WHERE TO START IN MATHS AND SCIENCE TUTORING

WTS TUTORING

PHYSICAL SCIENCES

GRADE 12

CAPS PAPERS & SOLUTIONS

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HERE YOU WILL FIND:

- EXAMINATION GUIDELINES
- INSTRUCTIONS AND INFORMATION
- CAPS PAST PAPERS AND SOLUTIONS {2014 TO 2017}
- WTS TUTORS CENTRES

PUBLISHERS

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Examination Guidelines

1. INTRODUCTION

The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences outlines the nature and purpose of the subject Physical Sciences. This guides the philosophy underlying the teaching and assessment of the subject in Grade 12.

The purpose of these Examination Guidelines is to:

- Provide clarity on the depth and scope of the content to be assessed in the Grade 12 National Senior Certificate (NSC) Examination in Physical Sciences.
- Assist teachers to adequately prepare learners for the examinations.

This document deals with the final Grade 12 external examinations. It does not deal in any depth with the School-Based Assessment (SBA).

These Examination Guidelines should be read in conjunction with:

- The *National Curriculum Statement (NCS) Curriculum and Assessment Policy Statement (CAPS):* Physical Sciences
- The National Protocol of Assessment: *An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding the National Protocol for Assessment (Grades R–12)*
- The national policy pertaining to the programme and promotion requirements of the National Curriculum Statement, Grades R–12

2. ASSESSMENT IN GRADE 12

2.1 Format of question papers

Paper	Type of questions	Duration	Total	Date	Marking
1	**Physics** 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	External
2	**Chemistry** 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	External

2.2 Numbering and sequence of questions

QUESTION 1: Multiple-choice questions
Subquestions numbered 1.1 to 1.10 (2 marks each)
Questions will be arranged from lower to higher cognitive levels (easier to more challenging) and may cover all cognitive levels.

QUESTION 2 onwards:
Longer questions assessing skills and knowledge across cognitive levels. Numbering starts with QUESTION 2 and will be continuous. Subquestions will be numbered by two digits, e.g. 2.1, 2.2. Numbering is restricted to a maximum of three digits, e.g. 2.1.1, 2.1.2.

2.3 Information sheets

The separate information sheets for Paper 1 and Paper 2 are included in this document.

2.4 Weighting of cognitive levels

Papers 1 and 2 will include questions across four cognitive levels. The distribution of cognitive levels in Physics and Chemistry papers is given below.

Cognitive level	Description	Paper 1 (Physics)	Paper 2 (Chemistry)
1	Remembering (Recall)	15%	15%
2	Understanding (Comprehension)	35%	40%
3	Applying and analysing	40%	35%
4	Evaluating and creating (synthesis)	10%	10%

2.5 Weighting of prescribed content

Paper 1: Physics Focus							
Content	**Marks**	**Total**	**Duration**	**Weighting of questions across cognitive levels**			
Mechanics	63	150 marks	3 hours	15	35	40	10
Waves, sound and light	17						
Electricity and magnetism	55						
Matter and materials	15						

Paper 2: Chemistry Focus							
Content	**Marks**	**Total**	**Duration**	**Weighting of questions across cognitive levels**			
Chemical change	84	150 marks	3 hours	15	40	35	10
Chemical systems	18						
Matter and materials	48						

2.6 Skills in Physical Sciences

- Identify and question phenomena:
  - Formulate an investigative question.
  - List all possible variables.
  - Formulate a testable hypothesis.

- Design/Plan of an investigation:
  - Identify variables (dependent, independent and controlled variables).
  - List appropriate apparatus.
  - Plan the sequence of steps which should include, amongst others:
    - The need for more than one trial to minimise experimental errors.
    - Identify safety precautions that need to be taken.
    - Identify conditions that ensure a fair test.
    - Set an appropriate control.

- Graphs:
  - Draw accurate graphs from given data/information.
  - Interpret graphs.
  - Draw sketch graphs from given information.

- Results:
  - Identify patterns/relationships in data.
  - Interpret results.

- Conclusions:
  - Draw conclusions from given information, e.g. tables, graphs.
  - Evaluate the validity of conclusions.

- Calculations:
  - Solve problems using two or more different calculations (multistep calculations).

- Descriptions:
  - Explain/Describe/Argue the validity of a statement/event using scientific principles.

2.7 Prior knowledge from Grades 10 and 11

All skills and application of knowledge learnt in Grades 10 and 11 are applicable to assessment in Grade 12. In addition to content from Grades 10 and 11 included under examinable content for Grade 12, skills and knowledge from Grades 10 and 11 that may be assessed in Grade 12 include the following:

- The use of equations of motion in solving problems dealing with momentum, vertical projectile motion, work, energy and power
- Sound waves and properties of sound
- Electromagnetism

NOTE: Although there will be no direct questions about these aspects, applications thereof can be assessed.

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

Work-energy theorem

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

Conservation of energy with non-conservative forces present

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

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:
  - Conservation of atoms
  - 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.

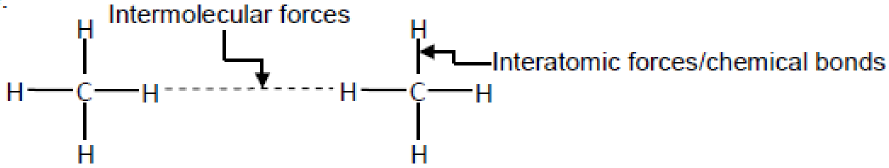
More complex stoichiometric calculations

- 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.

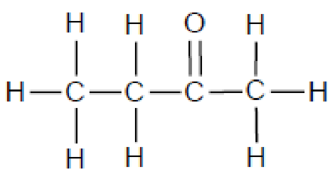
- Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.
  Boiling point:
  The temperature at which the vapour pressure equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
  Melting point:
  The temperature at which 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:
  - Alkanes (no ring structures)
  - Alkenes (no ring structures)
  - Alkynes
  - Halo-alkanes (primary, secondary and tertiary haloalkanes; no ring structures)
  - Alcohols (primary, secondary and tertiary alcohols)
  - Carboxylic acids
  - Esters
  - Aldehydes
  - Ketones
- Know the following definitions/terms:
  - Molecular formula: A chemical formula that indicates the type of atoms and the correct number of each in a molecule.
    Example: C_4H_8O
  - 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.

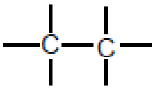
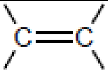
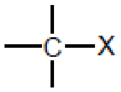
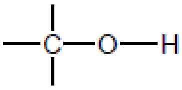
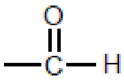
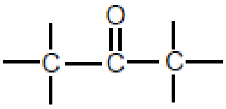
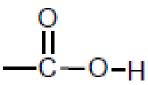
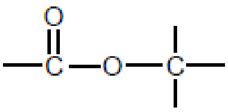


  - Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.

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

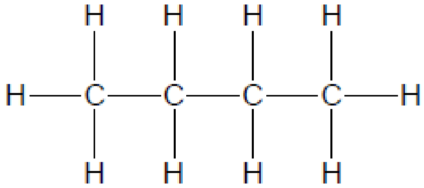
  - Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.
  - Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH_2 group
  - Saturated compounds: Compounds in which there are no multiple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

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

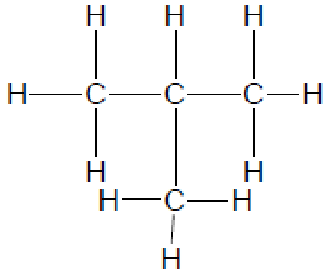
Homologous series	**Structure of functional group**	
	Structure	**Name**
Alkanes		Only C-H and C-C single bonds
Alkenes		Carbon-carbon double bond
Alkynes		Carbon-carbon triple bond
Haloalkanes	 (X = F, Cℓ, Br, I)	-
Alcohols		Hydroxyl group
Aldehydes		Formyl group
Ketones		Carbonyl group
Carboxylic acids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

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

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

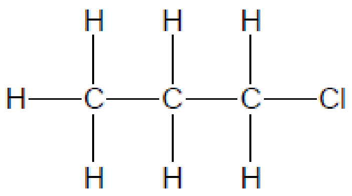


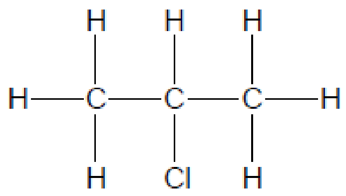
Butane

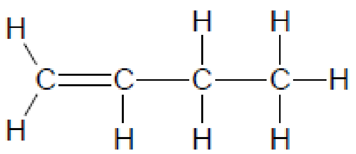


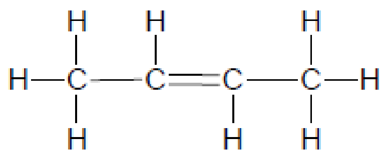
2-methylpropane

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

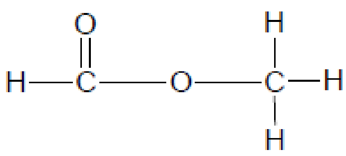

1-chloropropane

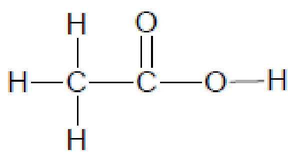

2-chloropropane


but-1-ene


but-2-ene

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


methyl methanoate


ethanoic acid

IUPAC naming and formulae

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

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

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

Oxidation of alkanes

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

Esterification

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

Substitution, addition and elimination reactions

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

4. GENERAL INFORMATION

4.1 Quantities, symbols and units

The most common quantities, symbols and SI units used in introductory Physics are listed below.
A quantity should not be confused with the unit in which it is measured.

Quantity	Preferred symbol	Alternative symbol	Unit name	Unit symbol
mass	m		kilogram	kg
position	x, y		metre	m
displacement	Δx, Δy	s	metre	m
velocity	v_x, v_y	u, v	metre per second	$m \cdot s^{-1}$
initial velocity	v_i	u	metre per second	$m \cdot s^{-1}$
final velocity	v_f	v	metre per second	$m \cdot s^{-1}$
acceleration	a		metre per second per second	$m \cdot s^{-2}$
acceleration due to gravity	g		metre per second per second	$m \cdot s^{-2}$
time (instant)	t		second	s
time interval	Δt		second	s
energy	E		joule	J
kinetic energy	K	E_k	joule	J
potential energy	U	E_p	joule	J
work	W		joule	J
work function	W_0		joule	J
power	P		watt	W
momentum	p		kilogram metre per second	$kg \cdot m \cdot s^{-1}$
force	F		newton	N
weight	w	F_g	newton	N
normal force	N	F_N	newton	N
tension	T	F_T	newton	N
friction force	f	F_f	newton	N
coefficient of friction	μ, μ_s, μ_k		(none)	
torque	τ		newton metre	$N \cdot m$
wavelength	λ		metre	m
frequency	f	ν	hertz or per second	Hz or s^{-1}
period	T		second	s
speed of light	c		metre per second	$m \cdot s^{-1}$
refractive index	n		(none)	
focal length	f		metre	m
object distance	s	u	metre	m
image distance	s'	v	metre	m
magnification	m		(none)	
charge	Q, q		coulomb	C
electric field	E		newton per coulomb or volt per metre	$N \cdot C^{-1}$ or $V \cdot m^{-1}$
electric potential at point P	V_P		volt	V
potential difference	ΔV, V		volt	V
emf	**E**	ε	volt	V
current	I, i		ampere	A
resistance	R		ohm	Ω
internal resistance	r		ohm	Ω
magnetic field	B		tesla	T
magnetic flux	Φ		tesla·metre^2 or weber	$T \cdot m^2$ or Wb
capacitance	C		farad	F
inductance	L		henry	H

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)

PAST QUESTION PAPERS

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of 11 questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2014

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. 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 physical quantities is a measure of the inertia of a body?

