$/*Deel ewewigsmol deur 2 $dm^3$.* ✓
- Correct $K_c$ expression (formulae in square brackets). ✓
  *Korrekte $K_c$ uitdrukking (formules in vierkanthakies).*
- Substitution of $K_c$ value/*Vervanging van $K_c$-waarde.* ✓
- Substitution of concentrations into correct $K_c$ expression. ✓
  *Vervanging van konsentrasies in korrekte $K_c$-uitdrukking.*
- Final answer/*Finale antwoord*: 1,6 (mol) ✓

**OPTION 1/*OPSIE 1***

| | $N_2O_4$ | $NO_2$ | |
|---|---|---|---|
| Initial amount (moles) *Aanvangshoeveelheid (mol)* | **x** | 0 | |
| Change in amount (moles) *Verandering in hoeveelheid (mol)* | 0,2**x** ✓ | 0,4**x** | ratio ✓ *verhouding* |
| Equilibrium amount (moles) *hoeveelheid (mol)* | 0,8**x** | 0,4**x** | ✓ |
| Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)* | 0,4**x** | 0,2**x** | Divide by 2 $dm^3$ ✓ |

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} \checkmark$$

$$0{,}16 \checkmark = \frac{(0{,}2\mathbf{x})^2}{(0{,}4\mathbf{x})} \checkmark$$

$$\mathbf{x} = 1{,}6 \text{ (mol)} \checkmark$$

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.* $\frac{5}{8}$

**OPTION 2/*OPSIE 2***

$$\Delta n(N_2O_4) = \frac{20}{100}\mathbf{x} \checkmark = 0{,}2\mathbf{x}$$

$$\Delta n(NO_2) = 2\Delta n(N_2O_4) = 0{,}4\,\mathbf{x} \checkmark$$

$$n(N_2O_4)_{eq/ewe} = \mathbf{x} - 0{,}2\mathbf{x} = 0{,}8\mathbf{x} \quad \textbf{AND} \quad n(NO_2)_{eq/ewe} = 0 + 0{,}4\mathbf{x} \checkmark$$

$$c(N_2O_4)_{eq/ewe} = \frac{0{,}8\mathbf{x}}{2} = 0{,}4\mathbf{x}$$

$$c(NO_2)_{eq/ewe} = \frac{0{,}4\mathbf{x}}{2} = 0{,}2\mathbf{x} \checkmark$$

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} \checkmark$$

$$0{,}16 \checkmark = \frac{(0{,}2\mathbf{x})^2}{(0{,}4\mathbf{x})} \checkmark$$

$$\mathbf{x} = 1{,}6 \text{ (mol)} \checkmark$$

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 guidelines/*Nasienriglyne***
- Initial $n(N_2O_4)$/**x** divide by 2 $dm^3$. ✓
  *Aanvanklike $n(N_2O_4)$/**x** gedeel deur 2 $dm^3$.*
- $\Delta c(N_2O_4)$ = 20% of initial concentration/0,1x. ✓
- **USE** ratio/***GEBRUIK*** *verhouding:* $c(N_2O_4) : c(NO_2) = 1 : 2$. ✓
- $c(N_2O_4)_{eq/ewe} = c(N_2O_4)_{initial/begin} - \Delta c(N_2O_4)$.
  $c(NO_2)_{eq/ewe} = c(NO_2)_{initial/begin} + \Delta c(NO_2)$. ✓
- Correct $K_c$ expression (formulae in square brackets). ✓
  *Korrekte $K_c$ uitdrukking (formules in vierkanthakies).*
- Substitution of $K_c$ value/*Vervanging van $K_c$-waarde*. ✓
- Substitution of concentrations into $K_c$ expression. ✓
  *Vervanging van konsentrasies in $K_c$-uitdrukking.*
- Final answer/*Finale antwoord*: 1,6 (mol) ✓

**OPTION 3/*OPSIE 3***

| | $N_2O_4$ | $NO_2$ | |
|---|---|---|---|
| Initial concentration ($mol \cdot dm^{-3}$)<br>*Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)* | $\frac{x}{2} = 0,5\mathbf{x}$ | 0 | Divide by 2 $dm^3$ ✓ |
| Change ($mol \cdot dm^{-3}$)<br>*Verandering ($mol \cdot dm^{-3}$)* | 0,1**x** ✓ | 0,2**x** | ratio ✓<br>*verhouding* |
| Equilibrium concentration ($mol \cdot dm^{-3}$)<br>*Ewewigskonsentrasie ($mol \cdot dm^{-3}$)* | 0,4**x** | 0,2**x** | ✓ |

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} \checkmark$$

$$0,16 \checkmark = \frac{(0,2\mathbf{x})^2}{0,4\mathbf{x}} \checkmark$$

$\mathbf{x}$ = 1,6 (mol)✓

No $K_c$ expression, correct substitution/*Geen $K_c$-uitdrukking, korrekte substitusie:* Max./*Maks.* $\frac{6}{8}$

Wrong $K_c$ expression/*Verkeerde $K_c$-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

(8)
**[16]**





**QUESTION 7/*VRAAG 7***

7.1
7.1.1 An acid is a proton donor. ✓✓
*'n Suur is 'n protondonor/skenker.* (2)

7.1.2 $H_2O$ ✓ (1)

7.1.3 $HSO_4^-$ ✓✓ (2)

7.2
7.2.1 Reaction of a salt with water/$H_2O$. ✓✓
*Reaksie van 'n sout met water/$H_2O$.*

**Accept/*Aanvaar***
Reaction of cations or anions with water
*Reaksie van katione of anione met water* (2)

7.2.2
- $CO_3^{2-}(aq) + 2H_2O(\ell)$ ✓ $\rightleftharpoons H_2CO_3(aq) + 2OH^-(aq)$ ✓
  **OR/*OF***
  $CO_3^{2-}(aq) + H_2O(\ell) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$
  **Accept/*Aanvaar:***
  $CaCO_3(aq) + 2H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + Ca(OH)_2(aq)$
- The formation of $OH^-(aq)$ neutralises the excess acid. ✓
  *Die vorming van $OH^-(aq)$ neutraliseer die oormaat suur.*

**Marking guidelines/*Nasienriglyne***
- Reactants ✓ Products ✓
  *Reaktanse Produkte*
- The formation of $OH^-(aq)$ neutralises the excess acid. ✓
  *Die vorming van $OH^-(aq)$ neutraliseer die oormaat suur.*
- Ignore single arrows and phases./*Ignoreer enkelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- Ignore balancing./*Ignoreer balansering.*

(3)

7.3
7.3.1 $pH = -\log[H_3O^+]$ ✓
$5 \checkmark = -\log[H_3O^+]$
$[H_3O^+] = 1 \times 10^{-5}\ mol \cdot dm^{-3}$ ✓ (3)

7.3.2 **POSITIVE MARKING FROM QUESTION 7.3.1.**
***POSITIEWE NASIEN VAN VRAAG 7.3.1.***

**Marking guidelines/*Nasienriglyne***

- Any formula/*Enige formule*: $c = \frac{n}{V}$ /n = $\frac{m}{M}$ / $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ /c = $\frac{m}{MV}$ ✓
- Substitute/*vervang* V = 4 x $10^9$ $dm^3$ ✓
- Calculate $n_a$(reacted) = $n_a$(initial) – $n_a$(final) ✓✓
  *Bereken $n_a$(reageer) = $n_a$(begin) – $n_a$(finaal)*
- Use/*Gebruik* n(CaO) : n($H_3O^+$) = 1:2 ✓
- Substitution of/*Vervanging van* 56 g·$mol^{-1}$ ✓
- Final answer/*Finale antwoord*: m = 1,08 x $10^6$ g to/*tot* 1,09 x $10^6$ g ✓

**IF** final answer is negative:/***INDIEN*** finale antwoord negatief is Max/Maks: $\frac{6}{7}$

**OPTION 1/*OPSIE 1***

$c(H_3O^+)_{ini/aanv.} = \frac{n}{V}$ ✓

$1 \times 10^{-5} = \frac{n}{4 \times 10^9}$ ✓

$n_a = 4 \times 10^4$ mol

$n(H_3O^+)_{react/rea}$
= $4 \times 10^4 - 1{,}26 \times 10^3$ ✓✓
= $3{,}87 \times 10^4$ mol

n(CaO) = ½n($H_3O^+$)
= ½ x 3,87 x $10^4$ ✓
= 1,94 x $10^4$ mol

**OPTION 2/*OPSIE 2***

$c(H_3O^+)_{fin} = \frac{n}{V}$ ✓

$= \frac{1{,}26 \times 10^3}{4 \times 10^9}$ ✓

= 3,15 x $10^{-7}$ mol·$dm^{-3}$

$c(H_3O^+)_{rea}$ = 1 x $10^{-5}$ – 3,15 x $10^{-7}$ ✓✓
= 9,69 x $10^{-6}$ mol·$dm^{-3}$

$n(H_3O^+)_{rea}$ = cV
= (9,65 x $10^{-6}$)(4 x $10^9$)
= 3,87 x $10^4$ mol

n(CaO) = ½n($H_3O^+$)
= ½ x 3,87 x $10^4$ ✓
= 1,94 x $10^4$ mol

**OR/*OF***

$n(CaO) = \frac{m}{M}$

$1{,}94 \times 10^4 = \frac{m}{56}$ ✓

∴ m = 1,09 x $10^6$ g ✓

1 mol : 56 g ✓

1,94 x $10^4$ mol : m

∴ m = 1,09 x $10^6$ g ✓

**OPTION 3/*OPSIE 3***

$c(H_3O^+)_{fin} = \frac{n}{V}$ ✓

$= \frac{1{,}26 \times 10^3}{4 \times 10^9}$ ✓

= 3,15 x $10^{-7}$ mol·$dm^{-3}$

$c(H_3O^+)_{rea}$ = 1 x $10^{-5}$ – 3,15 x $10^{-7}$ ✓✓
= 9,69 x $10^{-6}$ mol·$dm^{-3}$

c(CaO) = ½c($H_3O^+$) ✓ = 4,845 x $10^{-6}$ mol·$dm^{-3}$

$c = \frac{m}{MV}$ ∴ $4{,}845 \times 10^{-6} = \frac{m}{56(4 \times 10^9)}$ ✓ ∴ m = 1,09 x $10^6$ g ✓

(7)
**[20]**





**QUESTION 8/*VRAAG 8***

8.1
8.1.1 Loss of electrons./*Verlies aan elektrone*. ✓✓ **(2 or/*of* 0)** (2)

8.1.2 Fe → $Fe^{3+}$ + $3e^-$ ✓✓

**Marking guidelines/*Nasienriglyne***

- Fe ⇌ $Fe^{3+}$ + $3e^-$ $\frac{1}{2}$ $Fe^{3+}$ + $3e^-$ ⇌ Fe $\frac{0}{2}$
  $Fe^{3+}$ + $3e^-$ ← Fe $\frac{2}{2}$ $Fe^{3+}$ + $3e^-$ → Fe $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on $Fe^{3+}$/*Indien lading (+) weggelaat op* $Fe^{3+}$*:*
  Example/*Voorbeeld:* Fe → $Fe^3$ + $3e^-$ ✓ Max./*Maks:* $\frac{1}{2}$

(2)

8.1.3 Reducing agent/*Reduseermiddel* ✓ (1)

8.1.4 Fe is a stronger reducing agent ✓ than Cu ✓ and (Fe) will be oxidised ✓ (to $Fe^{3+}$)./*Fe is 'n sterker reduseermiddel as Cu en (Fe) sal geoksideer word (na $Fe^{3+}$).*

**OR/*OF***
Cu is a weaker reducing agent ✓ than Fe ✓and (Cu) will not be oxidised ✓ (to $Cu^{2+}$)./*Cu is 'n swakker reduseermiddel as Fe en (Cu) sal nie geoksideer word nie (na $Cu^{2+}$).* (3)

8.1.5 Zinc/Zn ✓
Stronger reducing agent (than Fe)./*Sterker reduseermiddel (as Fe).* ✓

**OR/*OF***
Zn will undergo oxidation (before Fe)./*Zn sal oksidasie (voor Fe) ondergaan.*

**OR/*OF***
Cu is a weaker reducing agent (than Fe)./*Cu is 'n swakker reduseermiddel (as Fe).* (2)

8.2
8.2.1 $3Cu^{2+}$ + 2Fe ✓ → 3Cu + $2Fe^{3+}$ ✓ Bal. ✓

**Marking guidelines/*Nasienriglyne***

- Reactants ✓ Products ✓ Balancing ✓
  *Reaktanse* *Produkte* *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*

(3)

8.2.2

| **OPTION 1/*OPSIE 1*** | **Notes/*Aantekeninge*** |
|---|---|
| $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓<br>= 0,34 ✓ – (-0,06) ✓<br>= 0,40 V ✓ | • Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*<br>• 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*** | |
|---|---|
| $Cu^{2+} + 2e^- \rightarrow Cu$ ✓ | $E^{\theta}$ = 0,34 V ✓ |
| $Fe \rightarrow Fe^{3+} + 3e^-$ | $E^{\theta}$ = 0,06 V ✓ |
| $3Cu^{2+} + 2Fe \rightarrow 3Cu + 2Fe^{3+}$ | $E^{\theta}$ = +0,40 V ✓ |

(4)
**[17]**

**QUESTION 9/*VRAAG 9***

9.1 A cell in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
*'n Sel waarin elektriese energie omgeskakel word na chemiese energie.*
***(2 of 0)***

**OR/*OF***
A cell in which electrical energy/electricity is used to obtain a chemical change/reaction. **(2 or 0)**
*'n Sel waarin elektriese energie/elektrisiteit gebruik word om 'n chemiese verandering/reaksie te veroorsaak.* ***(2 of 0)*** (2)

9.2 Any soluble copper(II) salt e.g./*Enige oplosbare koper(II)-sout bv.*
$CuSO_4/Cu(NO_3)_2/CuC\ell_2$ ✓ (1)

9.3 B ✓

$Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓

**Marking guidelines/*Nasienriglyne***
- $Cu \leftarrow Cu^{2+} + 2e^-$ ($\frac{2}{2}$) $Cu \rightleftharpoons Cu^{2+} + 2e^-$ ($\frac{0}{2}$)
  $Cu^{2+} + 2e^- \rightleftharpoons Cu$ ($\frac{1}{2}$) $Cu \rightarrow Cu^{2+} + 2e^-$ ($\frac{0}{2}$)
- Ignore if charge on electron is omitted./*Ignoreer indien lading op elektron uitgelaat is.*
- If a charge of an ion is omitted e.g. $Cu^2 + 2e^- \rightarrow Cu$ /*Indien lading op ioon uitgelaat is bv.* $Cu^2 + 2e^- \rightarrow Cu$ Max./*Maks*: $\frac{1}{2}$

(3)

9.4 Platinum/Pt ✓ **AND/*EN*** silver/Ag/*silwer* ✓ (2)
**[8]**





**QUESTION 10/*VRAAG 10***

10.1
10.1.1 Haber (process)/*Haber(proses)* ✓ (1)

10.1.2 Ostwald (process)/*Ostwald(proses)* ✓ (1)

10.2
10.2.1 Ammonium nitrate/*Ammoniumnitraat*/$NH_4NO_3$ ✓ (1)

10.2.2 Iron/iron oxide/Fe/FeO ✓
*Yster/ysteroksied*/Fe/FeO (1)

10.3 $2NH_3 + H_2SO_4$ ✓ $\rightarrow (NH_4)_2SO_4$ ✓ Bal ✓ (3)

**Marking guidelines/*Nasienriglyne***
- Reactants ✓ Products ✓ Balancing ✓
  *Reaktanse* *Produkte* *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

10.4

**Marking guidelines/*Nasienriglyne***
- Any ONE molar mass correct/*Enige EEN molêre massa korrek:*
  80 g·mol$^{-1}$/164 g·mol$^{-1}$/74,5 g·mol$^{-1}$ ✓
- m(N) = 7 (kg) **OR/*OF*** 0,14 ✓
- m(P) = 2,27 (kg) **OR/*OF*** 0,045 ✓
- m(K) = 9,42 (kg) **OR/*OF*** 0,188 ✓
- Final answer/*Finale antwoord*: 3 : 1 : 4 ✓
  **ACCEPT/*AANVAAR*:** 3,08 : 1 : 4,15 **OR/*OF*** 7 : 2,27 : 9,42