A Mass

B Energy

C Velocity

D Acceleration (2)

1.2 The magnitude of the gravitational force exerted by one body on another body is ***F***. When the distance between the centres of the two bodies is doubled, the magnitude of the gravitational force, in terms of ***F***, will now be …

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

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

C $2F$

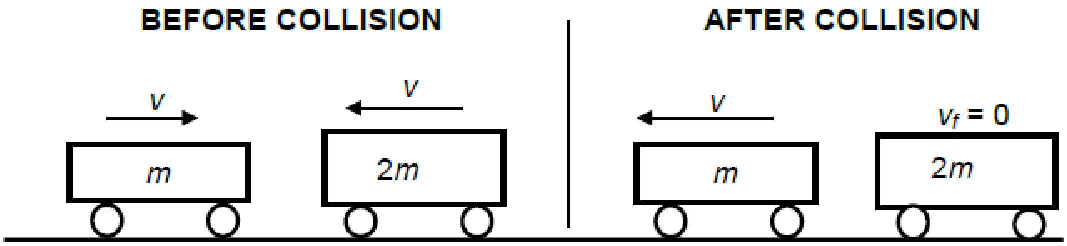
D $4F$ (2)

1.3 An object is thrown vertically upwards. Which ONE of the following regarding the object's velocity and acceleration at the highest point of its motion is CORRECT? Ignore the effects of friction.

	VELOCITY	ACCELERATION
A	Zero	Zero
B	Zero	Upwards
C	Maximum	Zero
D	Zero	Downwards

(2)

1.4 An object of mass m moving at velocity v collides head-on with an object of mass $2m$ moving in the opposite direction at velocity v. Immediately after the collision the smaller mass moves at velocity v in the opposite direction and the larger mass is brought to rest. Refer to the diagram below.



Ignore the effects of friction.

Which ONE of the following is CORRECT?

	MOMENTUM	MECHANICAL ENERGY
A	Conserved	Conserved
B	Not conserved	Conserved
C	Conserved	Not conserved
D	Not conserved	Not conserved

(2)

1.5 Two balls, **P** and **Q**, are dropped simultaneously from the same height. Ball **P** has TWICE the mass of ball **Q**. Ignore the effects of air friction.

Just before the balls hit the ground, the kinetic energy of ball **P** is x. The kinetic energy of ball **Q**, in terms of x, will be …

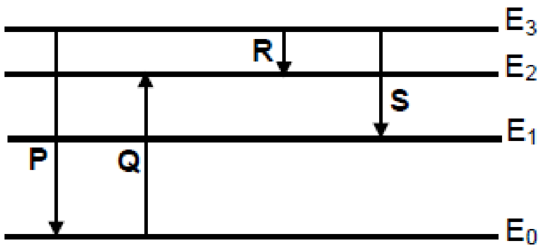
A $\frac{1}{4}x$

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

C x

D $2x$ (2)

1.6 The diagram below shows the electron transitions **P**, **Q**, **R** and **S** between different energy levels in an atom.



Which ONE of the transitions will result in an emission of a radiation with the longest wavelength?

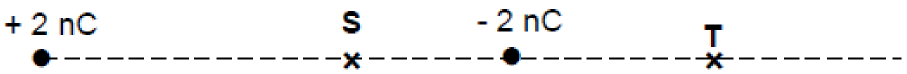
A **P**

B **Q**

C **R**

D **S** (2)

1.7 Two charges of + 2 nC and - 2 nC are located on a straight line. **S** and **T** are two points that lie on the same straight line as shown in the diagram below.



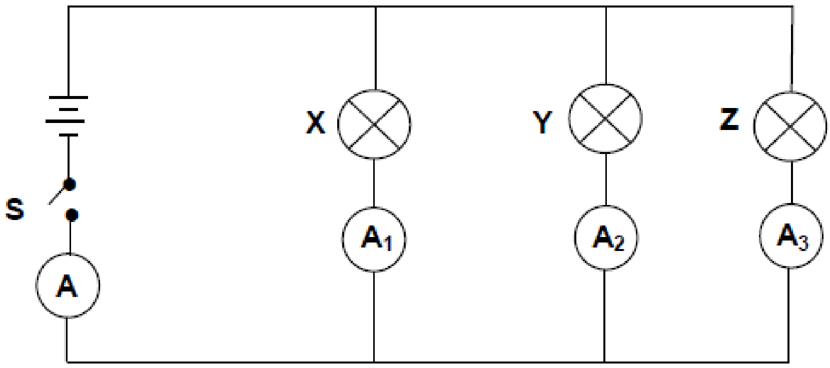
Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T**?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT S	**DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT T**
A	Right	Left
B	Left	Left
C	Right	Right
D	Left	Right

(2)

1.8 Three light bulbs, **X**, **Y** and **Z** with resistances *R*, 2*R* and *R* respectively, are connected in a circuit as shown below. The battery has negligible internal resistance.

When switch **S is closed**, all the bulbs light up. The reading on ammeter **A** is 2,5 A.

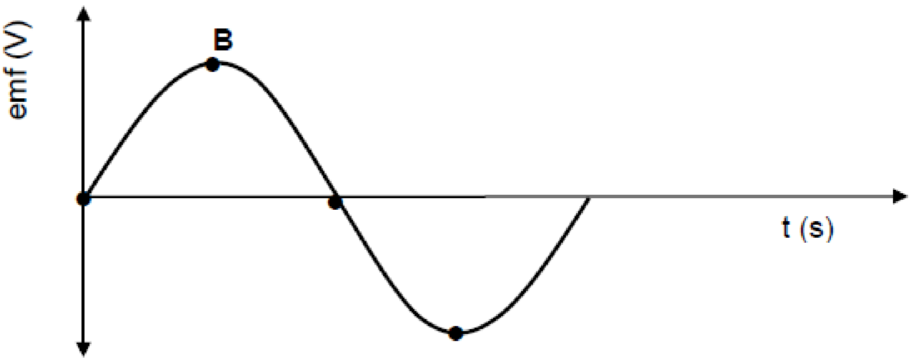


Which ONE of the following correctly describes the readings on the ammeters (in amperes) when bulb **Z** burns out?

	A_1	A_2	A_3	A
A	1,25	1,25	0	2,5
B	1,6	0,8	0,1	2,5
C	0,75	0,75	0	1,5
D	1	0,5	0	1,5

(2)

1.9 The coils of an AC generator make one complete rotation. The resulting graph for the output emf is shown below.



The position **B** on the graph is obtained when the plane of the coil is at an angle of … to the magnetic field.

A 0°

B 60°

C 90°

D 120° (2)

1.10 A learner makes the observations below after conducting an experiment using a photocell with frequencies of the incident light being above the threshold frequency (cut-off frequency).

(i) The photocurrent increases as the intensity of the incident light increases.

(ii) The ammeter in the circuit registers a current immediately after the incident light is radiated on the cathode.

(iii) The photocurrent increases as the frequency of the incident light increases.

Which of the observation(s) is/are CORRECT?

A (i) only

B (ii) only

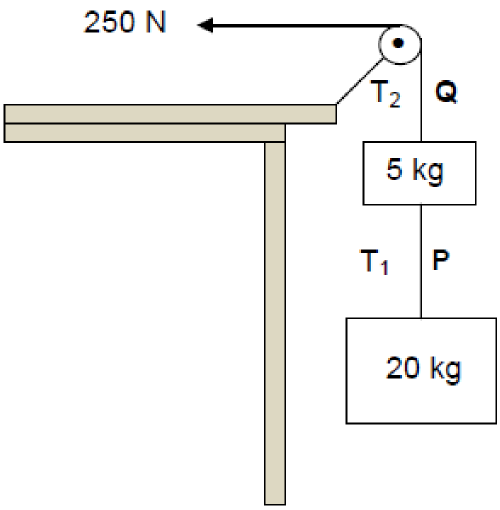
C (i) and (ii) only

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

[20]

QUESTION 2 (Start on a new page.)

Two blocks of masses 20 kg and 5 kg respectively are connected by a light inextensible string, **P**. A second light inextensible string, **Q**, attached to the 5 kg block, runs over a light frictionless pulley. A constant horizontal force of 250 N pulls the second string as shown in the diagram below. The magnitudes of the tensions in **P** and **Q** are T_1 and T_2 respectively. Ignore the effects of air friction.



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

2.2 Draw a labelled free-body diagram indicating ALL the forces acting on the **5 kg block**. (3)

2.3 Calculate the magnitude of the tension T_1 in string **P**. (6)

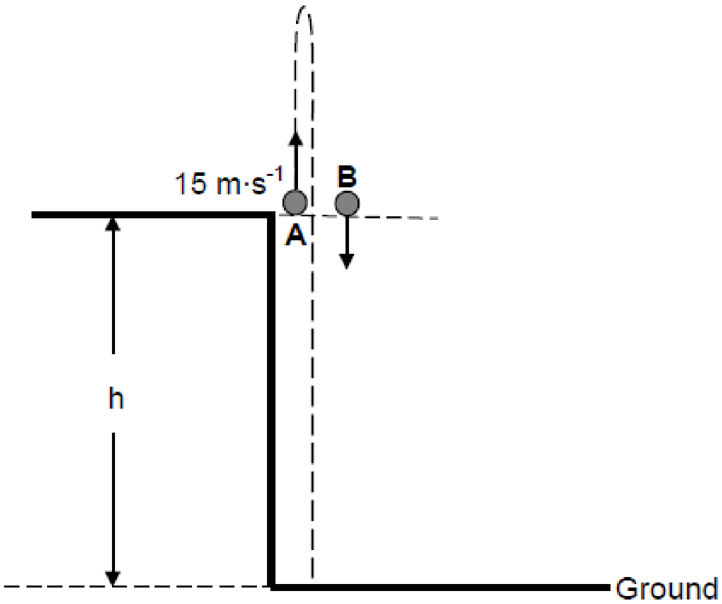
2.4 When the 250 N force is replaced by a sharp pull on the string, one of the two strings break.

Which ONE of the two strings, **P** or **Q**, will break? (1)
[12]

QUESTION 3 (Start on a new page.)

A ball, **A**, is thrown vertically upward from a height, h, with a speed of 15 $m \cdot s^{-1}$. AT THE SAME INSTANT, a second identical ball, **B**, is dropped from the same height as ball **A** as shown in the diagram below.

Both balls undergo free fall and eventually hit the ground.



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

3.2 Calculate the time it takes for ball **A** to return to its starting point. (4)

3.3 Calculate the distance between ball **A** and ball **B** when ball **A** is at its maximum height. (7)

3.4 Sketch a velocity-time graph in the ANSWER BOOK for the motion of ball **A** from the time it is projected until it hits the ground.

Clearly show the following on your graph:

- The initial velocity
- The time it takes to reach its maximum height
- The time it takes to return to its starting point (4)

[17]

QUESTION 4 (Start on a new page.)

Dancers have to learn many skills, including how to land correctly. A dancer of mass 50 kg leaps into the air and lands feet first on the ground. She lands on the ground with a velocity of 5 $m \cdot s^{-1}$. As she lands, she bends her knees and comes to a complete stop in 0,2 seconds.

4.1 Calculate the momentum with which the dancer reaches the ground. (3)

4.2 Define the term *impulse* of a force. (2)

4.3 Calculate the magnitude of the net force acting on the dancer as she lands. (3)

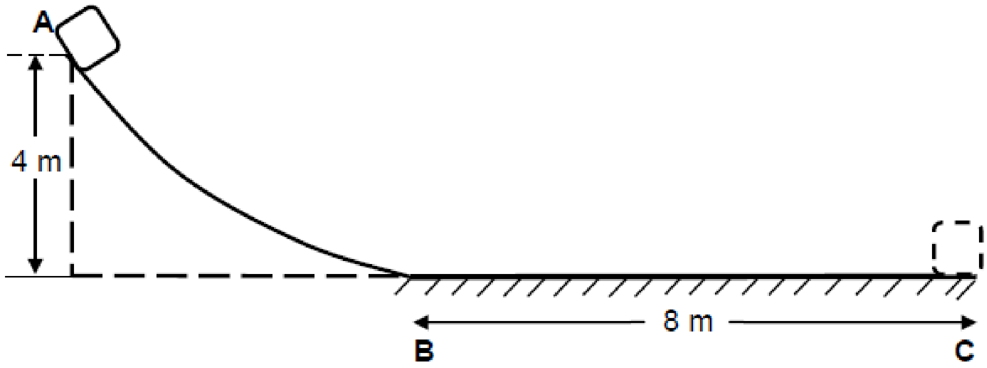
Assume that the dancer performs the same jump as before but lands without bending her knees.

4.4 Will the force now be GREATER THAN, SMALLER THAN or EQUAL TO the force calculated in QUESTION 4.3? (1)

4.5 Give a reason for the answer to QUESTION 4.4. (3)
[12]

QUESTION 5 (Start on a new page.)

5.1 The diagram below shows a track, **ABC**. The curved section, **AB**, is frictionless. The rough horizontal section, **BC**, is 8 m long.



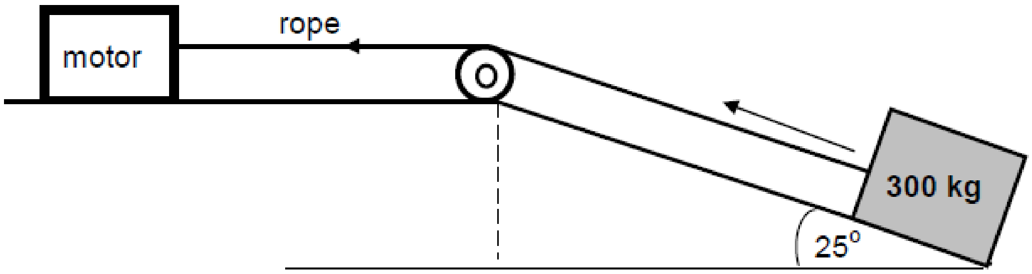
An object of mass 10 kg is released from point **A** which is 4 m above the ground. It slides down the track and comes to rest at point **C**.

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

5.1.2 Is mechanical energy conserved as the object slides from **A** to **C**? Write only YES or NO. (1)

5.1.3 Using ENERGY PRINCIPLES only, calculate the magnitude of the frictional force exerted on the object as it moves along **BC**. (6)

5.2 A motor pulls a crate of mass 300 kg with a constant force by means of a light inextensible rope running over a light frictionless pulley as shown below. The coefficient of kinetic friction between the crate and the surface of the inclined plane is 0,19.



5.2.1 Calculate the magnitude of the frictional force acting between the crate and the surface of the inclined plane. (3)

The crate moves up the incline at a constant speed of 0,5 $m \cdot s^{-1}$.

5.2.2 Calculate the average power delivered by the motor while pulling the crate up the incline. (6)

[18]

QUESTION 6 (Start on a new page.)

6.1 The siren of a stationary ambulance emits a note of frequency 1 130 Hz. When the ambulance moves at a constant speed, a stationary observer detects a frequency that is 70 Hz **higher** than that emitted by the siren.

6.1.1 State the Doppler effect in words. (2)

6.1.2 Is the ambulance moving *towards* or *away from* the observer? Give a reason for the answer. (2)

6.1.3 Calculate the speed at which the ambulance is travelling. Take the speed of sound in air as 343 $m \cdot s^{-1}$. (5)

6.2 A study of spectral lines obtained from various stars can provide valuable information about the movement of the stars.

The two diagrams below represent different spectral lines of an element. Diagram **1** represents the spectrum of the element in a laboratory on Earth. Diagram **2** represents the spectrum of the same element from a distant star.

Diagram 1

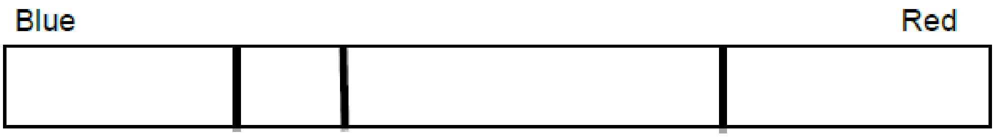
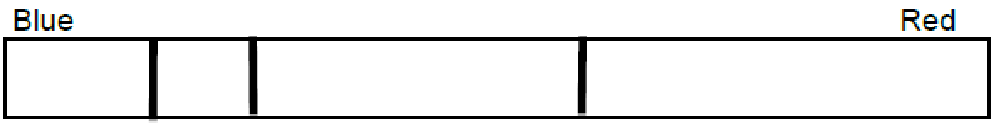


Diagram 2

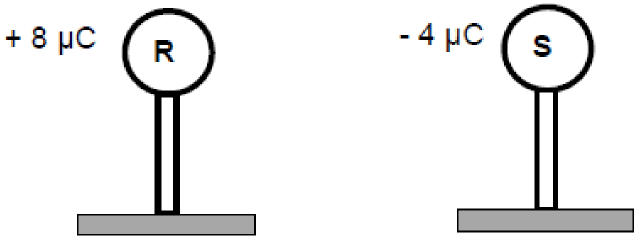


Is the star moving *towards* or *away from* the Earth? Explain the answer by referring to the shifts in the spectral lines in the two diagrams above. (2)

[11]

QUESTION 7 (Start on a new page.)

The diagram below shows two small identical metal spheres, **R** and **S**, each placed on a wooden stand. Spheres **R** and **S** carry charges of + 8 μC and - 4 μC respectively. Ignore the effects of air.



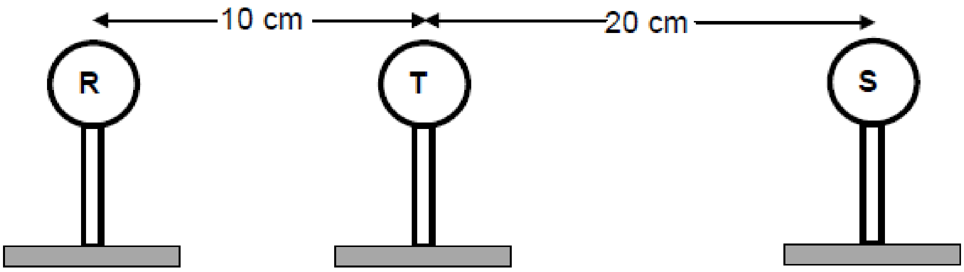
7.1 Explain why the spheres were placed on wooden stands. (1)

Spheres **R** and **S** are brought into contact for a while and then separated by a small distance.

7.2 Calculate the net charge on each of the spheres. (2)

7.3 Draw the electric field pattern due to the two spheres **R** and **S**. (3)

After **R** and **S** have been in contact and separated, a third sphere, **T**, of charge + 1 μC is now placed between them as shown in the diagram below.



7.4 Draw a free-body diagram showing the electrostatic forces experienced by sphere **T** due to spheres **R** and **S**. (2)

7.5 Calculate the net electrostatic force experienced by **T** due to **R** and **S**. (6)

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

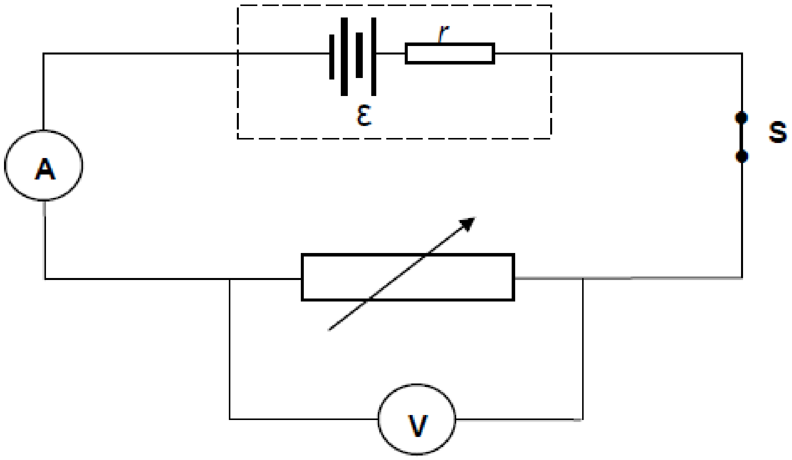
7.7 Calculate the magnitude of the net electric field at the location of **T** due to **R** and **S**. (Treat the spheres as if they were point charges.) (3)

[19]

QUESTION 8 (Start on a new page.)

NOTE: The graph for QUESTION 8.1.2 must be drawn on the GRAPH SHEET attached at the end of the QUESTION PAPER.

8.1 A group of learners conduct an experiment to determine the emf (ε) and internal resistance (r) of a battery. They connect a battery to a rheostat (variable resistor), a low-resistance ammeter and a high-resistance voltmeter as shown in the diagram below.



The data obtained from the experiment is displayed in the table below.