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $NH_4NO_3$:<br>80 g ✓ → 28 g N<br>20 kg → $\frac{28}{80}$ x 20<br>∴ m(N) = 7 kg ✓<br>$Na_3PO_4$:<br>164 g → 31 g P<br>12 kg → $\frac{31}{164}$ x 12<br>∴ m(P) = 2,27 kg ✓<br>KCℓ:<br>74,5 g → 39 g K<br>18 kg → $\frac{39}{74,5}$ x 18<br>∴ m(K) = 9,42 kg ✓<br>∴ N : P : K<br>7 : 2,27 : 9,42<br>3 : 1 : 4 ✓ | $n(NH_4NO_3) = \frac{m}{M}$<br>$= \frac{20\,000}{80}$ ✓ = 250 mol<br>$n(N) = 2n(NH_4NO_3)$ = 500 mol<br>m(N) = 500 x 14<br>= 7 000 g = 7 kg ✓<br>$n(Na_3PO_4) = \frac{12\,000}{164}$ = 73,17 mol<br>m(P) = 73,17 x 31<br>= 2 268 g = 2,27 kg ✓<br>$n(KC\ell) = \frac{18\,000}{74,5}$ = 241,61 mol<br>m(K) = 241,61 x 39<br>= 9 423 g = 9,42 kg ✓<br>∴ N : P : K<br>7 : 2,27 : 9,42<br>3 : 1 : 4 ✓ |

| **OPTION 3/*OPSIE 3*** | **OPTION 4/*OPSIE 4*** |
|---|---|
| $NH_4NO_3$: %N = $\frac{28}{80}$ ✓ x 100 = 35% | $NH_4NO_3$: |
| m(N) = $\frac{35}{100} \times 20 = 7$ kg ✓ | %N = $\frac{28}{80}$ ✓ x 100 = 35% |
| $Na_3PO_4$: | $Na_3PO_4$: |
| %P = $\frac{31}{164}$ x 100 = 18,9% | %P = $\frac{31}{164}$ x 100 = 18,9% |
| m(N) = $\frac{18,9}{100} \times 12$ = 2,27 kg ✓ | KCℓ: |
| KCℓ: | %K = $\frac{39}{74,5}$ x 100 = 52,34% |
| %K = $\frac{39}{74,5}$ x 100 = 52,34% | N: $\frac{20}{50}$ x 35 = 0,14 ✓ |
| m(K) = $\frac{52,34}{100} \times 18 = 9,42$ kg ✓ | P: $\frac{12}{50}$ x 18,9 = 0,045 ✓ |
| ∴ N : P : K = 7 : 2,27 : 9,42 | K: $\frac{18}{50}$ x 52,34 = 0,188 ✓ |
| = 3 : 1 : 4 ✓ | N : P : K = 0,14 : 0,045 : 0,188 |
| | = 3 : 1 : 4 ✓ |

(5)
**[12]**

**TOTAL/*TOTAAL*: 150**

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Province of the
EASTERN CAPE
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**NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT***

**GRADE/*GRAAD* 12**

**SEPTEMBER 2018**

# PHYSICAL SCIENCES P2
# *FISIESE WETENSKAPPE V2*
# MARKING GUIDELINE/*NASIENRIGLYN*

**MARKS/*PUNTE*: 150**

This marking guideline consists of 21 pages.
*Hierdie nasienriglyn bestaan uit 21 bladsye.*

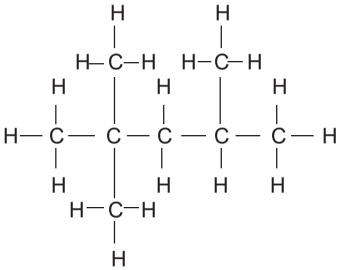
## QUESTION/*VRAAG* 1

| | | |
|---|---|---|
| 1.1 | C ✓✓ | (2) |
| 1.2 | B ✓✓ | (2) |
| 1.3 | A✓✓ | (2) |
| 1.4 | B ✓✓ | (2) |
| 1.5 | D ✓✓ | (2) |
| 1.6 | D ✓✓ | (2) |
| 1.7 | B✓✓ | (2) |
| 1.8 | A ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | **[20]** |

## QUESTION/*VRAAG* 2

2.1.1 Alkanes ✓/*Alkane* (1)

2.1.2



**Marking criteria/*Nasienriglyne*:**
- Correct stem i.e pentane./ *Korrekte stam d.i.pentaan.*✓
- Three methyl substituents *Drie metielsubstituente.*✓
- Whole structure correct./ *Hele struktuur korrek.* ✓ **3/3**

(3)

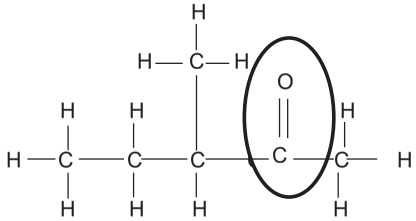
2.1.3 $CO_2$ ✓ and/*en* $H_2O$ ✓ (2)

2.2.1 Compounds with the <u>same molecular formula</u>, ✓ <u>but different positions of the functional group</u>. ✓ / *Verbindings met <u>dieselfde molekulêre formule</u>, maar <u>verskillende posisies van die funksionele groep.</u>* (2)





2.2.2



**Marking criteria/Nasienriglyne:**
- Correct functional group./ *Korrekte funksionele groep.*✓
- Whole structure correct./ *Hele struktuur korrek.* ✓ **2/2**

3-methyl ✓pentan-2-one ✓/ 3-methyl-2- pentanone
3-metiel ✓pentan-2-oon ✓/ 3-metiel-2- pentanoon (4)

2.3.1 2-chloro-3,4-dimethylhexane / *2-chloor-3,4-dimetielheksaan*

**Marking criteria/*Nasienriglyne*:**
- Correct stem i.e.hexane ✓ *Korrekte stam d.i. heksaan*
- First substituent, chloro, correctly identified ✓ *Eerste substituent, chloor korrek geïdentifiseer.*
- Second substituent, dimethyl, correctly identified ✓ *Tweede substituent, dimetiel, korrek geïdentifiseer.*
- Subtract a mark for missing hyphens, commas, incorrect numbering. *Trek 'n punt af vir enige koppelteken, komma wat uitgelaat is, verkeerde nommering.*

(3)

2.3.2 SECONDARY ✓ / SEKONDÊR (1)
**[16]**

## QUESTION/*VRAAG* 3

3.1 They are organic compounds that contain hydrogens and carbons only.✓✓
*Hulle is organiese verbindings wat slegs uit waterstof- en koolstofatome bestaan.* **(2 or/*of* 0)** (2)

3.2 53,3 ✓ (kPa)

**From A to C/*Van A na C***
Chain length decreases/surface area decreases/more branches. ✓
Strength of intermolecular forces/London forces/dispersion forces/induced-dipole forces decreases. ✓
Less energy needed to overcome/break intermolecular forces. ✓

*Kettinglengte neem af/oppervlaksarea neem af/meer vertakkings. Sterkte van intermolekulêre kragte/Londonkragte/dispersiekragte/geïnduseerde-dipool kragte neem af.*
*Minder energie word benodig om die intermolekulêre kragte te oorkom/breek.*

**OR/*OF***

**From C to A/*Van C na A***
Chain length increases/surface area increases/less branches. ✓
Strength of intermolecular forces/London forces/dispersion forces/induced-dipole forces increases. ✓
More energy needed to overcome/break intermolecular forces. ✓

*Kettinglengte neem toe/oppervlaksarea neem toe/minder vertakkings. Sterkte van intermolekulêre kragte/Londonkragte/dispersiekragte/geïnduseerde-dipool kragte neem toe.*
*Meer energie word benodig om die intermolekulêre kragte te oorkom/breek.* (4)

3.3 **E** ✓ (1)

3.3.1 Compound with lowest vapour pressure ✓
*Verbinding met die laagste dampdruk* (1)

3.3.2
- Compound **D**(ethanol) has one site for hydrogen bonding, whereas compound **E**(methanoic acid) has two sites for hydrogen bonding. ✓
  *Verbinding D(etanol) het een punt vir waterstofbindings, waar verbinding E(metanoësuur) twee punte het vir waterstofbindings.*
- Compound **E** has stronger hydrogen bonds than compound **D.** ✓
  *Verbinding **E** het sterker waterstofbindings as verbinding **D.*** (2)

**[10]**





## QUESTION/*VRAAG* 4

4.1 Substitution ✓/*Substitusie* (1)

4.2.1 Waft your hand across the beaker/test tube toward your nose and sniff/smell (cautiously).✓*I*
*Waai met jou hand oor die beker of proefbuis en ruik (versigtig).*

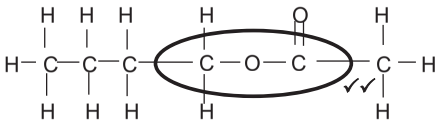
**OR/*OF***

Pour the ester into a bowl of water and this will help you to identify the smell of the ester./ *Gooi die ester in 'n glasbak met water om die reuk van die ester te kan identifiseer.* (1)

4.2.2 Esterification ✓/*Esterifikasie* (1)

4.2.3 Ethanoic acid ✓✓*I Etanoësuur* (2)

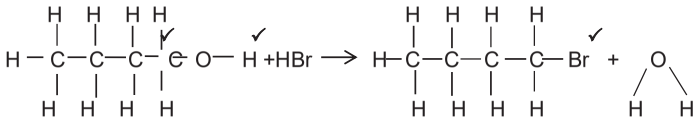
4.2.4



**Marking criteria/Nasienriglyne:**
- Functional group correct. *Funksionele groep korrek* 1/2
- Whole structure correct. *Hele struktuur korrek.* 2/2

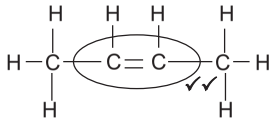
(2)

4.3



Accept/*Aanvaar*: $H_2O$ (4)

4.4.1



**Marking criteria/Nasienriglyne:**
- Correct functional group. *Korrekte funksionele groep.*✓ **1/2**
- Whole structure correct. *Hele struktuur korrek.* ✓ **2/2**

(2)

4.4.2 Concentrated $H_2SO_4$/Sulphuric acid ✓
*Gekonsentreerde $H_2SO_4$/Swaelsuur* (1)

4.4.3 (Excess) water/$H_2O$ ✓*I* Concentrated $H_2SO_4$
*(Oormaat) water/$H_2O$ /Gekonsentreerde* $H_2SO_4$ (1)

**[15]**

**QUESTION/*VRAAG* 5**

5.1 **ONLY ANY ONE OF / *SLEGS ENIGE EEN VAN*:**

- Change in concentration ✓ of reactants/products per (unit) time. ✓
  *Verandering in konsentrasie van reaktanse en produkte per (eenheids) tyd.*

- Rate of change in concentration. ✓✓
  *Tempo van verandering in konsentrasie.*

- Change in the amount/number of moles.volume/mass✓ of products or reactants per (unit) time. ✓
  *Verandering in hoeveelheid/aantal mol/volume/massa van produkte of reaktanse per (eenheids)tyd.*

- Amount / number of moles/volume/mass (of products) formed/ (reactants) used ✓per (unit) time. ✓
  Hoeveelheid / aantal mol /volume /masss (van produkte) gevorm/ (reaktantse) gebruik ✓per (*eenheids*) tyd

(2)

5.2 EQUAL TO ✓ *I GELYK AAN* (1)

5.3 Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t} = \frac{28-0}{15-0}$ ✓ = 1,87 ($cm^3.s^{-1}$) ✓ (2)

5.4

| **Criteria for investigative question/*Riglyne vir ondersoekende vraag*:** | |
|---|---|
| Dependent and independent variables correctly identified. *Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.* | ✓ |
| Asks a question about the relationship between independent and dependent variables./ *Vra 'n vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.* | ✓ |

**Examples/*Voorbeelde:***

- What is the effect of a catalyst on the rate of the reaction?
  *Wat is die effek van 'n katalisator op die reaksietempo?*
- What is the relationship between a catalyst and the rate of reaction? *Wat is die verwantskap tussen 'n katalisator en die reaksietempo?* (2)

**Notes/*Aantekeninge:***
- IF the answer to the question is a "YES" or "NO":/
  *INDIEN die antwoord op die vraag "JA" of "NEE" is.* Max/*Maks:* **1/2**

**Examples/*Voorbeelde:***
- Does the catalyst influence the rate of the reaction?
  *Beïnvloed die katalisator die reaksietempo?*
- Is there a relationship between the addition of a catalyst and reaction rate?
  *Is daar 'n verwantskap tussen die toevoeging van 'n katalisator en reaksietempo?*





5.5 EXOTHERMIC/*EKSOTERMIES* ✓

(Net) Energy is absorbed./More energy is released than absorbed. ✓/ Energy of reactants > Energy of products.
*(Netto) Energie word geabsorbeer./Meer energie word vrygestel as geabsorbeer./Energie van reaktante > Energie van produkte.* (2)

5.6 Experiment ***II*** ✓/*Eksperiment* ***II*** (1)

5.7
- A catalyst provides an alternative pathway of lower activation energy. ✓
- More particles will have sufficient/enough (kinetic) energy / $E_k \geq E_A$. ✓
- More effective collisions per unit time ✓/second. /Frequency of effective collisions increases.

- *'n Katalisator verskaf 'n alternatiewe pad van laer aktiveringsenergie.*
- *Meer deeltjies het genoegsame (kinetiese) energie / $E_k \geq E_A$.*
- *Meer effektiewe botsings per eenheidstyd/sekonde. / Frekwensie van effektiewe botsings neem toe.* (3)

**[13]**

**QUESTION/*VRAAG* 6**

6.1 The stage in a chemical reaction when the rate of the forward reaction equals the rate of the reverse reaction. ✓✓ **(2 marks or no marks)**

*Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die terugwaartse reaksie.* ***(2 punte of geen punte nie)***

**OR/*OF***

The state where the concentrations/quantities of reactants and products remain constant. ✓✓ **(2 marks or no marks)**

*Die toestand wanneer die konsentrasie/hoeveelhede van reaktanse en produkte konstant bly.* ***(2 punte of geen punte nie)***

(2)

6.2.1 DECREASES✓/*AFNEEM* (1)

6.2.2 NO EFFECT✓/*GEEN EFFEK*

$K_c$ will only change with a change in temperature.✓/$K_c$ is temperature dependent
*$K_c$ sal slegs verander met 'n verandering in temperatuur./ $K_c$ is temperatuur afhanklik* (2)

6.3.1 **Mark Allocations/*Puntetoekenning*:**

- Correct $K_c$ expression (formulae in square brackets). ✓ **Exp/*Eksp* 1 or/*of* 2**
  *Korrekte $K_c$ uitdrukking (formules in vierkanthakies).*
- Substitution of concentrations into $K_c$ expression.✓
  *Vervanging van konsentrasies in $K_c$ uitdrukking.*
- Substitution of $K_c$-value/*Vervanging van $K_c$ uitdrukking.*✓ **Exp/*Eksp 3***
- Substitution of concentrations into $K_c$ expression.✓
  *Vervanging van konsentrasies in $K_c$ uitdrukking.*
- Formula/*Formule*: n = cV
- Calculate/*Bereken* $n(N_2O_4)_{eq/ewe}$✓
- Calculate/*Bereken* $n(NO_2)_{eq/ewe}$. ✓
- Calculate/*Bereken* $\Delta n(NO_2) = n(NO_2)_{eq/ewe} - n(NO_2)_{initial/begin}$ ✓
- Use ratio $n(N_2O_4) : n(NO_2) = 1 : 2$ to calculate $\Delta n(N_2O_4)$ ✓
  *Gebruik verhouding: $n(N_2O_4) : n(NO_2) = 1 : 2$ om $\Delta n(N_2O_4)$ te bereken.*
- Calculate/*Bereken* $n(N_2O_4)_{initial/begin} = n(N_2O_4)_{eq/ewe} + \Delta n(N_2O_4)$ **=** 0,12 mol ✓





**OPTION/*OPSIE* 1**

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$ ✓

$= \frac{(0,0125)^2}{0,0336}$ ✓

$= 0,00465$

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$

$0,00465$✓ $= \frac{(0,0156)^2}{[N_2O_4]}$✓

$[N_2O_4]_{eq} = 0,052\ mol.dm^{-3}$

**OR/*OF***

**OPTION/*OPSIE* 2**

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$

$= \frac{(0,0107)^2}{0,0246}$

$= 0,00465$

| | $N_2O_4$ | $2NO_2$ | |
|---|---|---|---|
| $n_{initial/begin}$ ✓ | 0,1202 | 0 | |
| $\Delta n$ | 0,0156 | 0,0312✓ | Ratio/*Verhouding*✓ |
| $n_{eq/ewe}$ | 0,1046✓ | 0,0312✓ | |
| $c_{eq}$ | 0,052 | 0,0156 | |

**OPTION/*OPSIE* 3**

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$ ✓

$= \frac{(0,0125)^2}{0,0336}$ ✓

$= 0,00465$

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$

$0,00465$✓ $= \frac{(0,0156)^2}{[N_2O_4]}$✓

$[N_2O_4]_{eq} = 0,052\ mol.dm^{-3}$

$n(N_2O_4)_{eq} = cV = (0,052)(2)$✓$= 0,1046$ mol

$n(NO_2)_{eq} = cV = (0,0156)(2)$✓$= 0,0312$ mol

$\Delta n(NO_2) = n(NO_2)_{eq} - n(NO_2)_i = 0,0312 - 0 = 0,0312$ mol✓

$\Delta n(N_2O_4) = ½(0,0312)$✓$= 0,0156$ mol

Ratio = 1:2

$n(N_2O_4)_i = n(N_2O_4)_{eq} + \Delta n(N_2O_4)$

$= 0,1046 + 0,0156$

$= 0,12$ mol✓

**OR/*OF***

**OPTION/*OPSIE* 4**

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$

$= \frac{(0,0107)^2}{0,0246}$

$= 0,00465$

(9)