READING ON VOLTMETER (V)	READING ON AMMETER (A)
2	0,58
3	0,46
4	0,36
5	0,24
6	0,14

8.1.1 State ONE factor which must be kept constant during the experiment. (1)

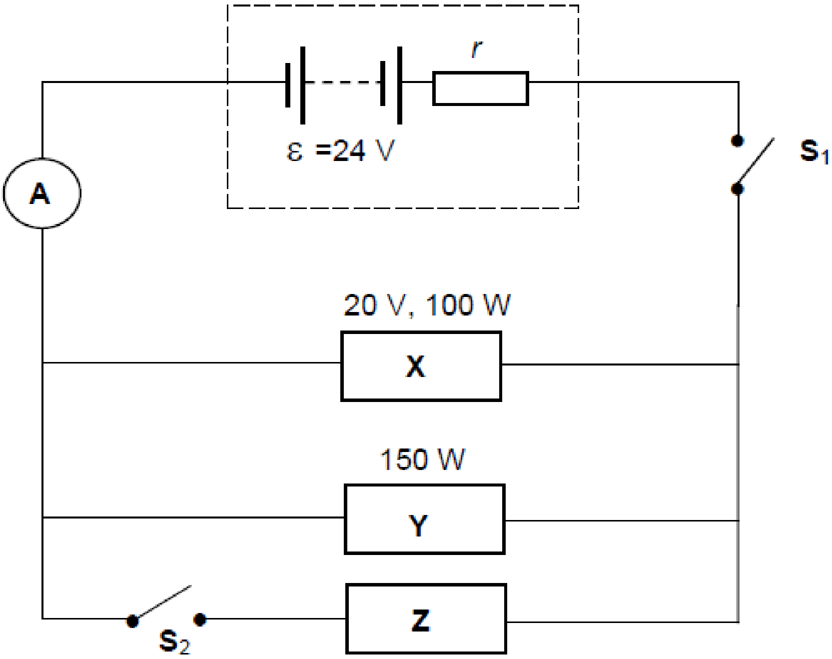
8.1.2 Using the information in the table above, plot the points and draw the line of best fit on the attached GRAPH SHEET. (3)

Use the graph drawn in QUESTION 8.1.2 to determine the following:

8.1.3 Emf (ε) of the battery (1)

8.1.4 Internal resistance of the battery, WITHOUT USING ANY FORM OF THE EQUATION $\varepsilon = I(R + r)$ (3)

8.2 Three electrical devices, **X**, **Y** and **Z**, are connected to a 24 V battery with internal resistance r as shown in the circuit diagram below. The power rating of each of the devices **X** and **Y** are indicated in the diagram.



With switch $\mathbf{S_1}$ closed and $\mathbf{S_2}$ open, the devices function as rated.

Calculate the:

8.2.1 Current in **X** (3)

8.2.2 Resistance of **Y** (3)

8.2.3 Internal resistance of the battery (5)

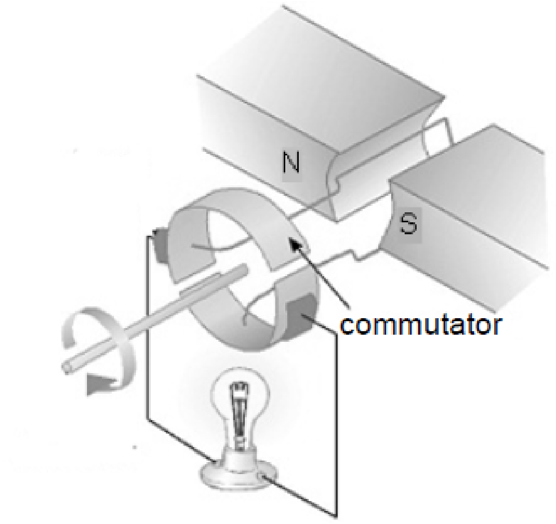
Now switch $\mathbf{S_2}$ is also closed.

8.2.4 Identify device **Z** which, when placed in the position shown, can still enable **X** and **Y** to operate as rated. Assume that the resistances of all the devices remain unchanged. (1)

8.2.5 Explain how you arrived at the answer to QUESTION 8.2.4. (2)
[22]

QUESTION 9 (Start on a new page.)

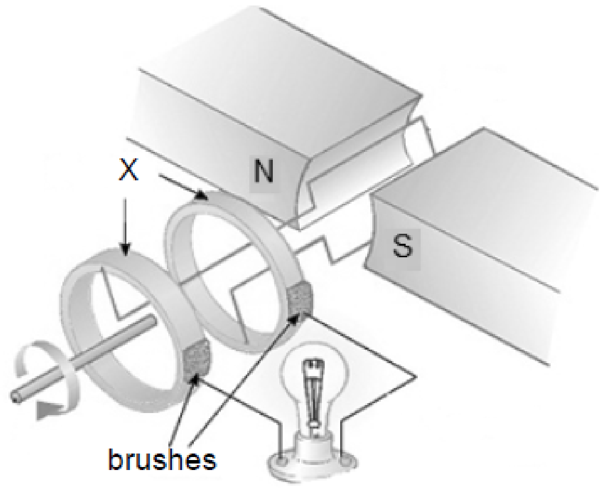
The diagram below represents a simplified version of an electrical machine used to light up a bulb.



9.1 Name the principle on which the machine operates. (1)

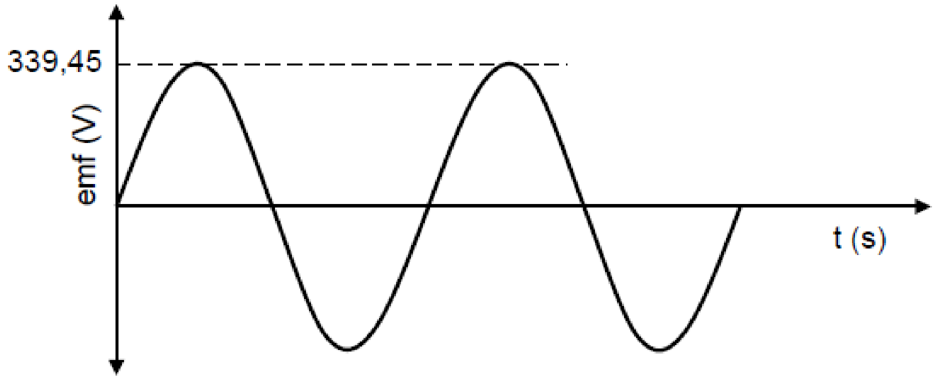
9.2 State ONE way in which to make this bulb burn brighter. (1)

Some changes have been made to the machine and a new device is obtained as shown below.



9.3 Name part **X** in the new device. (1)

9.4 The graph of output emf versus time obtained using the device in QUESTION 9.3 is shown below.

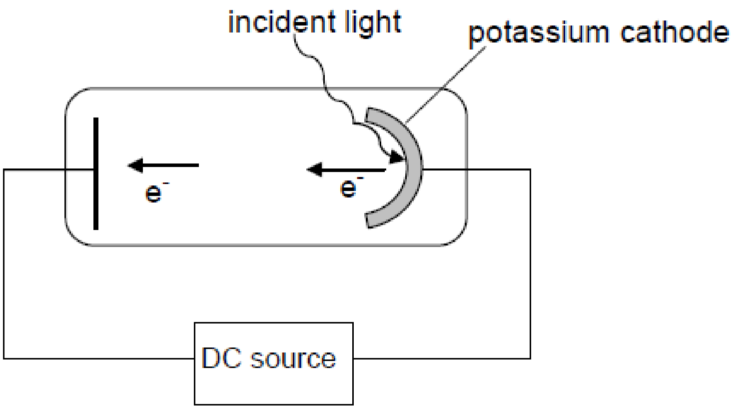


9.4.1 Define the term *root mean square value* of an AC voltage. (2)

9.4.2 Calculate the rms voltage. (3)
[8]

QUESTION 10 (Start on a new page.)

Ultraviolet light is incident onto a photocell with a potassium cathode as shown below. The threshold frequency of potassium is $5{,}548 \times 10^{14}$ Hz.



10.1 Define the term *threshold frequency (cut-off frequency)*. (2)

The maximum speed of an ejected photoelectron is $5{,}33 \times 10^5$ m·s^{-1}.

10.2 Calculate the wavelength of the ultraviolet light used. (5)

The photocell is now replaced by another photocell with a rubidium cathode. The maximum speed of the ejected photoelectron is $6{,}10 \times 10^5$ m·s^{-1} when the same ultraviolet light source is used.

10.3 How does the work function of rubidium compare to that of potassium? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

10.4 Explain the answer to QUESTION 10.3. (3)
[11]

TOTAL: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2014

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. 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 a primary nutrient for plants?

A Oxygen

B Carbon

C Potassium

D Magnesium (2)

1.2 Which ONE of the following statements is CORRECT?

Alkenes ...

A have the general formula C_nH_{2n+2}.

B are unsaturated hydrocarbons.

C readily undergo substitution reactions.

D have one triple bond between two carbon atoms. (2)

1.3 Consider the reaction represented by the balanced equation below:

$$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$$

In the above reaction, Cu(s) is the ...

A oxidising agent and is reduced.

B oxidising agent and is oxidised.

C reducing agent and is reduced.

D reducing agent and is oxidised. (2)

1.4 Which ONE of the following describes the effect of a positive catalyst on the net activation energy and the heat of reaction (ΔH) of a specific reaction?

	NET ACTIVATION ENERGY	**ΔH**
A	Increases	No effect
B	Decreases	Increases
C	No effect	Decreases
D	Decreases	No effect

(2)

1.5 The following equation represents the cracking of a hydrocarbon at high temperature and pressure:

$$C_{11}H_{24} \rightarrow 2C_2H_4 + \mathbf{Y} + C_4H_{10}$$

Which ONE of the following is the IUPAC name of product **Y**?

A Prop-1-ene

B Propane

C Ethene

D Ethane (2)

1.6 When 2-chlorobutane is strongly heated in the presence of concentrated sodium hydroxide, the major product formed is …

A but-1-ene.

B but-2-ene.

C butan-1-ol.

D butan-2-ol. (2)

1.7 A hypothetical reaction reaches equilibrium at 10 °C in a closed container according to the following balanced equation:

$$A(g) + B(g) \rightleftharpoons AB(g) \qquad \Delta H < 0$$

The temperature is now increased to 25 °C. Which ONE of the following is correct as the reaction approaches a new equilibrium?

	REACTION RATE	**YIELD OF PRODUCTS**
A	Increases	Remains the same
B	Increases	Decreases
C	Increases	Increases
D	Decreases	Decreases

(2)

1.8 Which ONE of the following represents the products formed during the hydrolysis of ammonium chloride?

A $NH_3(aq)$ and $H_3O^+(aq)$

B $NH_4^+(aq)$ and $C\ell^-(aq)$

C $HC\ell(aq)$ and $OH^-(aq)$

D $C\ell^-(aq)$ and $H_3O^+(aq)$ (2)

1.9 An electrochemical cell is used to electroplate an iron spoon with nickel.

Which ONE of the following half-reactions takes place at the positive electrode of this cell?

A $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$

B $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$

C $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

D $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$ (2)

1.10 The following reaction reaches equilibrium in a closed container at a certain temperature:

$$2O_3(g) \rightleftharpoons 3O_2(g)$$

The pressure is now decreased by increasing the volume of the container at constant temperature.