6.3.2 EQUAL TO ✓ / *GELYK AAN* (1)

6.3.3 Decrease in concentration of $N_2O_4$. ✓/ Decrease in [ $N_2O_4$ ]
*Afname in konsentrasie van $N_2O_4$ / Afname in [$N_2O_4$]* (1)
**[16]**





**QUESTION/*VRAAG* 7**

7.1.1 WEAK ACID✓/*SWAK SUUR*

–

It has a low $K_a$ value ✓/ The ionisation is NOT complete/incomplete.
*Dit het 'n lae $K_a$ waarde./ Die ionisasie is NIE volledig nie/onvolledig.* (2)

7.1.2 $C_2O_4^{2-}$✓ (1)

7.2.1 Hydrolysis is the reaction (of a salt) with water✓✓
*Hidrolise is die reaksie (van 'n sout) met water* (2)

7.2.2 $CH_3COOH$ ✓and/*en* $OH^-$✓ (2)

7.3.1 pH = - log[$H_3O^+$]✓
1✓ = - log[$H_3O^+$]
[$H_3O^+$] = 0,1 mol.dm$^{-3}$✓ (3)

7.3.2 **POSTIVE MARKING FROM QUESTION 7.3.1**
**POSITIEWE NASIEN VANAF VRAAG 7.3.1**

+

**OPTION/*OPSIE* 1**

n(NaOH) = cV ✓
= (0,025)(0,0322) ✓
=8,05 x $10^{-4}$ mol

n(HCℓ)$_{excess/oormaat}$ = n(NaOH)
= 8,05 x $10^{-4}$mol✓

**OPTION/*OPSIE* 2**

$\frac{n_a}{n_b} = \frac{c_aV_a}{c_bV_b}$ ✓

$\frac{1}{1} = \frac{(0,1)V_a}{(0,025)(32,2)}$ ✓

V(HCℓ)$_{excess/oormaat}$ = 8,05 cm$^3$

n(HCℓ)$_{excess/oormaat}$ = cV
=0,1(0,00805)
= 8,05 x $10^{-4}$ mol✓

(3)

7.3.3 **POSTIVE MARKING FROM QUESTION 7.3.2**
***POSITIEWE NASIEN VANAF VRAAG 7.3.2***

**OPTION/*OPSIE* 1**

$V(HC\ell)_{excess/oormaat} = n/c$
$= 0,000805 / 0,1$
$= 0,00805\ dm^3$

$V(HC\ell)_{reacted/gereageer}$
$= 0,050 - 0,00805$ ✓
$= 0,04195\ dm^3$

$n(HC\ell)_{reacted/gereageer} = cV$
$= (0,1)(0,04195)$ ✓
$= 0,004195$ mol

$n(CaCO_3) = ½\ n(HC\ell)_{reacted/gereageer}$
$= 0,0020975$ mol ✓

$m(CaCO_3) = nM$
$= (0,0020975)(100)$ ✓
$= 0,20975$ g

% purity/*suiwerheid* $= \frac{0,20975}{0,3} \times 100$ ✓
$= 69,92\%$ ✓

**Marking guidelines/*Nasienriglyne:***
- Subtract 0,00805 from 0,005✓
  *Trek 0,00805 van 0,005 af*
- Substitution into/ *Vervanging in* $n(HC\ell)_{reacted/gereageer} = cV$ ✓
- Use ratio/*Gebruik verhouding* 1 : 2✓
- Substitution into / *Vervanging in* $m(CaCO_3) = nM$✓
- Calculate/Bereken: % purity/*suiwerheid*✓
- Final answer/*Finale antwoord: 69,92%*✓

**RANGE** (69,92 TO 70%)

**OPTION/*OPSIE* 2**

$[HCl] = [H_3O^+] = 0,1\ mol.dm^{-3}$

$n_{HCl\ initial} = cV = 0,1 \times 50/1000$ ✓
$= 5 \times 10^{-3}$ mol

$n_{HCl\ excess} = 8,05 \times 10^{-4}$ mol (From 7.3.2)

$n_{HCl\ reacted} = 5 \times 10^{-3} - 8,05 \times 10^{-4}$ ✓

$= 4,195$ mol

$n_{CaCO3} = ½ \times 4,195$ ✓

$= 2,097 \times 10^{-3}$ mol

$m = nM = 2,097 \times 10^{-3} \times 100$ ✓
$= 0,20975$ g

$\%Purity = m_{pure}/m_{impure} \times 100$
$= 0,20975/0,3 \times 100$ ✓
$= 69,92\%$ ✓

(6)
**[19]**





**QUESTION/*VRAAG* 8**

8.1 A solution / liquid / dissolved substance that conducts electricity through the movement of ions ✓✓
*'n Oplossing / vloeistof / opgeloste stof wat elektrisiteit gelei deur die beweging van ione* (2)

8.2.1 Pressure: 1 atmosphere (atm) ✓/101,3 kPa / 1,013 x $10^5$ Pa
*Druk: 1 atmosfeer (atm) / 101,3 kPa / 1,013 x $10^5$ Pa* (1)

8.2.2 Platinum is a conductor of electricity ✓
*Platinum is 'n geleier van elektrisiteit* (1)

8.3 ANODE ✓ (1)

8.4

| **OPTION/*OPSIE 1*** | **Notes/Aantekeninge:** |
|---|---|
| $E^0_{cell/sel} = E^0_{cathode/katode} - E^0_{anode}$ ✓<br>$1,5$ ✓ $= E^0_{cathode/katode} - (-0,14)$ ✓<br>$E^0_{cathode/katode} = 1,36V$ ✓<br><br>$X_2 = C\ell_2$ ✓/Chlorine(gas)/*Chloor(gas)*<br><br>**Accept/*Aanvaar:***<br>$C\ell_2 / C\ell^-$ half reaction / *halfreaksie* | • Accept any other correct formula from the data sheet.<br>*Aanvaar enige ander korrekte formule vanaf gegewensblad.*<br>• Any other formula using unconventional abbreviations, e.g. $E^0_{cell} = E^0_{OA} - E^0_{RA}$<br>*Enige ander formule wat onkonvensionele afkortings gebruik, bv.*<br>$E^0_{sell} = E^0_{OM} - E^0_{RM}$ *gevolg deur korrekte vervangings:* Max/*Maks:* **3/4** |

**OPTION/*OPSIE 2***

✓ $X_2 + 2e^- \rightarrow X_2$ + 1,36(V) ✓
$Sn \rightarrow Sn^{+2} + 2e^-$ + 0,14(V) ✓
$X_2 + Sn \rightarrow X_2 + Sn^{+2}$ 1,50 (V) ✓

$X_2 = C\ell_2$ ✓/Chlorine(gas)/*Chloor(gas)*

**Accept/*Aanvaar:***
$C\ell_2 / C\ell^-$ half reaction / *halfreaksie* (5)

8.5 BECOMES ZERO✓/ *WORD NUL*

The electrical circuit is incomplete ✓*I*
*Die elektriese stroombaan is onvolledig* (2)

8.6 $3Mg(s) + 2A\ell^{+3}(aq)$ ✓ $\rightarrow 3Mg^{+2}(aq) + 2A\ell(s)$ ✓ Bal ✓

**Notes/*Aantekeninge*:**
- Reactants✓ Products✓ Balancing✓
- *Reaktanse* *Produkte* *Balansering*
- Ignore double arrows/*Ignoreer dubbelpyle*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)
**[15]**

## QUESTION/*VRAAG* 9

9.1.1 Battery ✓/Energy source/Power source
*Battery/Kragbron* (1)

9.1.2 Chlorine ✓/*Chloor*/$C\ell_2$ (1)

9.1.3 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

Ignore phases/*Ignoreer fases*

**Notes/*Aantekeninge:***

| | |
|---|---|
| $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ **(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)** | $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ **(1/2)** |

(2)

9.1.4 $C\ell^-$ ✓ OR/*OF* $NaC\ell$ (1)

9.2 $[H_3O^+] > 1 \times 10^{-7}$ ✓

Solution is alkaline✓/NaOH is formed
*Oplossing is alkalies/NaOH word gevorm* (2)

9.3 $Cu^{+2}$ is a stronger oxidising agent ✓(than $Na^+$) and will be reduced ✓ to Cu. ✓
*$Cu^{+2}$ is 'n sterker oksideermiddel (as $Na^+$) en sal gereduseer word (na Cu).* (3)
**[10]**





## QUESTION/*VRAAG* 10

10.1.1 Vanadium pentoxide/*Vanadiumpentoksied* /$V_2O_5$ ✓ (1)

10.1.2 $H_2SO_4$ ✓ (1)

10.1.3 Water ✓ (1)

10.1.4 Contact (process) / *Kontak (proses)* ✓ (1)

10.1.5 $NH_3(g) + H_2SO_4(aq)$ ✓ $\rightarrow$ $(NH_4)_2SO_4$ ✓ Bal. ✓ (3)

**Notes/*Aantekeninge:***
- Reactants ✓ *Reaktante* Products ✓ *Produkte* Balancing ✓ *Balansering*
- Ignore/*Ignoreer* ⇌ and phases/*en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

10.1.6 HIGHER THAN 450 $^0$C ✓/ HOÊR AS 450 $^0$C

**Mark independently/*Merk onafhanklik:***
- For all pressure values ✓
  *Vir alle waardes vir druk*
- Yield is lower for graph **Q** ✓
  *Opbrengs vir **Q** is laer*
- Reverse reaction which is endothermic will be favoured ✓
  *Terugwaartse reaksie wat endotermies is, word bevoordeel* (4)

10.2.1 Ensures quality seeds, fruit, vegetables and flowers. ✓
*Verseker kwaliteit saad, vrugte, groente en blomme.*
**OR/OF**
Help plants fight frost and resist diseases. ✓
*Help plante veg teen ys en bied weerstand teen siektes.* (1)

10.2.2

**OPTION/*OPSIE* 1**
% fertiliser = 100 – 76 = 24%✓
% K = 24 – (4+8) ✓= 12
m(K) = $\frac{12}{100}$ x m(bag) = 6 kg ✓
m(bag) = 50 kg ✓

**OPTION/*OPSIE* 2**
% fertiliser = 100 – 76 = 24%✓
% K = 24 – (4+8) ✓= 12
m(K) = $\frac{12}{24}$ x m(fertiliser) = 6 kg ✓
m(fertiliser) = 12 kg ✓
m(filler) = $\frac{12}{24}$ x 76 = 38 kg (24 : 76)
m(bag) = 12 + 38 = 50 kg

**Marking criteria/*Nasienriglyne:***
- Subtract to obtain % fertiliser.✓
  *Aftrekking om % kunsmis te kry.*
- -(4+8) for % K in bag of fertiliser/*in sak kunsmis* ✓
- Calculate mass **m** /*Bereken massa **m*** ✓
- Final answer/*Finale antwoord: 50 kg* ✓

(4)
**[16]**

**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)***

**FEBRUARY/MARCH/*FEBRUARIE/MAART* 2018**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 15 pages.**
***Hierdie nasienriglyne bestaan uit 15 bladsye.***

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**QUESTION 1/*VRAAG 1***

| | | |
|---|---|---|
| 1.1 | C ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | B ✓✓ | (2) |
| 1.4 | C ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | B ✓✓ | (2) |
| 1.7 | B ✓✓ | (2) |
| 1.8 | C ✓✓ | (2) |
| 1.9 | A ✓✓ | (2) |
| 1.10 | D ✓✓ | (2) |
| | | **[20]** |

**QUESTION 2/*VRAAG 2***

2.1
2.1.1 A ✓ (1)

2.1.2 B ✓ (1)

2.1.3 D ✓ (1)

2.1.4 D ✓ (1)

2.2
2.2.1 Butanal/*Butanaal* ✓ (1)

2.2.2 5-ethyl-6,6-dimethyloctan-3-ol/*5-etiel-6,6-dimetieloktan-3-ol*

**OR/*OF***
5-ethyl-6,6-dimethyl-3-octanol/*5-etiel-6,6-dimetiel-3-oktanol*

**Marking criteria/*Nasienriglyne:***
- Stem, i.e. octan./*Stam d.i. oktan.* ✓
- Correct functional group, i.e. –ol./*Korrekte funksionele groep d.i. –ol.* ✓
- Two methyl groups and one ethyl group.
  *Twee metielgroepe en een etielgroep.* ✓
- Correct numbering of substituents and functional group ✓
  *Korrekte nommering van substituente en funksionele groep.*

**IF/*INDIEN:***
Any error e.g. hyphens omitted and/or incorrect sequence:
*Enige fout bv. koppeltekens weggelaat en/of verkeerde volgorde:* Max./*Maks.* 3/4

(4)

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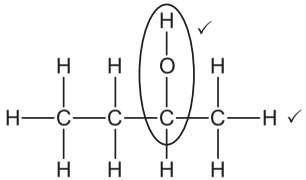
2.3 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups on parent chain. ✓
*Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituente/funksionele groepe op die stamketting.* (2)

2.4
2.4.1

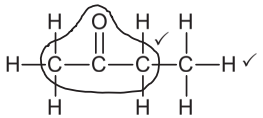


**Marking criteria/*Nasienriglyne:***
- Whole structure correct:
  *Hele struktuur korrek:* 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

**IF/*INDIEN*:**
More than one functional group:
*Meer as een funksionele groep:* 0/2

(2)

2.4.2

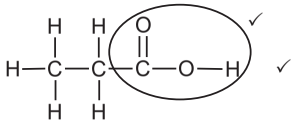


**Marking criteria/*Nasienriglyne:***
- Whole structure correct:
  *Hele struktuur korrek:* 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

**IF/*INDIEN*:**
More than one functional group:
*Meer as een funksionele groep:* 0/2

(2)

2.4.3



**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)
**[17]**





**QUESTION 3/*VRAAG 3***

3.1 150 kPa ✓ (1)

3.2
3.2.1 The temperature at which the vapour pressure equals atmospheric/external pressure. ✓✓ ( 2 or 0)
*Die temperatuur waar die dampdruk gelyk is aan atmosferiese/eksterne druk.* (2)

3.2.2 55 °C ✓ (1)

3.3
3.3.1 Z ✓ (1)

3.3.2
- Carboxylic acids have, in addition to London forces and dipole-dipole forces, two sites for hydrogen bonding between molecules. ✓
  *Karboksielsure het, in toevoeging tot Londonkragte en dipool-dipoolkragte, twee punte vir waterstofbinding tussen molekule.*
  **OR/*OF***
  Carboxylic acids can form dimers due to strong hydrogen bonding between molecules.
  *Karboksielsure kan dimere vorm as gevolg van sterk waterstofbindings tussen molekule.*
- Alcohols have, in addition to London forces and dipole-dipole forces, one site for hydrogen bonding between molecules. ✓
  *Alkohole het, in toevoeging tot Londonkragte en dipool-dipoolkragte, een punt vir waterstofbinding tussen molekule.*
- Ketones has, in addition to London forces, dipole-dipole forces between molecules. ✓
  *Ketone het, in toevoeging tot Londonkragte, dipool-dipoolkragte tussen molekule.*
- Intermolecular forces in carboxylic acids is the strongest./Most energy needed to overcome/break intermolecular forces in ethanoic acid. ✓
  *Intermolekulêre kragte in karboksielsure is die sterkste./Die meeste energie word benodig om intermolekulêre kragte in karboksielsure te oorkom/breek.* (4)

3.3.3 Propanone/*Propanoon* ✓

**OR/*OF***
Propan-2-one/*Propan-2-oon*

**OR/*OF***
2-propanone/2-*propanoon* (1)
**[10]**

## QUESTION 4/*VRAAG 4*

4.1 The chemical process in which longer chain hydrocarbon molecules are broken down ✓ to shorter more useful molecules. ✓
*Die chemiese proses waarin langer ketting koolwaterstofmolekule afgebreek word in korter meer bruikbare molekule.* (2)

4.2
4.2.1 III ✓ (1)

4.2.2 II ✓ (1)

4.2.3 I ✓ (1)

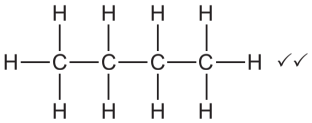
4.3
4.3.1 Heat/Light /UV light ✓
*Hitte/Lig/UV Lig* (1)

4.3.2 P or/*of* S ✓ (1)

4.3.3 Ethene/*Eteen* ✓ (1)

4.3.4 $C_8H_{18}$ ✓✓ (Correct Structural formula/*Korrekte struktuurformule* : $\frac{1}{2}$) (2)

4.3.5

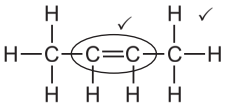


✓✓

**Marking criteria/*Nasienriglyne:***
- Whole structure correct:
  *Hele struktuur korrek:* $\frac{2}{2}$
- 4 C atoms in chain:/*4 C-atome in ketting:* Max/*Maks.*: $\frac{1}{2}$
- Correct condensed formula/*Korrekte gekondenseerde formule*: $\frac{1}{2}$

(2)

4.3.6



**Marking criteria/*Nasienriglyne:***
- Whole structure of alkene/haloalkane correct:
  *Hele struktuur van alkeen/haloalkaan korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* $\frac{1}{2}$
- Correct condensed structure/*Korrekte gekondenseerde struktuur*:
  $CH_3CH{=}CHCH_3$ $\frac{1}{2}$

(2)
**[14]**



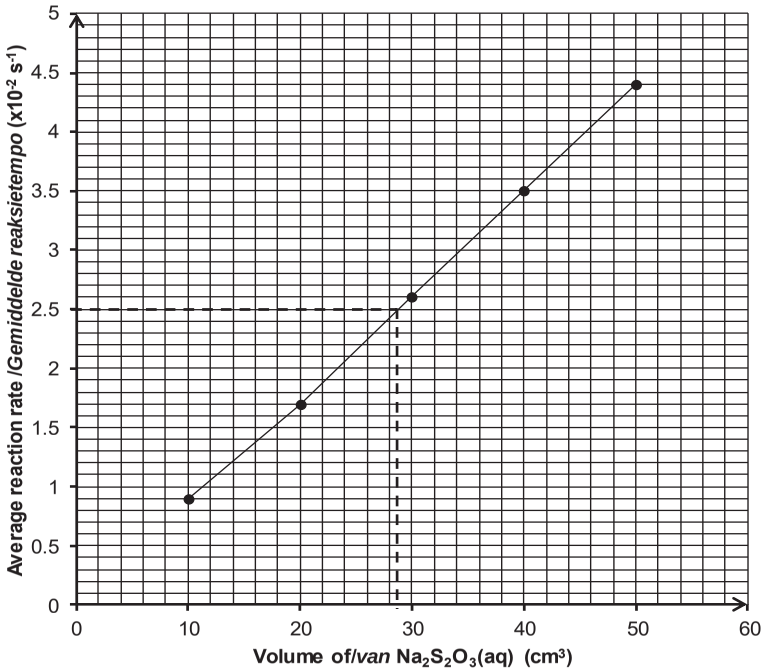


## QUESTION 5/*VRAAG 5*

5.1 **ONLY ANY ONE OF/*SLEGS ENIGE EEN VAN*:**
- Change in concentration ✓ of a reactant/product per unit time. ✓
  *Verandering in konsentrasie van reaktanse/produkte per eenheidtyd.*
- *Rate of change in concentration.* ✓✓
  *Tempo van verandering in konsentrasie.*
- *Change in amount/number of moles/volume/mass of products/reactants per (unit) time./Verandering in hoeveelheid/getal mol/volume/massa van produkte/reaktanse per (eenheid)tyd.*
- *Amount/number of moles/volume/mass of products formed OR reactants used per (unit) time./Hoeveelheid/getal mol/volume/massa van produkte gevorm OF reaktanse gebruik per (eenheid)tyd.* (2)

5.2 More than/*Groter as* ✓
**Accept/*Aanvaar***
Equal to/*Gelyk aan* (1)

5.3 **Graph of average reaction rate versus volume of $Na_2S_2O_3(aq)$**
***Grafiek van gemiddelde reaksietempo teenoor volume $Na_2S_2O_3(aq)$***




| **Marking criteria/*Nasienriglyne:*** | |
|---|---|
| Any 3 points correctly plotted./*Enige 3 punte korrek gestip.* | ✓ |
| All (5) points correctly plotted./*Alle (5) punte korrek gestip.* | ✓ |
| Straight line drawn./*Reguitlyn getrek.* | ✓ |

(3)

5.4

5.4.1

| **Marking criteria/*Nasienriglyne:*** |
|---|
| y axis/*y-as*: 2,5 x $10^{-2}$ $s^{-1}$ ✓ |
| Dotted line drawn from the y-axis to the x-axis as shown. ✓<br>*Stippellyn getrek van y-as na x-as soos getoon.* |
| V = 28 to 30 $cm^3$ ✓ |

(3)

5.4.2

| **Criteria for conclusion/*Riglyne vir gevolgtrekking*:** | |
|---|---|
| Dependent and independent variables correctly identified.<br>*Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.* | ✓ |
| Relationship between the independent and dependent variables correctly stated./*Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.* | ✓ |

**Examples/*Voorbeelde*:**

- Reaction rate of reaction increases with an increase in concentration/volume of sodium thiosulphate.
  *Reaksietempo neem toe met 'n toename in konsentrasie/volume van natriumtiosulfaat.*
- Reaction rate decreases with a decrease in concentration/volume of sodium thiosulphate.
  *Reaksietempo neem af met 'n afname in konsentrasie/volume van natriumtiosulfaat.*
- Reaction rate is (directly) proportional to concentration/volume of sodium thiosulphate.
  *Reaksietempo is (direk) eweredig aan konsentrasie/volume van natriumtiosulfaat.*

(2)

5.5

- More( $Na_2S_2O_3$) particles per unit volume. ✓
  *Meer $Na_2S_2O_3$-deeltjies per eenheid volume.*
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
  *Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.*
- Increase in reaction rate./*Toename in reaksietempo.* ✓

(3)

5.6

**OPTION 1/*OPSIE 1***

$n(S)_{produced/gevorm} = \frac{m}{M}$

$= \frac{1,62}{32}$ ✓

$= 0,0506$ mol

$n(Na_2S_2O_3) = n(S) = 0,0506$ mol ✓

$n(Na_2S_2O_3) = \frac{m}{M}$

$0,0506 = \frac{m}{158}$ ✓

$\therefore m(Na_2S_2O_3) = 7,99$ g ✓

[Range/*Gebied*: 7,90 to 8,06]

**Marking criteria/*Nasienriglyne:***

- Substitute/*Vervang* 32 in $n = \frac{m}{M}$ ✓
- Use ratio/*Gebruik verhouding*: $Na_2S_2O_3$: S = 1 : 1 ✓
- Substitute/*Vervang* 158 in $n = \frac{m}{M}$ ✓
- Final answer/*Finale antwoord*: 7,90 to/*tot* 8,06 g ✓

**OPTION 2/*OPSIE 2***

158 g ✓ $Na_2S_2O_3$ ⟶ 32 g ✓ S

∴ x ⟶ 1,62 g S ✓

$x = \frac{158 \times 1,62}{32} = 7,99$ g ✓

[Range/*Gebied*: 7,90 to 8,06]

(4)

**[18]**





## QUESTION 6/*VRAAG 6*

6.1

6.1.1 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. ✓✓
*Wanneer die ewewig in 'n geslote sisteem versteur word, stel die sisteem 'n nuwe ewewig in deur die reaksie wat die versteuring teenwerk, te bevoordeel.* (2)

6.1.2

- Percentage yield increases with an increase in temperature. ✓
  *Persentasie opbrengs verhoog met toename in temperatuur.*
- Forward reaction is favoured. ✓
  *Voorwaartse reaksie word bevoordeel.*
- Increase in temperature favours an endothermic reaction. ✓
  *Toename in temperatuur bevoordeel die endotermiese reaksie.*

(3)

6.1.3 When the pressure increases, the reaction that leads to a decrease in the number of moles will be favoured. ✓✓
*Wanneer die druk verhoog, word die reaksie wat tot 'n afname in die aantal mol lei, bevoordeel.*
**Accept/*Aanvaar***
When the pressure increases, the yield increases ✓ because the equilibrium position shifts to the right. ✓
*Wanneer die druk toeneem, neem die opbrengs toe omdat die ewewigsposisie na regs skuif.* (2)

6.1.4 I ✓✓ (2)

6.2

**Mark allocation/*Puntetoekenning***

- Substitution of/*Vervanging van 36,5 g·mol*$^{-1}$ *in* $n = \frac{m}{M}$. ✓
- Change/*Verandering* n(HCℓ) = initial/*aanvanklik* – equilibrium/*ewewig*. ✓
- USING ratio/*GEBRUIK verhouding:* 4 : 1 : 2 : 2 ✓
- Equilibrium: $n(O_2)$ & $n(H_2O)$ & $n(C\ell_2)$ = initial ± change ✓
  *Ewewig: : $n(O_2)$ & $n(H_2O)$ & $n(C\ell_2)$ = aanvanklik ± verandering*
- Divide by volume/*Gedeel deur volume* (0,2 $dm^3$) ✓
- Correct $K_c$ expression (formulae in square brackets). ✓
  *Korrekte $K_c$ -uitdrukking (formules tussen vierkanthakies).*
- Substitution of reactant concentrations/*Vervanging van reaktanskonsentrasies.* ✓
- Substitution of product concentrations./*Vervanging van produk-konsentrasies.* ✓
- Final answer/*Finale antwoord:* 13,966 to/*tot* 18,72 ✓
  Range/*Gebied:* 13,966 to/*tot* 18,72

**OPTION 1/*OPSIE 1***

| | $HC\ell$ | $O_2$ | $C\ell_2$ | $H_2O$ | |
|---|---|---|---|---|---|
| Initial quantity/*Aanvangs-hoeveelheid (mol)* | 0,2 | 0,11 | 0 | 0 | |
| Change/*Verandering (mol)* | 0,15 ✓ | 0,0375 | 0,075 | 0,075 | ratio ✓ *verhouding* |
| Quantity at equilibrium *Hoeveelheid by ewewig (mol)* | $\frac{1,825}{36,5}$ = 0,05 ✓ | 0,0725 | 0,075 | 0,075 | ✓ |
| Equilibrium concentration/*Ewewigskon sentrasie (mol·dm$^{-3}$)* | 0,25 | 0,3625 | 0,375 | 0,375 | Divide by 0,2✓ *Deel deur 0,2* |

$$K_c = \frac{[C\ell_2]^2[H_2O]^2}{[HC\ell]^4[O_2]} ✓ = \frac{(0,375)^2(0,375)^2 ✓}{(0,25)^4(0,3625)✓} = 13,97 ✓$$

No $K_C$ expression, correct substitution/*Geen $K_c$-uitdrukking, korrekte vervanging:* Max./*Maks.* $\frac{8}{9}$

Wrong $K_C$ expression/*Verkeerde $K_c$-uitdrukking*: Max./*Maks.* $\frac{5}{9}$

(9)

**OPTION 2/*OPSIE 2:***

$n(HC\ell)_{equilibrium/ewewig} = \frac{m}{M} = \frac{1,825}{36,5}$ ✓ = 0,05 mol

$n(HC\ell)_{reacted/reageer}$ = 0,2 – 0,05 = 0,15 mol ✓

$n(O_2)_{reacted/reageer} = ¼n(HC\ell)_{reacted/reageer}$ = ¼ x 0,15 = 0,0375 mol
$n(C\ell_2)_{formed/gevorm} = ½n(HC\ell)_{reacted/reageer}$ = ½ x 0,15 = 0,075 mol
$n(H_2O)_{formed/gevorm} = ½n(HC\ell)_{reacted/reageer}$ = ½ x 0,15 = 0,075 mol
} Using ratio ✓

$n(O_2)_{equilibrium/ewewig}$ = 0,11 – 0,0375 = 0,0725 mol
$n(C\ell_2)_{equilibrium/ewewig} = n(H_2O)_{equilibrium/ewewig}$ = 0,075 mol
} ✓

$c(O_2)_{equilibrium/ewewig} = \frac{n}{V} = \frac{0,0375}{0,2}$ = 0,3625 mol·dm$^{-3}$

$c(C\ell_2)_{equilibrium/ewewig} = c(H_2O)_{equilibrium/ewewig} = \frac{n}{V}$
$= \frac{0,075}{0,2}$ = 0,375 mol·dm$^{-3}$
} Divide by/ *deel deur* 0,2✓

$$K_c = \frac{[H_2O]^2[C\ell_2]^2}{[HC\ell]^4[O_2]} ✓ = \frac{(0,375)^2(0,375)^2✓}{(0,25)^4(0,3625)✓} = 13,97 ✓$$

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.* $\frac{5}{9}$

(9)





**CALCULATIONS USING CONCENTRATIONS**
***BEREKENINGE WAT KONSENTRASIES GEBRUIK***

**Mark allocation/*Puntetoekenning***

- Substitution of/*Vervanging van 36,5 g·mol$^{-1}$* $n = \frac{m}{M}$. ✓
- Initial concentration of reactants/*Aanvanklike konsentrasie van reaktanse*: $c(HC\ell)$ = 1,0 & $c(O_2)$ = 0,55 mol·dm$^{-3}$ ✓
- Change: $c(HC\ell)$ = 0,75 mol·dm$^{-3}$ (initial – equilibrium) ✓
  *Verandering: $c(HC\ell)$ = 0,75* mol·dm$^{-3}$ *(aanvanklik – ewewig)*
- USING ratio/*GEBRUIK verhouding:* 4 : 1 : 2 : 2 ✓
- Equilibrium/*Ewewig*: $c(H_2O) = c(C\ell_2)$ = 0,3625 mol·dm$^{-3}$ (initial+change) and $c(O_2)$ = 0,3625 mol·dm$^{-3}$ (initial – change) ✓
  *Ewewig*: $c(H_2O) = c(C\ell_2)$ = 0,3625 mol·dm$^{-3}$ (*aanvanklik* + *verandering*) en $c(O_2)$ = 0,0,3625 mol·dm$^{-3}$ *(aanvanklik – verandering)*
- Correct $K_c$ expression (formulae in square brackets). ✓
  *Korrekte $K_c$ -uitdrukking (formules tussen vierkanthakies).*
- Substitution of reactant concentrations./*Vervanging van reaktanskonsentrasies.* ✓
- Substitution of product concentrations./*Vervanging van produkkonsentrasies.* ✓
- Final answer/*Finale antwoord*: 13,97 ✓
  Range/*Gebied:* 13,966 to/*tot* 18,72

**OPTION 3/*OPSIE 3***

$n(HC\ell)_{equilibrium/ewewig} = \frac{m}{M}$
$= \frac{1,825}{36,5}$ ✓
= 0,05 mol

| | $HC\ell$ | $O_2$ | $H_2O$ | $C\ell_2$ | |
|---|---|---|---|---|---|
| Initial concentration/ *Aanvangskonsentrasie (mol·dm$^{-3}$)* | 1,0 ✓ | 0,55 | 0 | 0 | Divide by 0,2 ✓ *Deel deur 0,2* |
| Change in concentration *Verandering in konsentrasie* (mol·dm$^{-3}$) | 0,75 ✓ | 0,1875 | 0,375 | 0,375 | ratio ✓ *verhouding* |
| Equilibrium concentration Ewewigskonsentrasie (mol·dm$^{-3}$) | 0,25 | 0,3625 | 0,375 | 0,375 | ✓ |

$$K_c = \frac{[C\ell_2]^2[H_2O]^2}{[HC\ell]^4[O_2]} ✓ = \frac{(0,375)^2(0,375)^2✓}{(0,25)^4(0,3625)✓} = 13,97 ✓$$

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.* $\frac{5}{9}$

(9)
**[18]**

## QUESTION 7/*VRAAG 7*

7.1

7.1.1 $H_2O$ ✓
$HSO_4^-$ ✓ (2)

7.1.2 Strong/*Sterk* ✓
Completely ionised (in water)./*Volledig geïoniseer (in water).* ✓ (2)

7.2

7.2.1

**Marking Criteria/*Nasienriglyne***

- Formula/*Formule:* $\frac{c_a \times V_a}{c_a \times V_b} = \frac{n_a}{n_b}$ / $c = \frac{n}{V}$ ✓
- Substitute/*Vervang* 0,15 x 24 **OR/*OF*** 0,15 x 0,024 ✓
- Use/*Gebruik* 26 $cm^3$ **OR/*OF*** 0,026 $dm^3$ ✓
- Use mole ratio/*Gebruik molverhouding*: 1:2 ✓
- Final answer/*Finale antwoord:* 0,28 $mol \cdot dm^{-3}$ ✓ (0.2769… $mol \cdot dm^{-3}$)

**OPTION 1/*OPSIE 1***

$\frac{c_a \times V_a}{c_a \times V_b} = \frac{n_a}{n_b}$ ✓

$\frac{0,15 \times 24}{c_b \times 26} = \frac{1}{2}$ ✓

$c(NaOH) = 0,28\ mol \cdot dm^{-3}$ ✓

**OPTION 2/*OPSIE 2***

$n(H_2SO_4) = cV$ ✓
$= (0,15)(0,024)$ ✓
$= 3,6 \times 10^{-3}$ mol

$n(NaOH) = \underline{2}(3,6 \times 10^{-3})$ ✓
$= 7,2 \times 10^{-3}$ mol

$c = \frac{n}{V}$

$= \frac{7,2 \times 10^{-3}}{0,026}$ ✓

$= 0,28\ mol \cdot dm^{-3}$ ✓ (5)