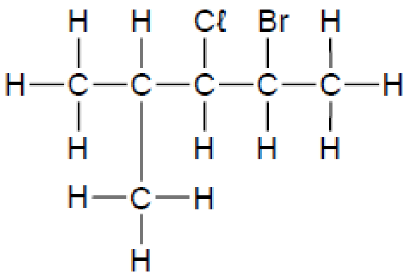
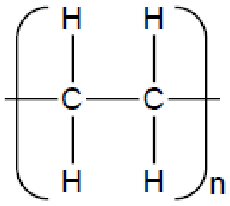
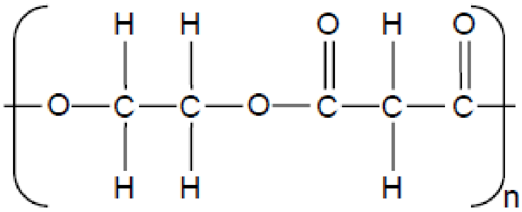
Which ONE of the following is correct as the reaction approaches a new equilibrium?

	NUMBER OF MOLES OF $O_3(g)$	NUMBER OF MOLES OF $O_2(g)$	CONCENTRATION OF $O_2(g)$
A	Increases	Decreases	Decreases
B	Decreases	Increases	Increases
C	Decreases	Increases	Decreases
D	Increases	Decreases	Increases

(2)
[20]

QUESTION 2 (Start on a new page.)

Consider the organic compounds represented by the letters **A** to **F** in the table below.

A	2,2,4-trimethylhexane	**B**	$CH_3CH_2CH_2CH_2CHO$
C		**D**	
E		**F**	Pentan-2-one

2.1 Write down the LETTER that represents the following:

2.1.1 An aldehyde (1)

2.1.2 A condensation polymer (1)

2.1.3 A compound which has a carbonyl group bonded to two carbon atoms as its functional group (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **C** (3)

2.2.2 The monomer of compound **D** (1)

2.3 Write down the structural formula of:

2.3.1 Compound **A** (2)

2.3.2 Compound **F** (2)

2.4 The table contains compounds which are functional isomers.

2.4.1 Define the term *functional isomer*. (2)

2.4.2 Write down the LETTERS that represent two compounds that are functional isomers. (1)

[14]

QUESTION 3 (Start on a new page.)

3.1 Give a reason why alkanes are *saturated* hydrocarbons. (1)

3.2 Write down the structural formula of:

3.2.1 The functional group of alcohols (1)

3.2.2 A tertiary alcohol that is a structural isomer of butan-1-ol (2)

3.3 Learners investigate factors that influence the boiling points of alkanes and alcohols. In one of the investigations they determine the boiling points of the first three alkanes.

3.3.1 Write down an investigative question for this investigation. (2)

3.3.2 Fully explain why the boiling point increases from methane to propane. (3)

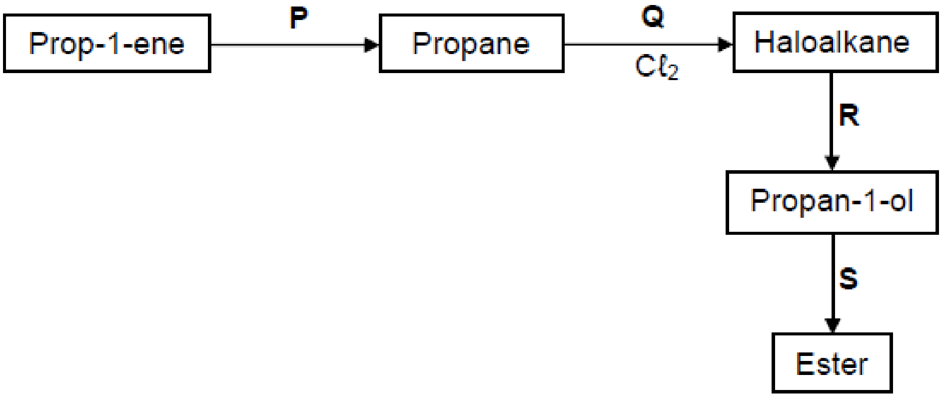
3.4 The learners find that the boiling point of propan-1-ol is higher than that of propane.

Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)

[12]

QUESTION 4 (Start on a new page.)

The flow diagram below shows the preparation of an ester using prop-1-ene as a starting reagent. **P**, **Q**, **R** and **S** represent different organic reactions.



4.1 Write down the type of reaction represented by:

4.1.1 **Q** (1)

4.1.2 **R** (1)

4.2 For reaction **P** write down the:

4.2.1 Type of addition reaction (1)

4.2.2 Balanced equation using structural formulae (3)

4.3 Write down the structural formula of the haloalkane formed in reaction **Q**. (2)

4.4 In reaction **S** propan-1-ol reacts with ethanoic acid to form the ester.

For this reaction write down the:

4.4.1 Name of the reaction that takes place (1)

4.4.2 FORMULA or NAME of the catalyst needed (1)

4.4.3 Structural formula of the ester formed (2)

4.4.4 IUPAC name of the ester formed (2)

4.5 The propan-1-ol formed in reaction **R** can be converted to prop-1-ene. Write down the FORMULA or NAME of the inorganic reagent needed. (1)

[15]

QUESTION 5 (Start on a new page.)

5.1 Define the term *reaction rate* in words. (2)

Learners use the reaction between IMPURE POWDERED calcium carbonate and excess hydrochloric acid to investigate reaction rate. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

They perform four experiments under different conditions of concentration, mass and temperature as shown in the table below. They use identical apparatus in the four experiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	**2**	**3**	**4**
Concentration of acid ($mol{\cdot}dm^{-3}$)	1	0,5	1	1
Mass of impure calcium carbonate (g)	15	15	15	25
Initial temperature of acid (°C)	30	30	40	40

5.2 The results of experiments **1** and **3** are compared in the investigation.

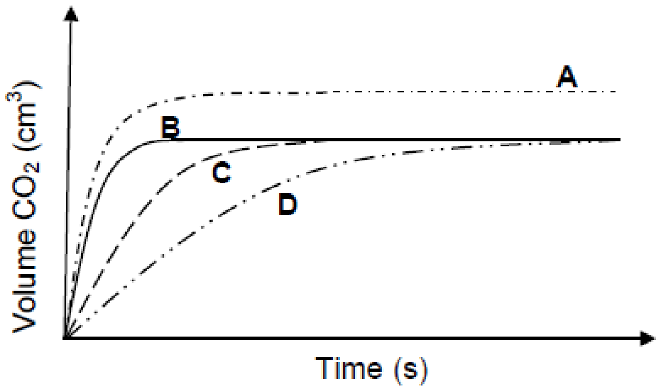
Write down the:

5.2.1 Independent variable (1)

5.2.2 Dependent variable (1)

5.3 Use the collision theory to explain why the reaction rate in experiment **4** will be higher than that in experiment **3**. (3)

The learners obtain graphs **A**, **B**, **C** and **D** below from their results.



5.4 Which ONE of the graphs (**A**, **B**, **C** or **D**) represents experiment **1**? Fully explain the answer by comparing experiment **1** with experiments **2**, **3** and **4**. (6)

5.5 When the reaction in experiment **4** reaches completion, the volume of gas formed is 4,5 dm^3. Assume that the molar gas volume at 40 °C is equal to 25,7 dm^3.

Calculate the mass of the impurities present in the calcium carbonate. (5)

[18]

QUESTION 6 (Start on a new page.)

A certain amount of nitrogen dioxide gas (NO_2) is sealed in a gas syringe at 25 °C. When equilibrium is reached, the volume occupied by the reaction mixture in the gas syringe is 80 cm^3. The balanced chemical equation for the reaction taking place is:

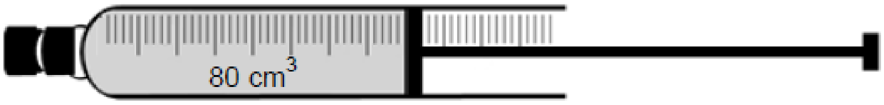
$$\underset{\text{dark brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{N_2O_4(g)} \qquad \Delta H < 0$$

6.1 Define the term *chemical equilibrium*. (2)

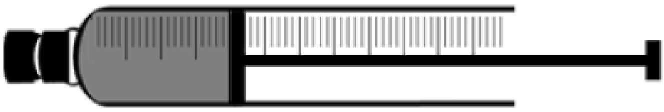
6.2 At equilibrium the concentration of the $NO_2(g)$ is 0,2 $mol \cdot dm^{-3}$. The equilibrium constant for the reaction is 171 at 25 °C.

Calculate the initial number of moles of $NO_2(g)$ placed in the gas syringe. (8)

6.3 The diagram below shows the reaction mixture in the gas syringe after equilibrium is established.

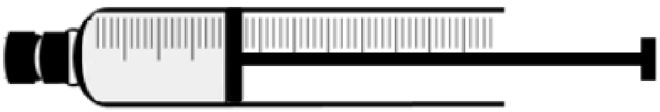


The pressure is now increased by decreasing the volume of the gas syringe at constant temperature as illustrated in the diagram below.



6.3.1 IMMEDIATELY after increasing the pressure, the colour of the reaction mixture in the gas syringe appears darker than before. Give a reason for this observation. (1)

After a while a new equilibrium is established as illustrated below. The colour of the reaction mixture in the gas syringe now appears lighter than the initial colour.



6.3.2 Use Le Chatelier's principle to explain the colour change observed in the gas syringe. (3)

6.4 The temperature of the reaction mixture in the gas syringe is now increased and a new equilibrium is established. How will each of the following be affected?

6.4.1 Colour of the reaction mixture
Write down only DARKER, LIGHTER or REMAINS THE SAME. (1)

6.4.2 Value of the equilibrium constant (K_c)
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[16]

QUESTION 7 (Start on a new page.)

7.1 Nitric acid (HNO_3), an important acid used in industry, is a strong acid.

7.1.1 Give a reason why nitric acid is classified as a strong acid. (1)

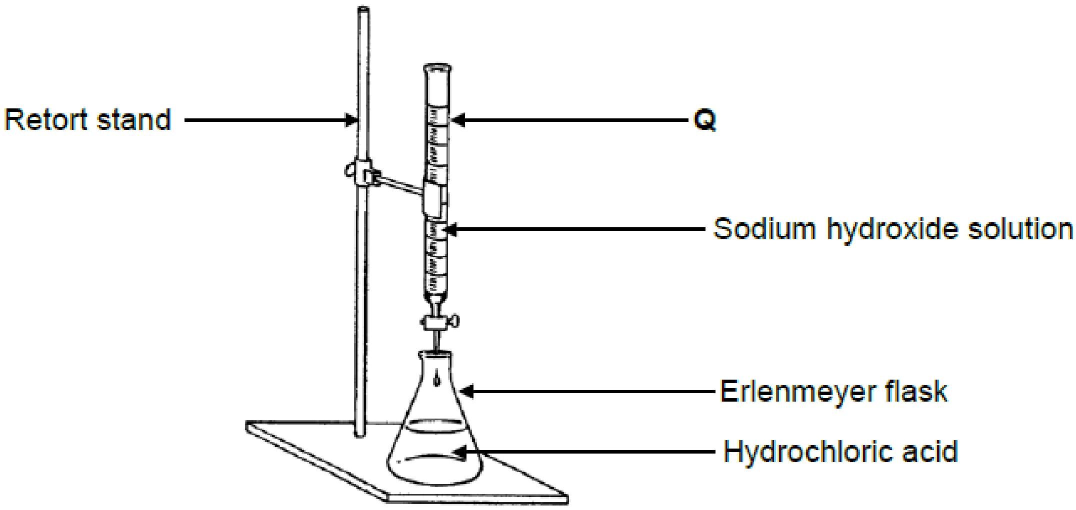
7.1.2 Write down the NAME or FORMULA of the conjugate base of nitric acid. (1)

7.1.3 Calculate the pH of a 0,3 mol·dm^{-3} nitric acid solution. (3)

7.2 A laboratory technician wants to determine the percentage purity of magnesium oxide. He dissolves a 4,5 g sample of the magnesium oxide in 100 cm^3 hydrochloric acid of concentration 2 mol·dm^{-3}.