7.2.2

**Marking Criteria/*Nasienriglyne***

- Calculate/*Bereken* n(NaOH): 0,02 x 0,28 ✓
- Calculate/*Bereken* $n(H_2SO_4)$: 0,03 x 0,15 ✓
- Use ratios/*Gebruik molverhouding*: $n(H_2SO_4) = ½n(NaOH)$ ✓
- $n(H_2SO_4)_{excess} = n(H_2SO_4)_{initial} – n(H_2SO_4)_{used} = 0,0045 – 0,0028$ ✓
- Substitute/*Vervang* 0,05 $dm^3$ in $c = \frac{n}{V}$ ✓
- Substitution/*Vervang* 2 x 0,034 in $2[H_2SO_4]$ ✓
- Formula/*Formule:* $-\log[H_3O^+]$ **OR/*OF*** Substitute/*Vervang:* -log(0,068) ✓
- Final answer: 1,10 to/*tot* 1,167 ✓

**OPTION 1/*OPTION 1***

$n(NaOH) = cV$
$= 0,02 \times 0,28$ ✓
$= 0,0056$ mol

$n(H_2SO_4) = 0,03 \times 0,15$ ✓
$= 0,0045$ mol

$n(H_2SO_4)_{used} = ½n(NaOH)$ ✓
$= 0,0028$

$n(H_2SO_4)_{excess} = 0,0045–0,0028$ ✓
$= 0,0017$ mol

$[H_2SO_4] = \frac{n}{V} = \frac{0,0017}{0,05}$ ✓
$= 0,034\ mol \cdot dm^{-3}$

$[H_3O^+] = 2[H_2SO_4]$
$= 2 \times 0,034$ ✓
$= 0,068\ mol \cdot dm^{-3}$

$pH = -\log[H_3O^+]$ **OR/*OF*** -log(0,068) ✓
$= 1,17$ ✓ (1,167)

**OPTION 2/*OPTION 2***

$n(NaOH) = cV$
$= 0,02 \times 0,28$ ✓
$= 0,0056$ mol

$n(H_2SO_4) = 0,03 \times 0,15$ ✓
$= 0,0045$ mol

$n(H_3O^+) = 2n(H_2SO_4)$ ✓
$= 2 \times 0,0045$
$= 0,009$ mol

$n(H_3O^+)_{excess} = 0,009 – 0,0045$ ✓
$= 0,0034$ mol

$c(H_3O^+) = \frac{n}{V}$

$= \frac{0,0034}{0,05}$ ✓ ✓

$= 0,068\ mol \cdot dm^{-3}$

$pH = -\log[H_3O^+]$ **OR/*OF*** -log(0,068) ✓
$= 1,17$ ✓ (1,167)

(8)
**[17]**

## QUESTION 8/*VRAAG 8*

8.1

8.1.1 A substance that loses/donates electrons./*'n Stof wat elektrone verloor/skenk.* ✓✓ ( 2 or 0) (2)

8.1.2 Platinum/Pt ✓ (1)

8.1.3 $Sn^{2+}$(aq)/tin(II) ions/*tin(II)-ione* ✓ (1)

8.1.4 Pt | $Sn^{2+}$(aq) ✓, $Sn^{4+}$(aq) ✓ || $Ag^{+}$(aq) ✓ | Ag(s)

**OR/*OF***
Pt| $Sn^{2+}$(1 mol·dm$^{-3}$) ,$Sn^{4+}$ (1 mol·dm$^{-3}$) || $Ag^{+}$ (1 mol·dm$^{-3}$) | Ag(s)

**ACCEPT/*AANVAAR***
Pt| $Sn^{2+}$ | $Sn^{4+}$ || $Ag^{+}$ | Ag (3)

8.1.5

| **OPTION 1/*OPSIE 1*** | **Notes/*Aantekeninge*** |
|---|---|
| $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓<br>= +0,80 ✓ - (+0,15) ✓<br>= 0,65 V ✓ | • Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*<br>• 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:* $\frac{3}{4}$ |

**OPTION 2/*OPSIE 2***

| | |
|---|---|
| ✓ $Ag^{+}$(aq) + $e^{-}$ → Ag(s) | 0,80 V ✓ |
| $Sn^{2+}$(aq) → $Sn^{4+}$(aq) + $2e^{-}$ | -0,15 V ✓ |
| $2Ag^{+}$(aq) + $Sn^{2+}$(aq) → $Sn^{4+}$(aq) + 2Ag(s) | 0,65 V ✓ |

(4)

8.2

8.2.1 Magnesium becomes smaller./Brown solid forms/Mg disappears/eaten away/Mg changes colour. ✓
*Magnesium word kleiner./Bruin vaste stof vorm/Mg verdwyn/weggevreet/Mg verander van kleur.* (1)

8.2 2 $Cu^{2+}$ is a stronger oxidising agent ✓(than $Mg^{2+}$) and will be reduced to ✓ Cu. ✓
*$Cu^{2+}$ is 'n sterker oksideermiddel (as $Mg^{2+}$) en sal na* Cu *gereduseer word.*

**OR/*OF***
Mg is a stronger reducing agent ✓(than Cu) and will reduce $Cu^{2+}$ to Cu.
*Mg is 'n sterker reduseermiddel (as* Cu*) en sal* $Cu^{2+}$ *na* Cu *reduseer.* (3)
**[15]**





## QUESTION 9/*VRAAG 9*

9.1 The chemical process in which electrical energy is converted to chemical energy. ✓✓
*'n Chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.*

**OR/*OF***
The use of electrical energy to produce a chemical change.
*Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.* (2)

9.2 B ✓ (1)

9.3 $Cu^{2+}$(aq) + $2e^{-}$ → Cu ✓✓ (2)

**Marking criteria/*Nasienriglyne***
- Cu ← $Cu^{2+}$(aq) + $2e^{-}$ ($\frac{2}{2}$) $Cu^{2+}$(aq) + $2e^{-}$ ⇌ Cu ($\frac{1}{2}$)
  Cu ⇌ $Cu^{2+}$(aq) + $2e^{-}$ ($\frac{0}{2}$) $Cu^{2+}$(aq) + $2e^{-}$ ← Cu ($\frac{0}{2}$)
- Ignore if charge omitted on electron./*Ignoreer indien lading op elektron weggelaat word.*
- If charge (+) omitted on $Cu^{2+}$/*Indien lading (+) weggelaat op* $Cu^{2+}$.
  Max./*Maks:* $\frac{1}{2}$

9.4

$$\% \text{ purity/}suiwerheid = \frac{m(Cu)}{m(Cu)_{impure/onsuiwer}} \times 100$$
$$= \frac{4,4 ✓}{5 ✓} \times 100 ✓$$
$$= 88\% ✓$$
(4)

**Marking criteria/*Nasienriglyne:***
- Substitute/*Vervang* 4,4 ✓
- Substitute/*Vervang* 5 ✓
- x 100 ✓
- Final answer/*Finale antwoord:* 88% ✓

**[9]**

**QUESTION 10/*VRAAG 10***

10.1
10.1.1 $N_2(g) + 3H_2(g)$ ✓ $\rightarrow 2NH_3(g)$ ✓ bal ✓

| **Notes/*Aantekeninge:*** |
|---|
| • Reactants ✓ Products ✓ Balancing ✓<br>*Reaktanse* ✓ *Produkte* ✓ *Balansering* ✓ |
| • Ignore if phases are omitted/*Ignoreer indien fases uitgelaat word* |
| • Ignore/*Ignoreer* ⇌ |
| • Marking rule/*Nasienreël* 3.9 |

(3)

10.1.2 $(NH_4)_2SO_4$ ✓ (1)

10.1.3 Ostwald process/*Ostwaldproses* ✓ (1)

10.1.4 Ammonium nitrate/*Ammoniumnitraat* ✓ (1)

10.2
10.2.1 The ratio of nitrogen (N), phosphorous (P) and potassium (K) in a certain fertiliser.✓
*Die verhouding van stikstof (N), fosfor (P) en kalium (K) in 'n sekere kunsmis.*
**Accept/*Aanvaar*** :
nitrogen, phosphorous and potassium/*stikstof, fosfor en kalium.* (1)

10.2.2 Percentage fertiliser in the bag./*Persentasie kunsmis in die sak.* ✓ (1)

10.2.3

| **OPTION 1/*OPSIE 1*:** | **OPTION 2/*OPSIE 2*:** |
|---|---|
| % K = $\frac{5}{12}$ ✓ x 22% ✓<br>= 9,17%<br>∴ m(N) = $\frac{9,17}{100} \times 10$ kg ✓<br>= 0,92 kg ✓ | m(nutrients/*voedingstowwe*):<br>$\frac{22}{100}$ ✓ x 10 = 2,2 kg<br>↓<br>∴ m(K) = $\frac{5}{12}$ ✓ (2,2) ✓<br>= 0,92 kg ✓ |

(4)
**[12]**

**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 2017**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

**These marking guidelines consist of 11 pages.**
***Hierdie nasienriglyne bestaan uit 11 bladsye.***

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**QUESTION/*VRAAG 1***

1.1 D ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 A ✓✓ (2)

1.5 C ✓✓ (2)

1.6 C ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

1.9 B ✓✓ (2)

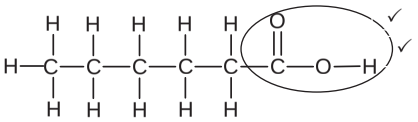
1.10 B ✓✓ (2)
**[20]**

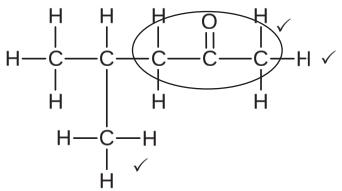
**QUESTION/*VRAAG 2***

2.1
2.1.1 Esters ✓ (1)

2.1.2 Ethyl ✓ butanoate ✓/*Etielbutanoaat* (2)

2.1.3 Butanoic acid/*Butanoësuur* ✓ (1)

2.1.4

(2)

2.2

(3)





2.3
2.3.1 $C_nH_{2n-2}$ ✓ (1)

2.3.2 5-ethyl-2,6-dimethylhept-3-yne/5-ethyl-2,6-dimethyl-3-heptyne
*5-etiel-2,6-dimetielhept-3-yn/5-etiel-2,6-dimetiel-3-heptyn* (3)
**[13]**

**QUESTION/*VRAAG 3***

3.1 **ANY ONE/*ENIGE EEN*:**
- They have ONLY single bonds. ✓
  *Hulle het SLEGS enkelbindings.*
- They have single bonds between C atoms.
  *Hulle het enkelbindings tussen C-atome.*
- They have no double OR triple bonds OR multiple bonds.
  *Hulle het geen dubbel- OF trippelbindings OF meervoudige bindings nie.*
- They contain the maximum number of H atoms bonded to C atoms.
  *Hulle bevat die maksimum getal H-atome gebind aan C-atome.*
- Each C atom is bonded to four other atoms.
  *Elke C-atoom is gebind aan vier ander atome.* (1)

3.2 The pressure exerted by a vapour in equilibrium with its liquid ✓ in a closed system. ✓
*Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem.* (2)

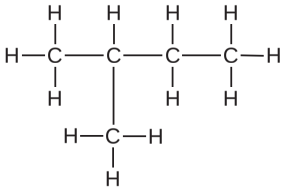
3.3
3.3.1 Increases/*Verhoog* ✓ (1)

3.3.2 Q ✓
It is the temperature where the graph intercepts the dotted line. ✓
*Dit is die temperatuur waar die grafiek die stippellyn sny.*

**OR/*OF***
It is the temperature where the vapour pressure of compound **Q** equals atmospheric pressure/is equal to 760 mmHg.
*Dit is die temperatuur waar die dampdruk van verbinding **Q** gelyk is aan atmosferiese druk/gelyk is aan 760 mmHg.* (2)

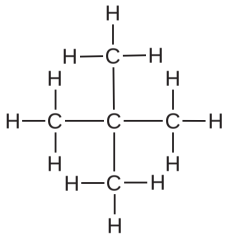
3.3.3 S ✓
- At a given temperature, **S** has the lowest vapour pressure/highest boiling point. ✓
  *By 'n gegewe temperatuur het **S** die laagste dampdruk/hoogste kookpunt.*
- Strongest intermolecular forces/London forces/dispersion forces/induced dipole forces. ✓
  *Sterkste intermolekulêre kragte/London-kragte/dispersiekragte/geïnduseerde dipoolkragte.*
- Highest energy needed to overcome/break the intermolecular forces. ✓
  *Hoogste energie benodig om intermolekulêre kragte te oorkom/breek.* (4)

3.4
3.4.1



✓✓

**OR/*OF***



2-methylbutane ✓
*2-metielbutaan*

2,2-dimethylpropane✓
*2,2-dimetielpropaan*

(3)

3.4.2 Higher than/*Hoër as* ✓ (1)
**[14]**

**QUESTION/*VRAAG 4***

4.1 Secondary/*Sekondêre* ✓
The C atom bonded to the –OH group is bonded to TWO other C atoms. ✓
*Die C-atoom gebind aan die –OH-groep is aan TWEE ander C-atome gebind.* (2)

4.2
4.2.1 Dehydration ✓
*Dehidrasie/dehidratering* (1)

4.2.2 Hydration ✓
*Hidrasie/hidratering* (1)

4.2.3 Dehydrohalogenation/dehydrobromination ✓
*Dehidrohalogenasie/dehidrohalogenering/dehidrobrominasie/ dehidrobrominering* (1)

4.3
4.3.1 Substitution/Hydrolysis ✓
*Substitusie/Hidrolise* (1)

4.3.2
- Dilute base/sodium hydroxide/NaOH ✓
  *Verdunde basis/natriumhidroksied/NaOH*
- Moderate temperature/(mild) heat ✓
  *Matige temperatuur/(matige) hitte* (2)

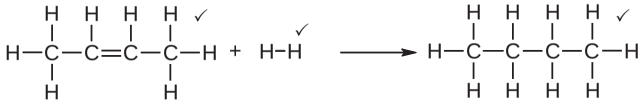
4.3.3 2-✓bromobutane ✓/*2-bromobutaan* (2)

4.4 NaOH/KOH ✓ (1)





4.5



(3)

4.6 Butane/*Butaan* (1)
**[15]**

**QUESTION/*VRAAG 5***

5.1 **ANY ONE/*ENIGE EEN*:**
- Change in concentration of products/reactants per (unit) time. ✓✓
  *Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.*
- Rate of change in concentration.
  *Tempo van verandering in konsentrasie.*
- 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 or reactants used per (unit) time.
  *Hoeveelheid/getal mol/volume/massa van produkte gevorm of reaktanse gebruik per (eenheid) tyd.* (2)

5.2

| **Marking criteria/*Nasienriglyne:*** | |
|---|---|
| Dependent and independent variables correctly identified.<br>*Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.* | ✓ |
| Ask a question about the relationship between the independent and dependent variables./*Vra* 'n *vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.* | ✓ |

**Examples/*Voorbeelde*:**
- What is the relationship between concentration and reaction rate?
  *Wat is die verwantskap tussen konsentrasie en reaksietempo?*
- How does the reaction rate change when the concentration changes/increases/decreases?
  *Hoe sal die reaksietempo verander wanneer die konsentrasie verander/ verhoog/verlaag?* (2)

5.3 Q ✓
- Smaller gradient./Less steep. ✓
  *Kleiner gradiënt./Minder steil.*
- Reaction **I** has the lowest HCℓ concentration and will take longer to reach completion/for the maximum volume of gas to be formed. ✓
  *Reaksie* **I** *het die laagste* HCℓ-konsentrasie en *neem langer om voltooi te word/die maksimum volume gas te vorm.* (3)

5.4

**OPTION 1/*OPSIE 1***

Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t}$

$15 = \frac{\Delta V}{30 - 0}$ ✓

$V(H_2)_{produced/berei} = 450\ cm^3$

$n(H_2)_{produced/berei} = \frac{V}{V_m}$

$= \frac{450}{24\ 000}$ ✓

$= 0{,}0188$ mol

$n(Zn) = n(H_2) = 0{,}0188$ mol ✓

$n(Zn)_{used/gebruik} = \frac{m}{M}$

$\therefore 0{,}0188 = \frac{m}{65}$ ✓

$\therefore m(Zn) = 1{,}22$ g ✓

**OPTION 2/*OPSIE 2***

Ave rate/*Gem. tempo* = $\frac{15}{24\ 000}$ ✓

$= 6{,}25 \times 10^{-4}\ mol{\cdot}s^{-1}$

$V(H_2)_{produced/berei} = 6{,}25 \times 30$ ✓

$= 0{,}0188$ mol

$n(Zn) = n(H_2) = 0{,}0188$ mol ✓

$n(Zn)_{used} = \frac{m}{M}$

$0{,}0188 = \frac{m}{65}$ ✓

$\therefore m(Zn) = 1{,}22$ g ✓

**OPTION 3/*OPSIE 3***

Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t}$

$15 = \frac{\Delta V}{30 - 0}$ ✓

$V(H_2)_{produced/berei} = 450\ cm^3$

65 g ✓ Zn …… 24 000 $cm^3$ ✓
x g Zn ……450 $cm^3$ ✓
x = 1,22 g ✓ (5)

5.5
5.5.1 Equal to/*Gelyk aan* ✓ (1)

5.5.2 Equal to/*Gelyk aan* ✓ (1)

5.6
- At higher temperature the average kinetic energy of particles is higher. ✓
  *By hoër temperatuur is die gemiddelde kinetiese energie van deeltjies hoër.*
- More molecules gain sufficient/enough kinetic energy **OR** more molecules have kinetic energy equal to or greater than the activation energy. ✓
  *Meer molekule het voldoende/genoeg kinetiese energie* ***OF*** *meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.*
- More effective collisions per unit time./Frequency of effective collisions increases. ✓
  *Meer effektiewe botsings per eenheidtyd./Frekwensie van effektiewe botsings neem toe.* (3)

**[17]**





**QUESTION/*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.*

**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)

6.2
6.2.1

**OPTION 1/*OPSIE 1***

$n = \frac{m}{M}$

$= \frac{112}{28}$ ✓

$= 0{,}04$ mol

| | $COBr_2$ | CO | $Br_2$ |
|---|---|---|---|
| Initial quantity (mol) *Aanvangshoeveelheid (mol)* | | 0 | 0 |
| Change (mol) *Verandering (mol)* | 0,04 | 0,04 | 0,04 |
| Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)* | | 0,04 | 0,04 ✓ |
| Equilibrium concentration/ *Ewewigskonsentrasie* ($mol{\cdot}dm^{-3}$) | | 0,02 | 0,02 |

Divide by 2 ✓
*Deel deur 2*

$K_c = \frac{[CO][Br_2]}{[COBr_2]}$ ✓

$0{,}19$ ✓ $= \frac{(0{,}02)^2}{[COBr_2]}$ ✓

$[COBr_2] = 2{,}11 \times 10^{-3}\ mol{\cdot}dm^{-3}$ ✓

**OPTION 2/*OPSIE 2***

$n = \frac{m}{M}$

$= \frac{1,12}{28}$ ✓

$= 0,04$ mol

$n(CO)_{formed/gevorm} = n(Br_2)_{formed/gevorm}$ ✓

$= 0,04$ mol

$c(CO)_{eq/ewe} = c(Br_2)_{eq/ewe}$

$= \frac{n}{V}$

$= \frac{0,04}{2}$ ✓

$= 0,02\ mol\cdot dm^{-3}$

$K_c = \frac{[CO][Br_2]}{[COBr_2]}$ ✓

$0,19$ ✓ $= \frac{(0,2)^2}{[COBr_2]}$ ✓

$[COBr_2] = 2,11 \times 10^{-3}\ mol\cdot dm^{-3}$ ✓ (7)

6.2.2

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $n(COBr_2)_{eq/ewewig} = cV$<br>$= 2,11 \times 10^{-3} \times 2$ ✓<br>$= 4,22 \times 10^{-3}$ mol<br>$n(COBr_2)_{initial/begin}$<br>$= 0,04 + 4,22 \times 10^{-3}$ ✓<br>$= 0,044$ mol<br>% decomposed $= \frac{0,04}{0,044}$ ✓ $\times 100$<br>$= 90,46\%$ ✓<br><br>Range/*Gebied*: 90,46 – 90,9% | $n(COBr_2)_{eq/ewewig} = cV$<br>$= 2,11 \times 10^{-3} \times 2$ ✓<br>$= 4,22 \times 10^{-3}$ mol<br>$n(COBr_2)_{initial/begin}$<br>$= 0,04 + 4,22 \times 10^{-3}$ ✓<br>$= 0,044$ mol<br>$m(COBr_2)_{initial/begin} = nM$<br>$= 0,044 \times 188$<br>$= 8,27$ g<br>$m(COBr_2)_{reacted/reageer} = 0,04 \times 188$<br>$= 7,52$ g<br>% decomposed/*ontbind* $= \frac{7,52}{8,27}$ ✓ $\times 100$<br>$= 90,9\%$ ✓ |

(4)

6.3 $K_c < 0,19$ (1)

6.4 Decreases/*Verminder* ✓
A decreases in pressure <u>favours the reaction that produces the larger number of moles of gas</u>./*'n Afname in druk bevoordeel die reaksie wat die groter aantal mol gas lewer.* ✓
The <u>forward reaction will be favoured</u>./*Die voorwaartse reaksie sal bevoordeel word.* ✓ (3)

**[17]**





**QUESTION/*VRAAG 7***

7.1
7.1.1 Weak/*Swak* ✓
Dissociates/Ionises incompletely (in water) ✓
*Dissosieer/Ioniseer onvolledig (in water)* (2)

7.1.2 $NH_4^+$ ✓ (1)

7.1.3 $H_2O$/water **OR/*OF*** $NH_3$ ✓ (1)

7.2
7.2.1 Acidic/*Suur* ✓
$pH < 7$ ✓ (2)

7.2.2

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $pH = -\log[H_3O^+]$ ✓<br>$6$ ✓ $= -\log[H_3O^+]$<br>$[H_3O^+] = 1 \times 10^{-6}\ mol\cdot dm^{-3}$<br><br>$[H_3O^+][OH^-] = 10^{-14}$ ✓<br>$[OH^-] = 1 \times 10^{-8}\ mol\cdot dm^{-3}$ ✓ | $pH + pOH = 14$ ✓<br>$6$ ✓$+ pOH = 14$<br><br>$pOH = -\log[OH^-]$ ✓<br>$8 = -\log[OH^-]$<br>$[OH^-] = 1 \times 10^{-8}\ mol\cdot dm^{-3}$ ✓ |

(4)

7.3

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $n(Na_2CO_3) = \frac{m}{M}$ ✓<br>$= \frac{0,29}{106}$ ✓<br>$= 2,74 \times 10^{-3}$ mol<br>$n(HC\ell) = 2n(Na_2CO_3)$ ✓<br>$= 5,47 \times 10^{-3}$ mol<br>$c(HC\ell)_{dilute/verdun} = \frac{n}{V}$<br>$= \frac{5,47 \times 10^{-3}}{0,05}$ ✓<br>$= 0,1094\ mol\cdot dm^{-3}$<br>$cV(HC\ell)_{dilute/verdun} = cV(HC\ell)_{conc/gekons}$<br>$0,1094 \times 500$ ✓ $= (HC\ell)_{conc/gekons} \times 5$ ✓<br>$\therefore c(HC\ell)_{conc/gekons} = 10,94\ mol\cdot dm^{-3}$ ✓ | $n(Na_2CO_3) = \frac{m}{M}$ ✓<br>$= \frac{0,29}{106}$ ✓<br>$= 2,74 \times 10^{-3}$ mol<br>$n(HC\ell) = 2n(Na_2CO_3)$ ✓<br>$= 5,47 \times 10^{-3}$ mol<br>In 50 $cm^3$:<br>$n(HC\ell) = 5,47 \times 10^{-3}$ mol<br>In 500 $cm^3$:<br>$n(HC\ell) = \frac{500}{50}$ ✓ $(5,47 \times 10^{-3})$ ✓<br>$= 0,547$ mol<br>$c(HC\ell)_{conc/gekons} = 0,547 \times \frac{1000}{5}$ ✓<br>$= 10,94\ mol\cdot dm^{-3}$ ✓ |

(7)

**[17]**

**QUESTION/*VRAAG 8***

8.
8.1.1 Voltmeter/Multimeter ✓ (1)

8.1.2 Anode ✓ (1)

8.1.3 $3Ag^{+}(aq) + A\ell(s)$ ✓ → $3Ag(s) + A\ell^{3+}(aq)$ ✓ Bal. ✓ (3)

8.1.4

| **OPTION1/*OPSIE 1*** |
|---|
| $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓<br>= +0,80 ✓ - (- 1,66) ✓<br>= 2,46 V ✓ |
| **OPTION 2/*OPSIE 2*** |
| ✓ $Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ 0,80 V ✓<br>$A\ell(s) \rightarrow A\ell^{3+}(aq) + 3e^{-}$ 1,66 V ✓<br>$3Ag^{+}(aq) + A\ell(s) \rightarrow 3Ag(s) + A\ell^{3+}(aq)$ 2,46 V ✓ |

(4)

8.2
8.2.1 Platinum/Pt/Carbon/C/*Koolstof* ✓ (1)

8.2.2 **ANY TWO/*ENIGE TWEE*:**
Concentration/*Konsentrasie*: 1 mol·dm$^{-3}$ ✓
Temperature/*Temperatuur*: 25 °C/298 K ✓
Pressure/*Druk:* 101,3 kPa/1,01 x 10$^{5}$ Pa/1 atm (2)

8.2.3 Zinc/Zn/*sink* ✓ (1)

8.2.4 PQ ✓ (1)
**[14]**

**QUESTION/*VRAAG 9***

9.1 DC ✓ (1)

9.2 Cathode/*Katode* ✓
$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu$ ✓✓

9.3 $Cu^{2+}$ is a stronger oxidising agent ✓ than $Zn^{2+}$ ions ✓ and therefore $Zn^{2+}$ ions will not be reduced (to Zn). ✓
*$Cu^{2+}$ is 'n sterker oksideermiddel as $Zn^{2+}$-ione en dus sal $Zn^{2+}$-ione nie gereduseer word nie (na Zn).* (3)

9.4
9.4.1 (Chlorine) gas/bubbles is/are formed. ✓
*(Chloor)gas/borrels vorm.* (1)

9.4.2 Decreases/*Verlaag* ✓ (1)
**[9]**





**QUESTION 10/*VRAAG 10***

10.1
10.1.1 Ammonia/*Ammoniak* ✓ (1)

10.1.2 $NO_2$ ✓ (1)

10.1.3 Catalytic oxidation of ammonia ✓
*Katalitiese oksidasie van ammoniak* (1)

10.1.4 Platinum/Pt ✓ (1)

10.1.5 Ostwald (process)/*Ostwald(proses)*✓ (1)

10.1.6 Haber (process)/*Haber(proses)*✓ (1)

10.1.7 $NH_3 + HNO_3$ ✓ → $NH_4NO_3$ ✓ Bal. ✓ (3)

10.2
10.2.1

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| N : P : K<br>10 : 5 : 15<br>m(fertiliser/*kunsmis*) = $\frac{30}{100}$ x 15<br>= 4,5 kg<br>m(P) = $\frac{5}{30}$ x 4,5 ✓<br>= 0,75 kg ✓ | m(fertiliser/*kunsmis*) = $\frac{5}{100}$ x 15 ✓<br>= 0,75 kg ✓ |

(2)

10.2.2 %fertiliser/*kunsmis* = 10 + 5 + 15 = 30%
%filler/*bindstof* = 100 – 30 = 70%
$m_{(filler/bindstof)} = \frac{70}{100}$ ✓ x 15 ✓
= 10,5 kg ✓ (3)
**[14]**

**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 2016**

**MEMORANDUM**

**MARKS/*PUNTE*: 150**

**This memorandum consists of 22 pages.**
***Hierdie memorandum bestaan uit 22 bladsye.***

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**QUESTION 1/*VRAAG 1***

| | | |
|---|---|---|
| 1.1 | D ✓✓ | (2) |
| 1.2 | C ✓✓ | (2) |
| 1.3 | C ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | D ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | A ✓✓ | (2) |
| 1.9 | B ✓✓ | (2) |
| 1.10 | B ✓✓ | (2) |
| | | **[20]** |

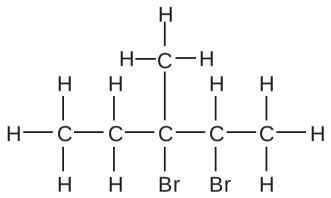
**QUESTION 2/*VRAAG 2***

2.1

| | | |
|---|---|---|
| 2.1.1 | A **OR/*OF*** D ✓ | (1) |
| 2.1.2 | B ✓ | (1) |
| 2.1.3 | E ✓ | (1) |
| 2.1.4 | D ✓ | (1) |

2.2

2.2.1



**Marking criteria/*Nasienriglyne:***
- Five C atoms in longest chain. ✓
  *Vyf C-atome in langste ketting.*
- Two Br and one methyl substituents. ✓
  *Twee Br- en een metielsubstituente.*
- Whole structure correct.
  *Hele struktuur korrek.* ✓

(3)

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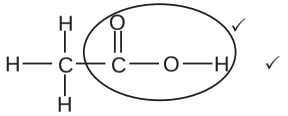
2.2.2

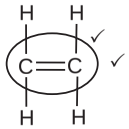


**Marking criteria/*Nasienriglyne:***
- Whole structure correct:
  *Hele struktuur korrek:* 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2
- Accept -OH as condensed.
  *Aanvaar -OH as gekondenseerd.*

**IF/*INDIEN*:**
More than one functional group/*Meer as een funksionele groep* 0/2

(2)

2.2.3



**Marking criteria/*Nasienriglyne:***
- Whole structure correct:/*Hele struktuur korrek:* 2/2
- Only functional group correct/*Slegs funksionele groep korrek* Max: 1/2

**IF/*INDIEN*:**
More than one functional group/*Meer as een funksionele groep* 0/2

(2)

2.3
2.3.1 Hydrogen (gas)/*Waterstof(gas)* ✓ (1)

2.3.2 Addition / Hydrogenation ✓
*Addisie / Hidrogenasie / Hidrogenering* (1)
**[13]**

**QUESTION 3/*VRAAG 3***

3.1 Compounds with the same molecular formula ✓ but different structural formulae.✓ / *Verbindings met dieselfde molekulêre formule maar verskillende struktuurformules.* (2)

3.2 Chain/*Ketting* ✓ (1)

3.3 **From A to C/*Van A na C*:**
- **Structure/*Struktuur*:**
  Less branched / less compact / less spherical/longer chain length / larger surface area (over which intermolecular forces act).✓
  *Minder vertak / minder kompak / minder sferies / langer kettinglengte / groter oppervlak (waaroor intermolekulêre kragte werk).*
- **Intermolecular forces/*Intermolekulêre kragte:***
  Stronger / more intermolecular forces / Van der Waals forces / London forces / dispersion forces.
  *Sterker / meer intermolekulêre kragte / Van der Waalskragte / London-kragte / dispersiekragte.* ✓
- **Energy/*Energie*:**
  More energy needed to overcome or break intermolecular forces / Van der Waals forces. ✓
  *Meer energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / London-kragte te oorkom.*





**OR/*OF***
**From C to A/*Van C na A*:**
- **Structure/*Struktuur*:**
  More branched / more compact / more spherical / smaller surface area (over which intermolecular forces act).✓
  *Meer vertak / meer kompak / meer sferies / kleiner oppervlak (waaroor intermolekulêre kragte werk).*
- **Intermolecular forces/*Intermolekulêre kragte:***
  Weaker / less intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓
  *Swakker/minder intermolekulêre kragte / Van der Waalskragte / Londonkragte / dispersiekragte.*
  **Energy/*Energie*:**
  Less energy needed to overcome or break intermolecular forces / Van der Waals forces. ✓
  *Minder energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / Londonkragte te oorkom.* (3)

3.4 A / 2,2-dimethylpropane / *2,2-dimetielpropaan* ✓
Lowest boiling point. / *Laagste kookpunt.*✓ (2)

3.5 $C_5H_{12} + 8O_2$ ✓ → $5CO_2 + 6H_2O$ ✓ Bal ✓

**Notes/*Aantekeninge:***
- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing ✓ *Balansering*
- 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 struktuur-formules gebruik:* Max/*Maks.* 2/3

(3)
**[11]**

## QUESTION 4/*VRAAG 4*

4.1
4.1.1 High temperature / heat / high energy / high pressure ✓
*Hoë temperatuur / hitte / hoë energie / hoë druk* (1)

4.1.2 $C_6H_{12}$ ✓

| **Accept/*Aanvaar:*** |
|---|
| Condensed structural formula and structural formula.<br>*Gekondenseerde struktuurformule en struktuurformule.*<br>E.g./Bv: $CH_3CH_2CH_2CH_2CHCH_2$ |

(1)

4.1.3 Alkenes/*Alkene* ✓ (1)

4.2 **X** / $C_6H_{12}$ / Alkene / *Alkeen* / Hexene / Hekseen ✓

**OPTION 1/*OPSIE 1***
- **X** is an alkene / has a double bond / unsaturated. ✓
  ***X** is 'n alkeen / het 'n dubbelbinding / onversadig.*
- **X** can undergo addition. ✓
  ***X** ondergaan addisie.*
- **X** will react without light / heat / is more reactive. ✓
  ***X** sal sonder lig / hitte reageer / is meer reaktief.*