7.2.1 Calculate the number of moles of hydrochloric acid added to the magnesium oxide. (3)

He then uses the apparatus below to titrate the EXCESS hydrochloric acid in the above solution against a sodium hydroxide solution.



7.2.2 Write down the name of apparatus **Q** in the above diagram. (1)

7.2.3 The following indicators are available for the titration:

INDICATOR	pH RANGE
A	3,1 – 4,4
B	6,0 – 7,6
C	8,3 – 10,0

Which ONE of the above indicators (**A**, **B** or **C**) is most suitable to indicate the exact endpoint in this titration? Give a reason for the answer. (3)

7.2.4 During the titration, the technician uses distilled water to wash any sodium hydroxide spilled against the sides of the Erlenmeyer flask into the solution.

Give a reason why the addition of distilled water to the Erlenmeyer flask will not influence the results. (1)

7.2.5 At the endpoint of the titration he finds that 21 cm^3 of a 0,2 mol dm^{-3} sodium hydroxide solution has neutralised the EXCESS hydrochloric acid.

Calculate the number of moles of hydrochloric acid in excess. (3)

7.2.6 The balanced equation for the reaction between hydrochloric acid and magnesium oxide is:

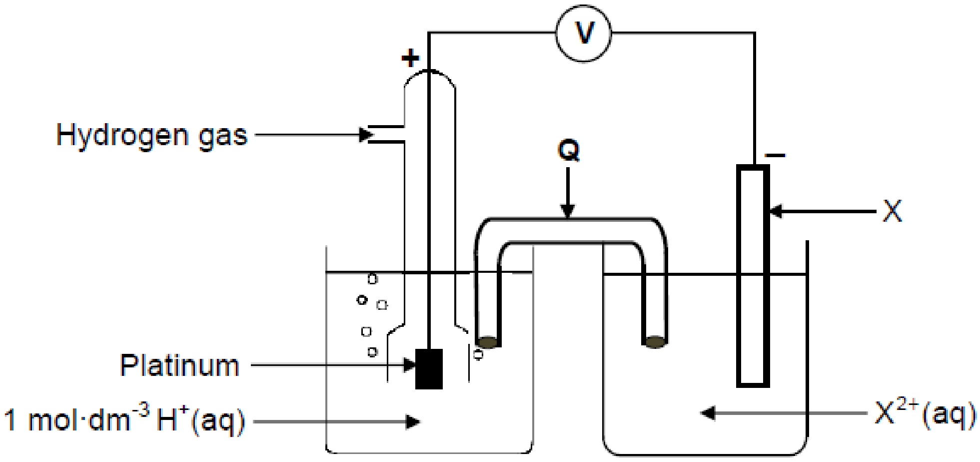
$$MgO(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + 2H_2O(\ell)$$

Calculate the percentage purity of the magnesium oxide. Assume that only the magnesium oxide in the 4,5 g sample reacted with the acid. (5)

[21]

QUESTION 8 (Start on a new page.)

A standard electrochemical cell is set up using a standard hydrogen half-cell and a standard $X|X^{2+}$ half-cell as shown below. A voltmeter connected across the cell, initially registers 0,31 V.



8.1 Besides concentration write down TWO conditions needed for the hydrogen half-cell to function under standard conditions. (2)

8.2 Give TWO reasons, besides being a solid, why platinum is suitable to be used as electrode in the above cell. (2)

8.3 Write down the:

8.3.1 NAME of component **Q** (1)

8.3.2 Standard reduction potential of the $X|X^{2+}$ half-cell (1)

8.3.3 Half-reaction that takes place at the cathode of this cell (2)

8.4 The hydrogen half-cell is now replaced by a **M**|**M**$^{2+}$ half-cell. The cell notation of this cell is:

$$\mathbf{M}(s) \mid \mathbf{M}^{2+}(aq) \parallel X^{2+}(aq) \mid X(s)$$

The initial reading on the voltmeter is now 2,05 V.

8.4.1 Identify metal **M**. Show how you arrived at the answer. (5)

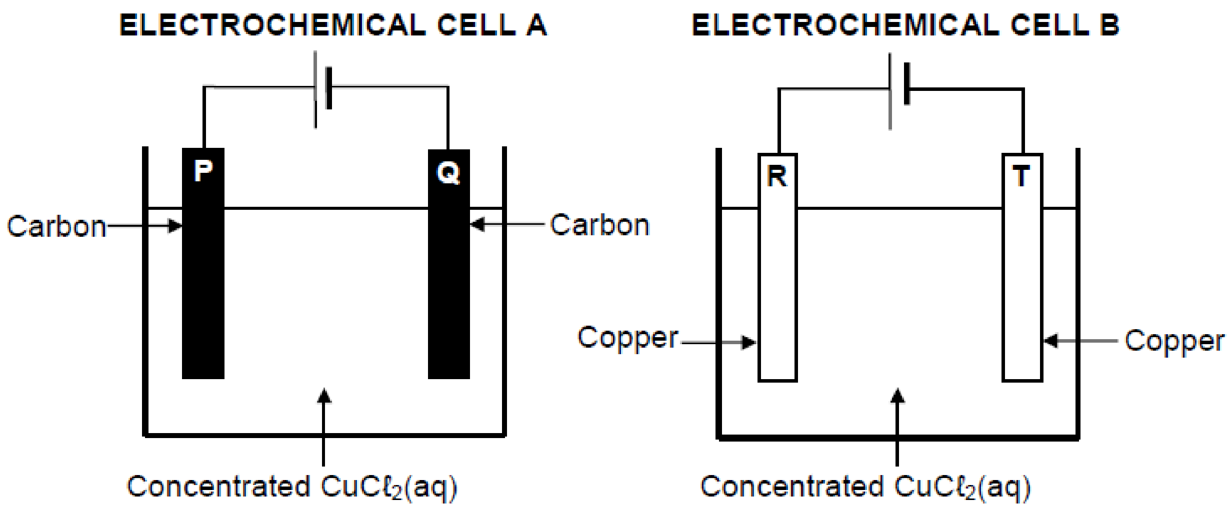
8.4.2 Is the cell reaction EXOTHERMIC or ENDOTHERMIC? (1)

8.5 The reading on the voltmeter becomes zero after using this cell for several hours. Give a reason for this reading by referring to the cell reaction. (1)

[15]

QUESTION 9 (Start on a new page.)

The simplified diagrams below represent two electrochemical cells, **A** and **B**. A concentrated copper(II) chloride solution is used as electrolyte in both cells.



9.1 Are **A** and **B** ELECTROLYTIC or GALVANIC cells? (1)

9.2 Which of the electrodes (**P**, **Q**, **R** or **T**) will show a mass increase? Write down a half-reaction to motivate the answer. (4)

9.3 Write down the NAME or FORMULA of the product formed at:

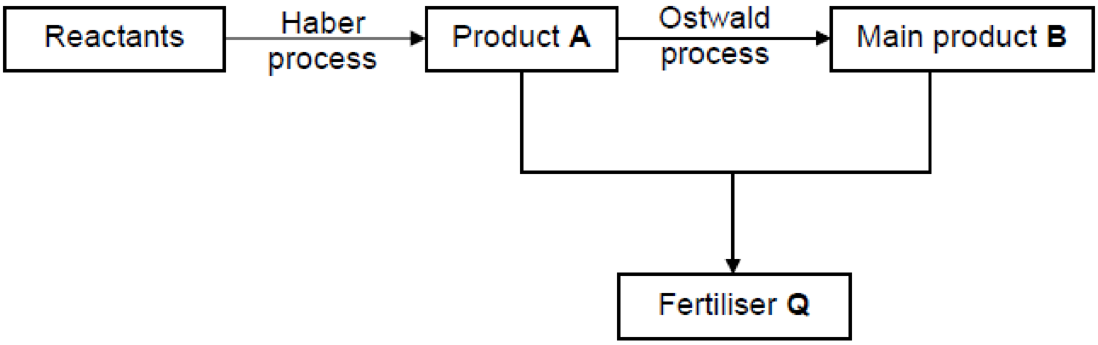
9.3.1 Electrode **P** (1)

9.3.2 Electrode **R** (1)

9.4 Fully explain the answer to QUESTION 9.3.2 by referring to the relative strengths of the reducing agents involved. (3)
[10]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows the processes involved in the industrial preparation of fertiliser **Q**.

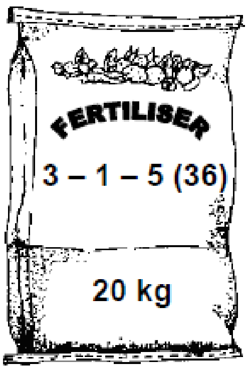


Write down the:

10.1.1 NAMES or FORMULAE of the reactants used in the Haber process (2)

10.1.2 Balanced equation for the formation of fertiliser **Q** (3)

10.2 The diagram below shows a bag of NPK fertiliser.



Calculate the mass of nitrogen in the bag. (4)
[9]

TOTAL: 150

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2015

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. 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 forces always acts perpendicular to the surface on which a body is placed?

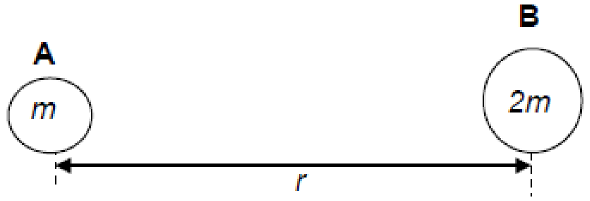
A Normal force

B Frictional force

C Gravitational force

D Tension force (2)

1.2 Two isolated bodies, **A** and **B**, having masses *m* and 2*m* respectively, are placed a distance *r* apart.



Consider the following statements regarding the gravitational force exerted by the bodies on each other.

(i) The force exerted by **B** on body **A** is half that exerted by **A** on body **B**.

(ii) The force exerted on the bodies is independent of the masses of the bodies.

(iii) The force exerted on body **A** by **B** is equal but opposite to that exerted on body **B** by **A**.

(iv) The forces will always be attractive.

Which of the statements above is/are TRUE?