**OPTION 2/*OPSIE 2***
- Butane is an alkane **OR** butane is saturated. ✓
  *Butaan is 'n alkaan **OF** butaan is versadig.*
- Butane can only undergo substitution. ✓
  *Butaan kan slegs substitusie ondergaan.*
- Butane will only react in the presence of light / heat **OR** butane is less reactive. ✓
  *Butaan sal slegs in die teenwoordigheid van lig / hitte reageer **OF** butaan is minder reaktief.* (4)

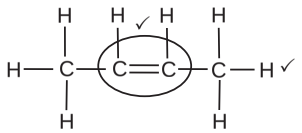
4.3
4.3.1 2-chloro✓butane ✓
*2-chlorobutaan* (2)

4.3.2 Substitution / Hydrolysis ✓
*Substitusie / Hidrolise* (1)





4.3.3



| **Marking criteria/*Nasienriglyne:*** |
|---|
| • Whole structure correct/*Hele struktuur korrek:* 2/2<br>• Only functional group correct/*Slegs funksionele groep korrek:* 1/2 |

| **IF/*INDIEN*:** | |
|---|---|
| More than one functional group/*Meer as een funksionele groep* | 0/2 |

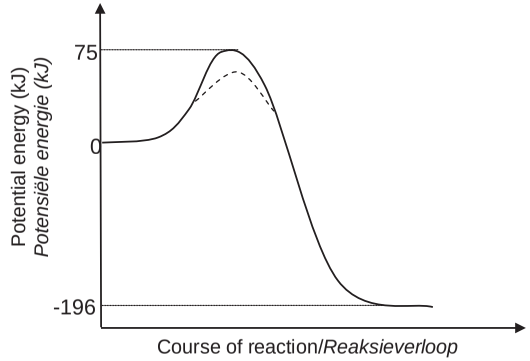
4.3.4 Hydration / *Hidrasie / Hidratering* ✓ (1)
**[13]**

## QUESTION 5/*VRAAG 5*

5.1
5.1.1 The minimum energy needed for a reaction to take place. ✓✓
*Die minimum energie benodig vir 'n reaksie om plaas te vind.*

**OR/*OF***
Minimum energy needed to form the activated complex./ *Minimum energie nodig om die geaktiveerde kompleks te vorm.* (2)

5.1.2




| **Marking criteria/*Nasienriglyne*:** | |
|---|---|
| Shape of curve for exothermic reaction as shown.<br>*Vorme van kurwe vir eksotermiese reaksie soos getoon.* | ✓ |
| Energy of activated complex shown as 75 kJ in line with the peak.<br>*Energie van geaktiveerde kompleks aangetoon as 75 kJ in lyn met die piek.* | ✓ |
| Energy of products shown as − 196 kJ below the zero.<br>*Energie van produkte getoon as − 196 kJ onderkant die nulpunt.* | ✓ |
| **IF/*INDIEN*:** Wrong shape, e.g. straight line./*Verkeerde vorm bv. reguitlyn.* | 0/3 |

(3)

5.1.3 ***Marking criteria/Nasienriglyne***

- Dotted line (---) on graph in QUESTION 5.1.2 showing lower energy for activated complex. ✓
  *Stippellyn (---) op grafiek in VRAAG 5.1.2 wat laer energie vir geaktiveerde kompleks toon.*
- Dotted curve starts at/above energy of reactants and ends at/above energy of products on the inside of the original curve. ✓
  *Stippellyn kurwe begin by/bokant energie van reaktanse en eindig by/bokant energie van produkte aan die binnekant van die oorspronklike kurwe.*

**Note/*Aantekening*:**
Allocate marks only if curve for either exothermic or endothermic reaction drawn in QUESTION 5.1.2.
*Ken punte slegs toe indien kurwe vir endotermiese of eksotermiese reaksie in VRAAG 5.1.2 geteken is.*

(2)

5.1.4

- A catalyst provides an alternative pathway of lower activation energy. ✓
  *'n Katalisator voorsien 'n alternatiewe pad van laer aktiveringsenergie.*
- More molecules have sufficient / enough (kinetic) energy. ✓
  *Meer molekule het voldoende / genoeg (kinetiese) energie.*
  **OR/*OF***
  More molecules have kinetic energy equal to or greater than the activation energy.
  *Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.*
- More effective collisions per unit time / second. ✓
  *Meer effektiewe botsings per eenheidstyd / sekonde.*
  **OR/*OF***
  Rate / frequency of effective collisions increases.
  *Tempo / frekwensie van effektiewe botsings neem toe.*

(3)

5.2

5.2.1 Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t}$

$= \frac{52-16}{40-10}$ ✓✓

$= 1,2\ (dm^3 \cdot s^{-1})$ ✓

**Accept/*Aanvaar*:**
- Volume range/*gebied*: 16 to/*tot* 17 $cm^3$
- Answer range/*Antwoordgebied:* 1,167 to 1,2 $dm^3 \cdot s^{-1}$

(3)





5.2.2

**Marking criteria/*Nasienriglyne:***
- $V(O_2) = 60\ dm^3$ AND/*EN* divide volume by 24./*deel volume deur* 24 ✓
- Use ratio/Gebruik *verhouding*: $n(H_2O_2) = 2n(O_2) = 1:2$ ✓
- Use 34 $g \cdot mol^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation. ✓
  *Gebruik 34* $g \cdot mol^{-1}$ *in* $n = \frac{m}{M}$ *of in verhoudingsberekening.*
- Final answer/*Finale antwoord:* 170 g ✓

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** | **OPTION 3/*OPSIE 3*** |
|---|---|---|
| $n(O_2) = \frac{V}{V_M}$<br>$= \frac{60}{24}$ ✓<br>$= 2,5$ mol<br>$n(H_2O_2) = 2n(O_2)$<br>$= 2(2,5)$ ✓<br>$= 5$ mol<br>$n(H_2O_2) = \frac{m}{M}$<br>$\therefore 5 = \frac{m}{34}$ ✓<br>$\therefore m = 170$ g ✓ | 24 $dm^3$ : 1 mol<br>60 $dm^3$ : 2,5 mol ✓<br>$n(H_2O_2) = 2n(O_2)$<br>$= 2(2,5)$ ✓<br>$= 5$ mol<br>34 g ✓: 1 mol<br>x : 5 mol<br>x = 170 g ✓ | $n(O_2) = \frac{V}{V_M}$<br>$= \frac{60}{24}$ ✓<br>$= 2,5$ mol<br>$n(O_2) = \frac{m}{M}$<br>$\therefore 2,5 = \frac{m}{32}$<br>$\therefore m = 80$ g ✓<br>2(34) g ✓ $H_2O_2$ ..... 32 g $O_2$<br>x g $H_2O_2$ ..... 80 g $O_2$<br>$m(H_2O_2) = 170$ g ✓ |

(4)

5.2.3 Equal to / *Gelyk aan* ✓ (1)

5.3

5.3.1 Q ✓ (1)

5.3.2 P ✓ (1)

**[20]**

**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 marks or no marks)**

*Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaarste reaksie.* ✓✓
***(2 punte of geen punte nie)***

**OR/*OF***
The state where the concentrations / quantities of reactants and products remain constant.
*Die toestand wanneer die konsentrasies / hoeveelhede van reaktanse en produkte konstant bly.* (2)

6.2
6.2.1 Remains the same / *Bly dieselfde* ✓ (1)

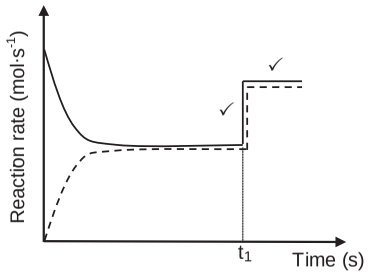
6.2.2 Decreases / *Verlaag* ✓

- When the temperature is increased the reaction that will oppose this increase / decrease the temperature will be favoured. ✓
  *Wanneer die temperatuur toeneem, sal die reaksie wat hierdie toename teenwerk / die temperatuur laat afneem bevoordeel word.*

  **OR/*OF***
  *The forward reaction is exothermic. / Die voorwaarste reaksie is eksotermies.*
- An increase in temperature favours the endothermic reaction. ✓
  *'n Toename in temperatuur bevoordeel die endotermiese reaksie.*
- The reverse reaction is favoured. ✓
  *Die terugwaartse reaksie word bevoordeel.* (4)

6.3

**Marking criteria/*Nasienriglyne*:**
- Vertical parallel lines show a sudden increase in rate of both forward and reverse reactions. / *Vertikale parallelle lyne wys 'n skielike toename in reaksietempo van beide voorwaartse en terugwaartse reaksies.* ✓
- Horisontal parallel lines showing a constant higher rate for both forward and reverse catalysed reactions after time $t_1$. / *Horisontale parallelle lyne wat 'n konstante hoër tempo aantoon vir beide voorwaartse en terugwaartse gekataliseerde reaksies na $t_1$.* ✓




(2)





6.4 **CALCULATIONS USING NUMBER OF MOLES**
***BEREKENINGE WAT AANTAL MOL GEBRUIK***

**Marking criteria/Nasinriglyne*:***
- Use/*Gebruik* M(PbS) = 239 g·mol$^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation/ *of in verhoudingsberekening*. ✓
- Use ratio/*Gebruik verhouding*: $n(H_2S)_{equil/ewewig} = n(PbS)$ ✓
- $n(H_2S)_{formed/gevorm} = n(H_2S)_{equilibrium/ewewig}$ ✓
- **USING** ratio/***GEBRUIK*** *verhouding:* $H_2 : H_2S = 1 : 1$ ✓
- $n(H_2)_{equilibrium/ewewig} = n(H_2)_{initial/aanvanklik} - n(H_2)_{formed/gevorm}$ ✓
- Divide equilibrium $n(H_2S)$ & $n(H_2)$ by 2 dm$^3$. ✓
  *Deel $n(H_2S)$ & $n(H_2)$ deur 2 dm$^3$*
- Correct $K_c$ expression ✓
  *Korrekte $K_c$ uitdrukking.*
- Substitution of concentrations into $K_c$ expression. ✓
  *Vervanging van konsentrasies in $K_c$-uitdrukking.*
- Final answer/*Finale antwoord*: 0,07 ✓
  **NB/*L.W.*:** If not rounded/*Indien nie afgerond nie*: 0,067

**OPTION 1/*OPSIE 1***

$n(PbS) = \frac{m}{M} = \frac{2,39}{239}$ ✓ $= 0,01$ mol

$n(H_2S)_{equilibrium/by\ ewewig} = n(PbS)$ ✓ = 0,01 mol

| | $H_2$ | $H_2S$ | |
|---|---|---|---|
| Initial quantity (mol)<br>*Aanvangshoeveelheid (mol)* | 0,16 | 0 | |
| Change (mol)<br>*Verandering (mol)* | 0,01 | 0,01 ✓ | ratio ✓<br>*verhouding* |
| Quantity at equilibrium (mol)/<br>*Hoeveelheid by ewewig (mol)* | 0,15 ✓ | 0,01 | |
| Equilibrium concentration (mol·dm$^{-3}$)<br>*Ewewigskonsentrasie (mol·dm$^{-3}$)* | 0,075 | 0,005 | divide by 2 ✓<br>*deel deur 2* |

$K_c = \frac{[H_2S]}{[H_2]}$ ✓
$= \frac{0,005}{0,075}$ ✓
$= 0,067 \approx 0,07$ ✓

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.* $\frac{6}{9}$

**IF/*INDIEN:*** [S] = 1 in $K_c = \frac{[H_2S]}{[H_2][S]}$
No mark for $K_c$ expression, but continue marking substitution and answer./*Geen punt vir $K_c$-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*

**OPTION 2/*OPSIE 2***

$n(PbS) = \frac{m}{M}$

$= \frac{2,39}{239}$ ✓

$= 0,01\,mol$

$n(H_2S)_{reacted/gereageer} = n(PbS)$ ✓ $= 0,01$ mol

$= n(H_2S)_{equilibrium/ewewig}$

$n(H_2S)_{formed/gevorm} = n(H_2S)_{equilibrium/ewewig} - n(H_2S)_{initial/aanvanklik}$

$= 0,01 - 0$ ✓

$= 0,01$ mol

$n(H_2)_{reacted/gereageer} = n(H_2S)_{formed/gevorm}$ ✓ $= 0,01$ mol

$n(H_2)_{equilibrium/ewewig} = n(H_2)_{initial/aanvanklik} - n(H_2)_{reacted/gereageer}$

$= 0,16 - 0,01$ ✓

$= 0,15$ mol

$c(H_2) = \frac{n}{V}$

$= \frac{0,15}{2}$

$= 0,075\ mol \cdot dm^{-3}$

$c(H_2S) = \frac{n}{V}$

$= \frac{0,01}{2}$ ✓

$= 0,005\ mol \cdot dm^{-3}$

$K_c = \frac{[H_2S]}{[H_2]}$ ✓

$= \frac{0,005}{0,075}$ ✓

$= 0,067 \approx 0,07$ ✓

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.* $^{6}/_{9}$

**IF/*INDIEN:*** $[S] = 1$ in $K_c = \frac{[H_2S]}{[H_2][S]}$

No mark for $K_c$ expression, but continue marking substitution and answer./*Geen punt vir $K_c$-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*





**OPTION 3/*OPSIE 3***

| | $H_2$ | $H_2S$ |
|---|---|---|
| Initial quantity (mol)<br>*Aanvangshoeveelheid (mol)* | 0,16 | 0 |
| Change (mol)<br>*Verandering (mol)* | x | x ✓ |
| Quantity at equilibrium (mol)/<br>*Hoeveelheid by ewewig (mol)* | 0,16 - x ✓ | x |
| Equilibrium concentration ($mol \cdot dm^{-3}$)<br>*Ewewigskonsentrasie ($mol \cdot dm^{-3}$)* | $\frac{0,16 - x}{2}$ | $\frac{x}{2}$ |

ratio ✓ *verhouding*

divide by 2 ✓ *deel deur 2*

$n(PbS) = \frac{m}{M}$

$= \frac{2,39}{239}$ ✓

$= 0,01\,mol$

$n(H_2S)_{equilibrium/by\ ewewig} = n(PbS)$ ✓ $\therefore x = 0,01$ mol

$[H_2]_{equilibrium/by\ ewewig} = \frac{0,16 - 0,01}{2} = 0,075\ mol \cdot dm^{-3}$

$[H_2S]_{equilibrium/by\ ewewig} = \frac{0,01}{2} = 0,005\ mol \cdot dm^{-3}$

$K_c = \frac{[H_2S]}{[H_2]}$ ✓

$= \frac{0,005}{0,075}$ ✓

$= 0,067 \approx 0,07$ ✓

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.* $^{6}/_{9}$

**IF/*INDIEN*:** $[S] = 1$ in $K_c = \frac{[H_2S]}{[H_2][S]}$

No mark for $K_c$ expression, but continue marking substitution and answer./*Geen punt vir $K_c$-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*

## CALCULATIONS USING CONCENTRATION
## *BEREKENINGE WAT KONSENTRASIE GEBRUIK*

**Marking criteria/Nasinriglyne:**

- Use/*Gebruik* M(PbS) = 239 g·mol$^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation/ *of in verhoudingsberekening*. ✓
- Use ratio/*Gebruik verhouding*: $n(H_2S)_{equil/ewewig} = n(PbS)$ ✓
- Divide equilibrium $n(H_2S)_{equil}$ & $n(H_2)_{initial}$ by 2 dm$^3$. ✓
  *Deel* $n(H_2S)_{ewewig}$ & $n(H_2)_{aanvanklik}$ *deur 2 dm$^3$*
- $[H_2S]_{formed/gevorm} = [H_2S])_{equilibrium/ewewig}$ ✓
- **USING** ratio/***GEBRUIK*** *verhouding:* $H_2 : H_2S = 1 : 1$ ✓
- $[H_2]_{equilibrium/ewewig} = [H_2]_{initial/aanvanklik} - [H_2]_{formed/gevorm}$ ✓
- Correct $K_c$ expression ✓
  *Korrekte $K_c$ uitdrukking*.
- Substitution of concentrations into $K_c$ expression. ✓
  *Vervanging van konsentrasies in $K_c$-uitdrukking.*
- Final answer/*Finale antwoord*: 0,07 ✓
  **Note/*Let Wel*:** If not rounded/*Indien nie afgerond nie*: 0,067

**OPTION 4/*OPSIE 4***

$n(PbS) = \frac{m}{M} = \frac{2,39}{239} = 0,01\,mol$

$n(H_2S)_{equilibrium/by\ ewewig} = n(PbS)$ ✓ = 0,01 mol

| | $H_2$ | $H_2S$ |
|---|---|---|
| Initial concentration/Aanvangs-konsentrasie (mol·dm$^{-3}$) | $\frac{0,16}{2}$ = 0,08 | 0 |
| Change in concentration/ *Verandering* in konsentrasie (mol·dm$^{-3}$) | 0,005 | 0,005 ✓ |
| Equilibrium concentration Ewewigskonsentrasie (mol·dm$^{-3}$) | 0,075 | $\frac{0,01}{2}$ = 0,005 |