A (i), (ii) and (iv) only

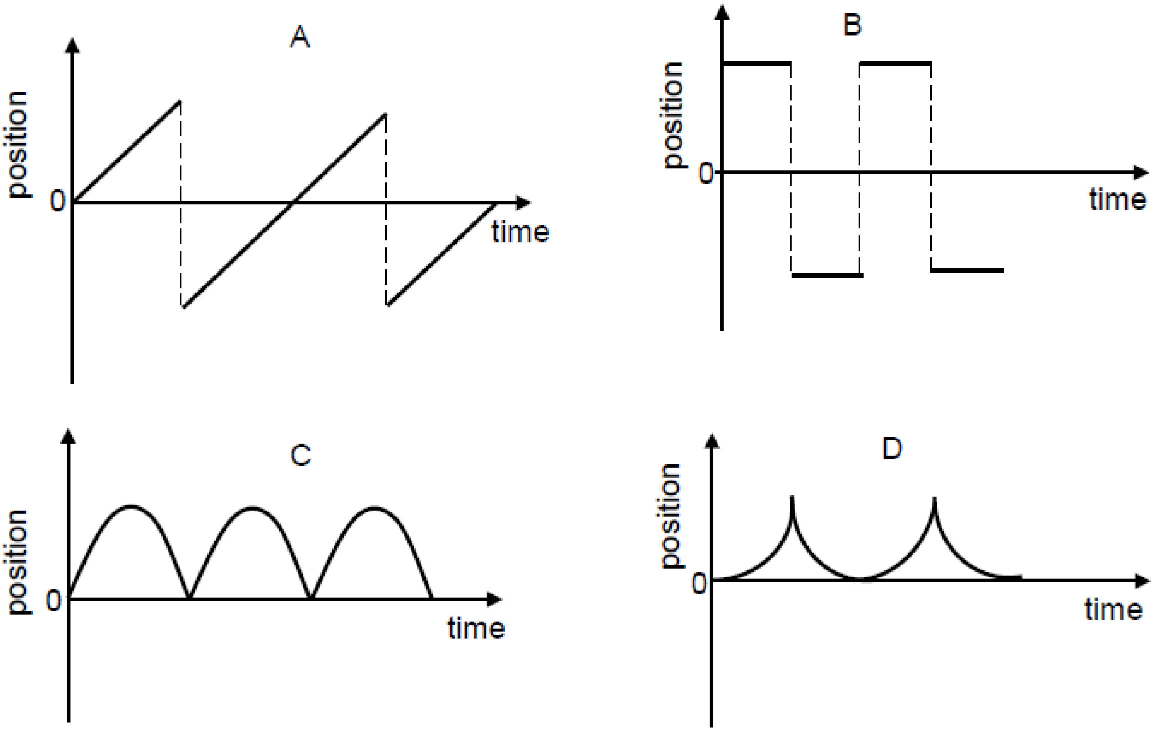
B (ii), (iii) and (iv) only

C (iii) and (iv) only

D (iv) only (2)

1.3 A ball is released from a height above the floor. The ball falls vertically and bounces off the floor a number of times. Ignore the effects of friction and assume that the collision of the ball with the floor is elastic. Take the point of release of the ball as the reference point and downward direction as positive.

Which ONE of the following is a CORRECT representation of the position-time graph for the motion of the ball?



(2)

1.4 Two bodies undergo an INELASTIC collision in the absence of friction. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	Not conserved	Conserved
B	Conserved	Not conserved
C	Not conserved	Not conserved
D	Conserved	Conserved

(2)

1.3 A ball is released from a height above the floor. The ball falls vertically and bounces off the floor a number of times. Ignore the effects of friction and assume that the collision of the ball with the floor is elastic. Take the point of release of the ball as the reference point and downward direction as positive.

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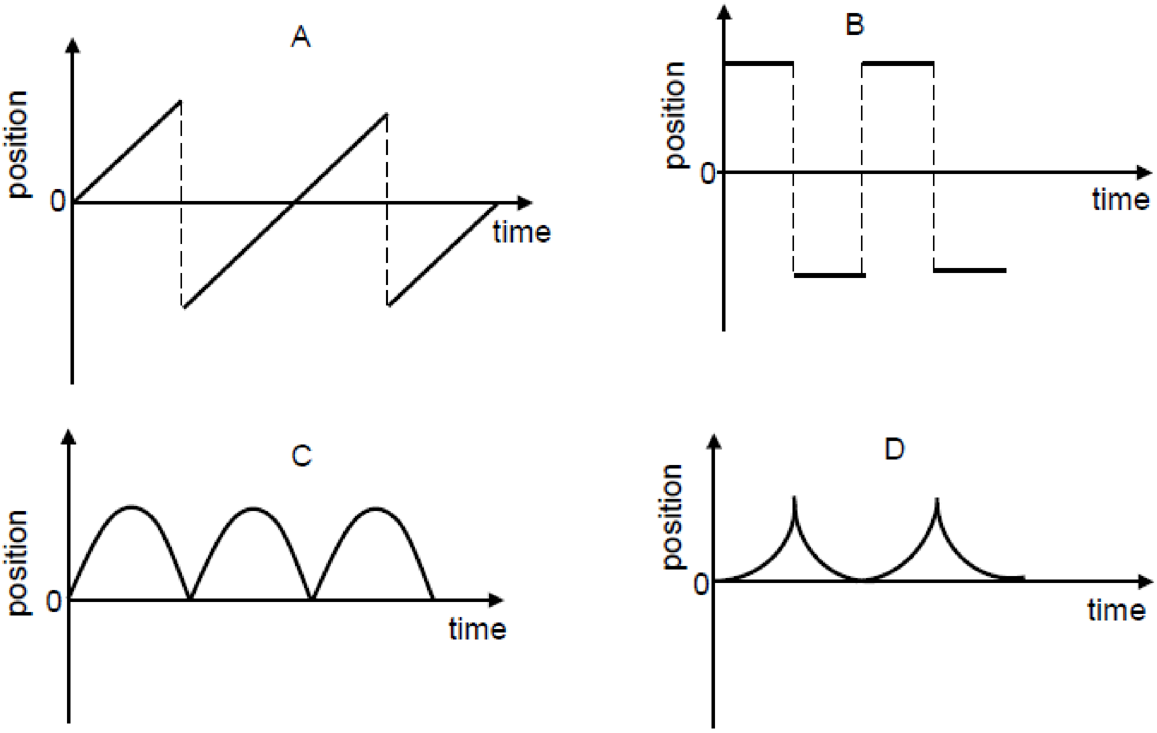


(2)

1.4 Two bodies undergo an INELASTIC collision in the absence of friction. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	Not conserved	Conserved
B	Conserved	Not conserved
C	Not conserved	Not conserved
D	Conserved	Conserved

(2)

1.5 The speed of a bicycle increases from 2 $m \cdot s^{-1}$ to 8 $m \cdot s^{-1}$. Its kinetic energy increases by a factor of …

A 4.

B 6.

C 8.

D 16. (2)

1.6 Which ONE of the following CANNOT be explained using the Doppler effect?

A Emission of electrons from a metal surface

B 'Flow meters' used in hospitals

C Red spectral lines from distant stars being shifted

D Observed frequency of light from moving bodies being higher than expected (2)

1.7 The magnitude of an electric field, a distance *r* from a point charge is ***E***. The magnitude of an electric field, a distance 2*r* from the same point charge will be …

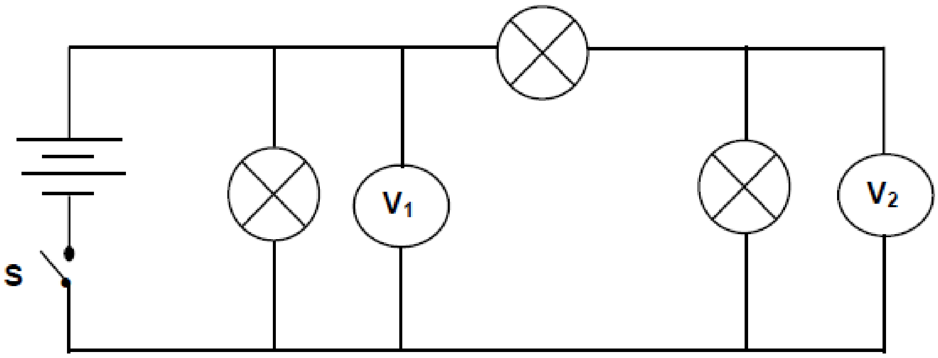
A $\frac{1}{4}\boldsymbol{E}$

B $\frac{1}{2}\boldsymbol{E}$

C $2\boldsymbol{E}$

D $4\boldsymbol{E}$ (2)

1.8 Three identical light bulbs are connected in a circuit as shown below. The resistances of the battery and connecting wires can be ignored.



Which ONE of the following statements is CORRECT when switch **S** is closed?

The reading on $\mathbf{V_1}$ is …

A half that on $\mathbf{V_2}$.

B equal to that on $\mathbf{V_2}$.

C twice that on $\mathbf{V_2}$.

D three times that on $\mathbf{V_2}$. (2)

1.9 The speed of rotation of the coils in an AC generator is increased. Which ONE of the following combinations of frequency and output voltage for the generator will occur as a result of the change?

	FREQUENCY	OUTPUT VOLTAGE
A	Increases	Increases
B	No change	Increases
C	Decreases	Decreases
D	Increases	No change

(2)

1.10 The spectrum of an element from a star shows some absorption lines. These lines are produced because …

A atoms absorb energy when moving from an excited state to a lower energy state.

B a cold gas absorbs certain frequencies of light passing through it.

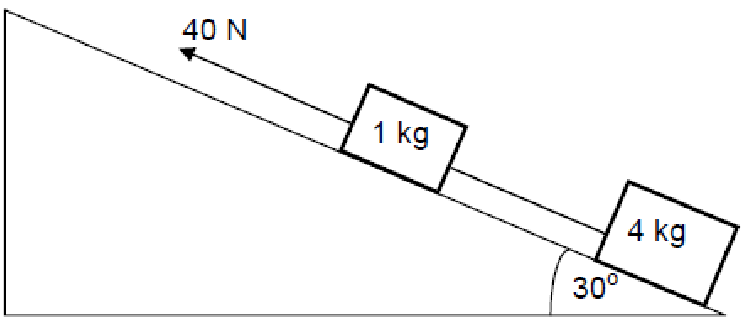
C a hot gas absorbs certain frequencies of light passing through it.

D atoms release energy when moving from an excited state to a lower energy state. (2)

[20]

QUESTION 2 (Start on a new page.)

A block of mass 1 kg is connected to another block of mass 4 kg by a light inextensible string. The system is pulled up a rough plane inclined at 30° to the horizontal, by means of a constant 40 N force parallel to the plane as shown in the diagram below.



The magnitude of the kinetic frictional force between the surface and the 4 kg block is 10 N. The coefficient of kinetic friction between the 1 kg block and the surface is 0,29.

2.1 State Newton's third law in words. (2)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on the **1 kg block** as it moves up the incline. (5)

2.3 Calculate the magnitude of the:

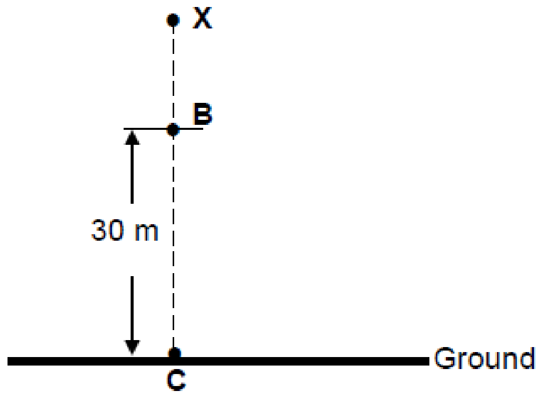
2.3.1 Kinetic frictional force between the 1 kg block and the surface (3)

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

[16]

QUESTION 3 (Start on a new page.)