$K_c = \frac{[H_2S]}{[H_2]}$
$= \frac{0,005}{0,075}$
$= 0,067 \approx 0,07$

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.* $\frac{6}{9}$

**IF/*INDIEN*:** [S] = 1 in $K_c = \frac{[H_2S]}{[H_2][S]}$
No mark for $K_c$ expression, but continue marking substitution and answer./*Geen punt vir $K_c$-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*





**OPTION 5/*OPSIE 5***

$n(PbS) = \frac{m}{M}$
$= \frac{2,39}{239}$
$= 0,01\,mol$

$n(H_2S)_{equilibrium/by\ ewewig} = n(PbS)$ ✓ = 0,01 mol

$[H_2S]_{equilibrium/by\ ewewig} = \frac{n}{V}$
$= \frac{0,01}{2}$
$= 0,005\ mol·dm^{-3}$

$[H_2]_{initial/aanvanklik} = \frac{n}{V}$
$= \frac{0,16}{2}$
$= 0,08\ mol·dm^{-3}$

$[H_2S]_{formed/gevorm} = [H_2S]_{equilibrium/by\ ewewig} - [H_2S]_{initial/aanvanklik}$
$= 0,005 - 0$ ✓
$= 0,005\ mol·dm^{-3}$

$[H_2]_{reacted/gereageer} = [H_2S]_{formed/gevorm}$ ✓ = 0,005 mol

$[H_2]_{equilibrium/ewewig} = [H_2]_{initial/aanvanklik} - [H_2]_{reacted/gereageer}$
$= 0,08 - 0,005$ ✓
$= 0,075$ mol

$K_c = \frac{[H_2S]}{[H_2]}$
$= \frac{0,005}{0,075}$
$= 0,067 \approx 0,07$

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.* $\frac{6}{9}$

**IF/*INDIEN*:** [S] = 1 in $K_c = \frac{[H_2S]}{[H_2][S]}$
No mark for $K_c$ expression, but continue marking substitution and answer./*Geen punt vir $K_c$-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*

(9)
**[18]**

## QUESTION 7/*VRAAG 7*

7.1

7.1.1 Hydrolysis is the reaction (of a salt) with water. ✓✓
*Hidrolise is die reaksie (van 'n sout) met water.*
**(2 or/*of* 0)**

**Accept/*Aanvaar:***
A chemical reaction in which water is a reactant.
*'n Chemiese reaksie waarin water 'n reaktans is.* (2)

7.1.2 Smaller than (7)/*Kleiner as (7)* ✓

$NH_4^+ + H_2O$ ✓ $\rightarrow NH_3 + H_3O^+$ ✓

**Accept/*Aanvaar*:**
$NH_4C\ell + H_2O \rightarrow NH_3 + H_3O^+ + C\ell^-$

$NH_4^+ \rightarrow NH_3 + H^+$

**Note/*Aantekening*:**
- Mark equation independently of first answer./*Sien vergelyking onafhanklik van eerste antwoord na.*
- If incorrect balancing/*Indien verkeerde balansering:* Max/*Maks.* $\frac{2}{3}$

**Marking criteria for equation/*Nasienriglyne vir vergelyking:***
- Reactants ✓ Products ✓
  *Reaktanse* *Produkte*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.* (3)

7.2

7.2.1

**Marking guidelines/*Nasienriglyne:***
- Substitution of/*Substitusie van* 98 g·mol$^{-1}$. ✓
- Final answer/*Finale antwoord:* 0,08 mol ✓

**Note/Let wel:**
If not rounded/*Indien nie afgerond nie*: (0,075 mol)

**OPTION 1/*OPSIE 1***

$n = \frac{m}{M}$

$= \frac{7,35}{98}$

= 0,08 mol ✓ (0,075 mol)

**OPTION 2/*OPSIE 2***

98 g ✓: 1 mol
7,35 :0,08 mol ✓

**OPTION 3/*OPSIE 3***

$c = \frac{m}{MV}$

$= \frac{7,35}{98 \times 0,5}$

= 0,15 mol·dm$^{-3}$

n = cV
= 0,15 x 0,5
= 0,08 mol ✓ (2)





7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1.**
***POSITIEWE NASIEN VAN VRAAG 7.2.1.***

**OPTION 1/*OPSIE 1***

pH = $-\log[H_3O^+]$ ✓
1,3 ✓ = $-\log[H_3O^+]$
$[H_3O^+]$ = 0,05 mol·dm$^{-3}$

$[H_2SO_4] = ½[H_3O^+]$
= ½ x 0,05 ✓
= 0,025 mol·dm$^{-3}$ (0,03)

$n(H_2SO_4)_{ex/oor}$ = cV ✓
= 0,025 x 0,5 ✓
= 0,0125 mol (0,02)

Q7.2.1

$n(H_2SO_4)_{react/rea}$ = 0,075 – 0,0125 ✓
= 0,0625 mol (0,06)

n(NaOH) = $2n(H_2SO_4)$
= 2 x 0,0625 ✓
= 0,125 mol (0,12)

**OR/*OF***

$n(NaOH) = \frac{m}{M}$

$0,125 = \frac{m}{40}$ ✓

m = 5 g ✓ (4,8 g)

**Marking guidelines/*Nasienriglyne:***
- Formula/*Formule:* pH = $-\log[H_3O^+]$ ✓
- Substitution of/*Substitusie van* 1,3 ✓
- Use $[H_2SO_4] : [H_3O^+]$ = 1 : 2 ✓
  *Gebruik* $[H_2SO_4] : [H_3O^+]$ = *1 : 2*
- Formula/*Formule:* $c = \frac{n}{V}$ ✓
- Multiply by 0,5 dm$^3$
  *Vermenigvuldig met 0,5 dm*$^3$ ✓
- Subtract $n_{initial} - n_{excess}$ ✓
  *Aftrek:* $n_{begin} - n_{oormaat}$
- Use n(NaOH) : $n(H_2SO_4)$ = 2:1 ✓
  *Gebruik n(NaOH) : $n(H_2SO_4)$ = 2:1*
- Substitution of 40 g·mol$^{-1}$ ✓
  *Vervanging van* 40 g·mol$^{-1}$
- Final answer: m = 5 g ✓
  *Finale antwoord: m = 5 g*

*Range/Gebied: 4,8 – 5,6 g*

1 mol : 40 g ✓
0,125 mol : 5 g ✓

**OPTION 2/*OPSIE 2***

$pH = -\log[H_3O^+]$ ✓
1,3 ✓ $= -\log[H_3O^+]$
$[H_3O^+] = 0,05\ mol{\cdot}dm^{-3}$

$n(H_3O^+)_{ex/oor} = cV$ ✓
$= (0,05)(0,5)$ ✓
$= 0,025\ mol$ (0,03)

Q7.2.1

$n(H_3O^+)_{in/aanv} = 2n(H_2SO_4)$
$= 0,075 \times 2$ ✓
$= 0,15\ mol$ (0,16)

$n(H_3O^+)_{react/reageer} = 0,15 - 0,025$ ✓
$= 0,125\ mol$ (0,13)

$n(NaOH) = n(H_3O^+)$ ✓
$= 0,125\ mol$ (0,13)

**OR/*OF***

$n(NaOH) = \frac{m}{M}$

$0,125 = \frac{m}{40}$ ✓

m = 5 g ✓ (5,2 g)

1 mol : 40 g ✓
0,125 mol : 5 g ✓

**Marking guidelines/*Nasienriglyne:***

- Formula/*Formule:* $pH = -\log[H_3O^+]$ ✓
- Substitution of/*Substitusie van* 1,3 ✓
- Formula/*Formule:* $c = \frac{n}{V}$ ✓
- Multiply by 0,5 $dm^3$
  *Vermenigvuldig met 0,5 $dm^3$* ✓
- Use $n(H_2SO_4) : n(H_3O^+) = 1 : 2$ ✓
  *Gebruik* $n(H_2SO_4) : n(H_3O^+) = 1 : 2$
- Subtract $n_{initial} - n_{excess}$ ✓
  *Aftrek:* $n_{begin} - n_{oormaat}$
- Use $n(H_3O^+) : n(NaOH) = 1 : 1$ ✓
  *Gebruik* $n(H_3O^+) : n(NaOH) = 1 : 1$
- Substitution of 40 $g{\cdot}mol^{-1}$ ✓
  *Vervanging van 40 $g{\cdot}mol^{-1}$*
- Final answer: m = 5 g ✓
  *Finale antwoord:* m = 5 g

*Range/Gebied: 4,8 – 5,6 g*





**OPTION 3/*OPSIE 3***

Q7.2.1

$[H_2SO_4]_{in/aanv} = \frac{n}{V}$ ✓
$= \frac{0,075}{0,5}$ ✓
$= 0,15\ mol{\cdot}dm^{-3}$ (0,16)

$[H_3O^+]_{in/aanv} = 2[H_2SO_4]$
$= 2 \times 0,15$ ✓
$= 0,3\ mol{\cdot}dm^{-3}$ (0,32)

$pH = -\log[H_3O^+]$ ✓
1,3 ✓ $= -\log[H_3O^+]$
$[H_3O^+] = 0,05\ mol{\cdot}dm^{-3}$

$[H_3O^+]_{react/rea} = 0,3 - 0,05$ ✓
$= 0,25\ mol{\cdot}dm^{-3}$ (0,27)

$[H_2SO_4]_{react/rea} = ½[H_3O^+]$
$= ½ \times 0,25$
$= 0,125\ mol{\cdot}dm^{-3}$ (0,14)

**OR/*OF***

$n(H_2SO_4)_{react/reageer} = cV$
$= (0,125)(0,5)$
$= 0,0625\ mol$ (0,07)

$n(NaOH) = 2n(H_2SO_4)$
$= 2 \times 0,0625$ ✓
$= 0,125\ mol$ (0,14)

$n(NaOH) = \frac{m}{M}$

$0,125 = \frac{m}{40}$ ✓

m = 5 g ✓ (5,6 g)

$[H_2SO_4] : [NaOH]$
1 : 2
0,125 : 0,25 ✓ (0,28)

m = cMV
$= 0,25 \times 40$ ✓ $\times 0,5$
= 5 g ✓ (5,6 g)

**Marking guidelines/*Nasienriglyne:***

- Formula/*Formule:* $c = \frac{n}{V}$ ✓
- Divide by 0,5 $dm^3$
  *Deel deur 0,5 $dm^3$* ✓
- Use $[H_3O^+] : [H_2SO_4] = 2:1$ ✓
  *Gebruik* $[H_3O^+] : [H_2SO_4] = 2:1$
- Formula/*Formule:* $pH = -\log[H_3O^+]$ ✓
- Substitution of/*Substitusie van* 1,3 ✓
- Subtract $[H_3O^+]_{initial} - [H_3O^+]_{excess}$ ✓
  *Aftrek:* $[H_3O^+]_{begin} - [H_3O^+]_{oormaat}$
- Use $n(NaOH) : n(H_2SO_4) = 2:1$ ✓
  *Gebruik* $n(NaOH) : n(H_2SO_4) = 2:1$
  **OR/*OF***
  Use $[H_2SO_4] : [NaOH] = 1 : 2$ ✓
  *Gebruik* $[H_2SO_4] : [NaOH] = 1 : 2$
- Substitution of 40 $g{\cdot}mol^{-1}$ ✓
  *Vervanging van 40 $g{\cdot}mol^{-1}$*
- Final answer: m = 5 g ✓
  *Finale antwoord:* m = 5 g

*Range/Gebied: 4,8 – 5,6 g*

(9)
**[16]**

## QUESTION 8/*VRAAG 8*

8.1

8.1.1 $AgNO_3$ / Silver nitrate ✓
*$AgNO_3$ / Silwernitraat* (1)

8.1.2 $Ni \rightarrow Ni^{2+} + 2e^-$ ✓✓

**Marking guidelines/*Nasienriglyne:***
- $Ni \rightleftharpoons Ni^{2+} + 2e^-$ $\frac{1}{2}$ $Ni^{2+} + 2e^- \rightleftharpoons Ni$ $\frac{0}{2}$
  $Ni^{2+} + 2e^- \leftarrow Ni$ $\frac{2}{2}$ $Ni^{2+} + 2e^- \rightarrow Ni$ $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on $Ni^{2+}$ / *Indien lading (+) weggelaat op $Ni^{2+}$*: Max./*Maks:* $\frac{1}{2}$
  Example/*Voorbeeld:* $Ni \rightarrow Ni^{2} + 2e^-$ ✓ (2)

8.1.3 $Ni + 2Ag^+$ ✓ $\rightarrow Ni^{2+} + 2Ag$ ✓ Bal ✓

**OR/*OF***
$Ni + 2\ AgNO_3 \rightarrow Ni(NO_3)_2 + 2Ag$

**Notes/*Aantekeninge:***
- Reactants ✓ Products ✓ Balancing: ✓
  *Reaktanse* *Produkte* *Balansering*
- Ignore double arrows./*IDgnoreer dubbelpyle.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.* (3)

8.2

8.2.1 Ni ✓

Ni is a stronger reducing agent. / Ni has a higher reducing ability. / Ni is the anode. / Ni loses electrons. / Ni is oxidised. ✓
*Ni is die sterker reduseermiddel. / Ni het sterker reduseer vermoëe. / Ni is die anode. / Ni verloor elektrone. / Ni word geoksideer.* (2)

8.2.2 Ni (s) ✓| $Ni^{2+}$ (aq) ✓|| $Ag^+$(aq) ✓| Ag(s)

**OR/*OF***
Ni (s) | $Ni^{2+}$ (1 mol·dm$^{-3}$) || $Ag^+$(1 mol·dm$^{-3}$) | Ag(s)

**Accept/*Aanvaar:***
Ni | $Ni^{2+}$ || $Ag^+$ | Ag (3)





8.2.3

| **OPTION 1/*OPSIE 1*** | **Notes/*Aantekeninge*** |
|---|---|
| $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓<br>$= 0{,}80$ ✓ – (-0,27) ✓<br>$= 1{,}07$ V ✓ | • Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*<br>• 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*** | |
|---|---|
| $Ag^+ + e^- \rightarrow Ag$ ✓ | $E^\theta = 0{,}80$ V ✓ |
| $Ni \rightarrow Ni^{2+} + 2e^-$ | $E^\theta = +0{,}27$ V ✓ |
| $Ag^+ + Ni \rightarrow Ag + Ni^{2+}$ | $E^\theta = +1{,}07$ V ✓ |

(4)

8.2.4 Increases / *Verhoog* ✓ (1)
**[16]**

## QUESTION 9/*VRAAG 9*

9.1 Endothermic / *Endotermies* ✓ (1)

9.2 Anode ✓

Connected to the positive terminal of the battery. ✓
*Geskakel aan positiewe terminaal van battery.* (2)

9.3

9.3.1 Chlorine (gas) / $C\ell_2$ / *Chloor(gas)* ✓ (1)

9.3.2 Hydrogen (gas) /$H_2$ / *Waterstof(gas)* ✓ (1)

9.3.3 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

Ignore phases/*Ignoreer fases*

**Notes/*Aantekeninge***
$H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ ($\frac{2}{2}$) $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ ($\frac{1}{2}$)
$H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ ($\frac{0}{2}$) $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ ($\frac{0}{2}$) (2)

9.4 Basic / *Basies* ✓

**OR/*OF*** Alkaline / *Alkalies*

$OH^-$ (ions) / NaOH / Strong base forms.✓
*$OH^-$(-ione) / NaOH / Sterk basis vorm.* (2)

**[9]**





**QUESTION 10/*VRAAG 10***

10.1

10.1.1 Haber (process) / *Haberproses* ✓ (1)

10.1.2 Contact process / Catalytic oxidation of $SO_2$ ✓
*Kontakproses / Katalitiese oksidasie van $SO_2$* (1)

10.1.3 Sulphur trioxide / $SO_3$ / *Swaweltrioksied* ✓ (1)

10.1.4 $SO_3 + H_2SO_4$ ✓ → $H_2S_2O_7$ ✓ 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)

10.1.5 $H_2SO_4$ ✓ + $2NH_3$ ✓ → $(NH_4)_2SO_4$ ✓ Bal. ✓

**Notes/*Aantekeninge***
- Reactants ✓✓ *Reaktanse* Products ✓ *Produkte* Balancing ✓ *Balansering*
- Ignore/*Ignoreer* ⇌ and phases/*en fases*.
- Marking rule 6.3.10/*Nasienreël 6.3.10* (4)

To our STEM in ACTION partners,

# Thank you!

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in our
Nelson Mandela Metro

@mandelaunistem

stemadmin@mandela.ac.za

STEM in ACTION MandelaUni

amtc.mandela.ac.za

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+27 82 481 0144

+27 41 504 1396