An object is released from rest from a point **X,** above the ground as shown in the diagram below. It travels the last 30 m (**BC**) in 1,5 s before hitting the ground. Ignore the effects of air friction.



3.1 Name the type of motion described above. (1)

3.2 Calculate the:

3.2.1 Magnitude of the velocity of the object at point **B** (4)

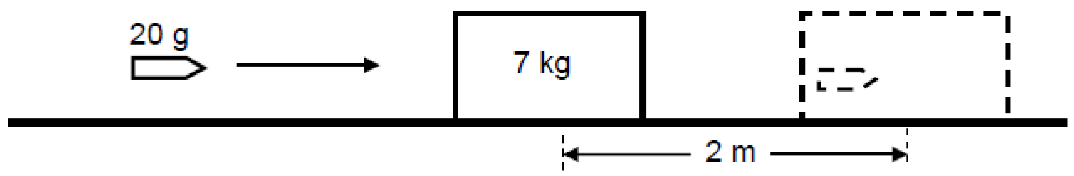
3.2.2 Height of point **X** above the ground (5)

After hitting the ground, the object bounces once and then comes to rest on the ground.

3.3 Sketch an acceleration-time graph for the entire motion of the object. (3)
[13]

QUESTION 4 (Start on a new page.)

The diagram below shows a bullet of mass 20 g that is travelling horizontally. The bullet strikes a stationary 7 kg block and becomes embedded in it. The bullet and block together travel on a rough horizontal surface a distance of 2 m before coming to a stop.



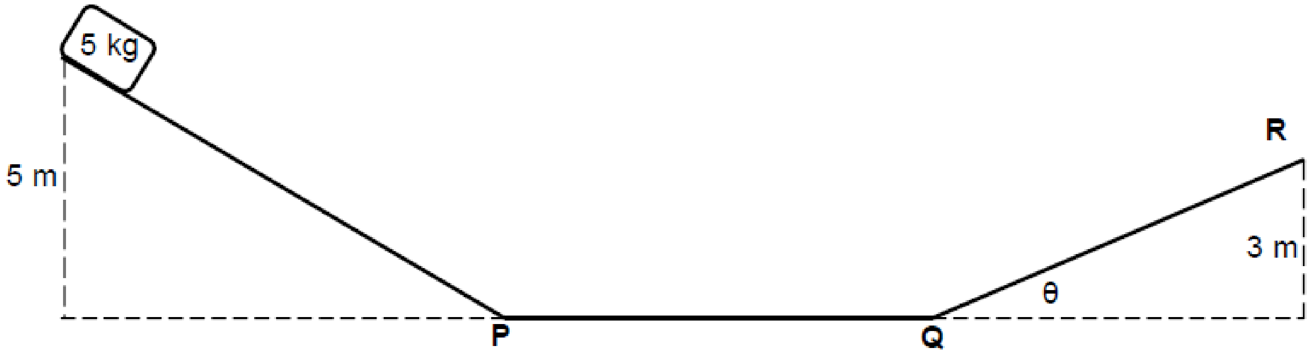
4.1 Use the work-energy theorem to calculate the magnitude of the velocity of the bullet-block system immediately after the bullet strikes the block, given that the frictional force between the block and surface is 10 N. (5)

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

4.3 Calculate the magnitude of the velocity with which the bullet hits the block. (4)
[11]

QUESTION 5 (Start on a new page.)

A 5 kg block is released from rest from a height of 5 m and slides down a frictionless incline to point **P** as shown in the diagram below. It then moves along a frictionless horizontal portion **PQ** and finally moves up a second rough inclined plane. It comes to a stop at point **R** which is 3 m above the horizontal.



The frictional force, which is a non-conservative force, between the surface and the block is 18 N.

5.1 Using ENERGY PRINCIPLES only, calculate the speed of the block at point **P**. (4)

5.2 Explain why the kinetic energy at point **P** is the same as that at point **Q**. (2)

5.3 Explain the term *non-conservative force.* (2)

5.4 Calculate the angle (θ) of the slope **QR**. (7)
[15]

QUESTION 6 (Start on a new page.)

The Doppler effect is applicable to both sound and light waves. It also has very important applications in our everyday lives.

6.1 A hooter on a <u>stationary</u> train emits sound with a frequency of 520 Hz, as detected by a person standing on the platform. Assume that the speed of sound is 340 $m \cdot s^{-1}$ in still air.

Calculate the:

6.1.1 Wavelength of the sound detected by the person (2)

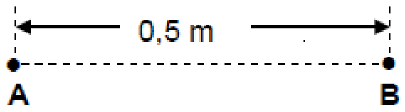
6.1.2 Wavelength of the sound detected by the person when the train moves towards him/her at a constant speed of 15 $m \cdot s^{-1}$ with the hooter still emitting sound (6)

6.2 Explain why the wavelength calculated in QUESTION 6.1.1 differs from that obtained in QUESTION 6.1.2. (2)

6.3 Use your knowledge of the Doppler effect to explain *red shifts.* (2)
[12]

QUESTION 7 (Start on a new page.)

Two identical negatively charged spheres, **A** and **B**, having charges of the **same magnitude**, are placed 0,5 m apart in vacuum. The magnitude of the electrostatic force that one sphere exerts on the other is 1,44 x 10^{-1} N.



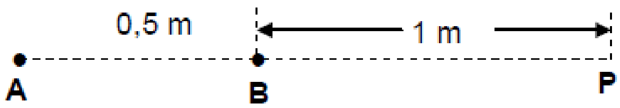
7.1 State Coulomb's law in words. (2)

7.2 Calculate the:

7.2.1 Magnitude of the charge on each sphere (4)

7.2.2 Excess number of electrons on sphere **B** (3)

7.3 **P** is a point at a distance of 1 m from sphere **B**.



7.3.1 What is the direction of the net electric field at point **P**? (1)

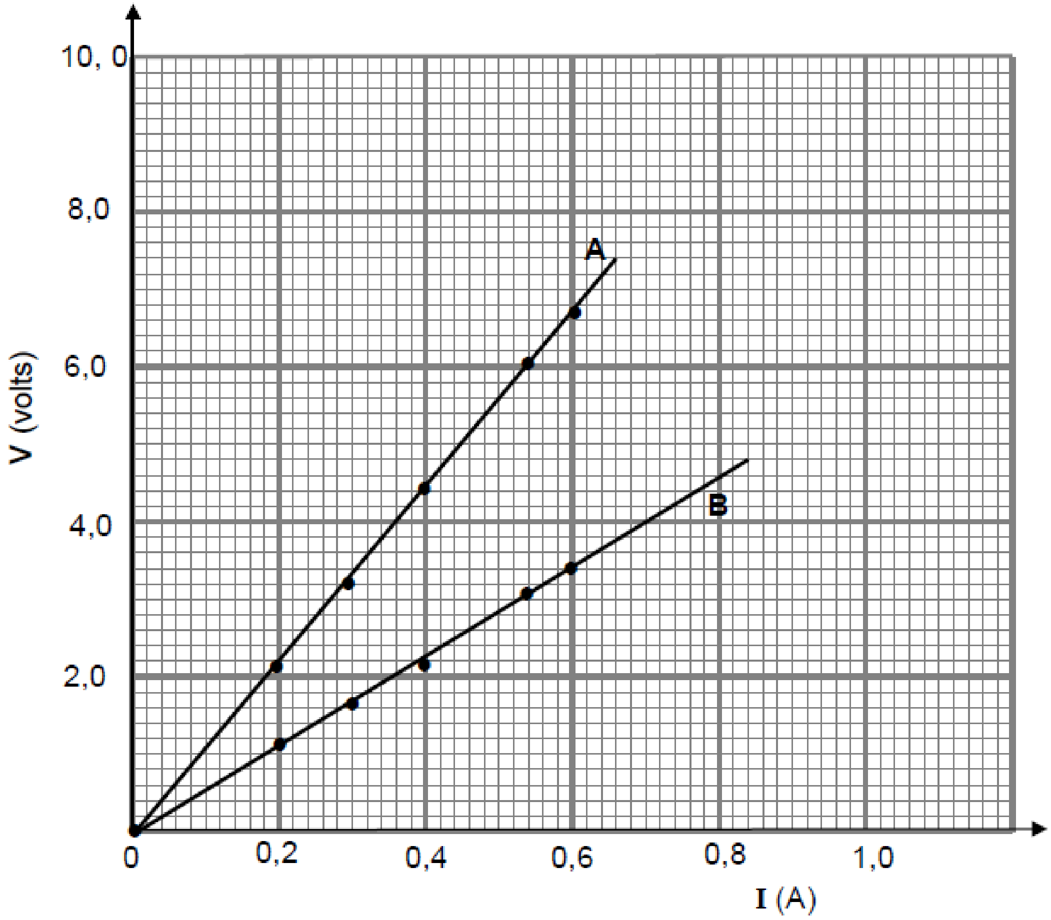
7.3.2 Calculate the number of electrons that should be removed from sphere **B** so that the net electric field at point **P** is 3 x 10^4 N·C^{-1} to the right. (8)

[18]

QUESTION 8 (Start on a new page.)

8.1 Learners want to construct an electric heater using one of two wires, **A** and **B**, of different resistances. They conduct experiments and draw the graphs as shown below.

Graph of V versus I for resistors A and B

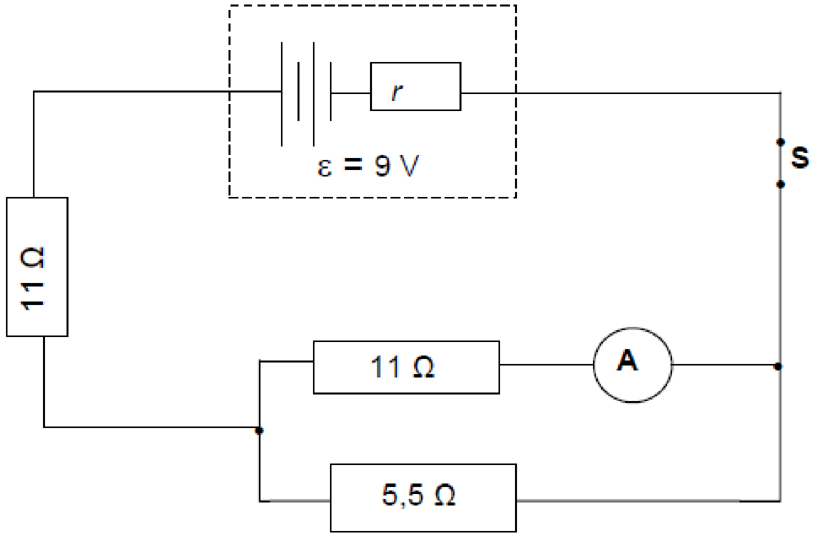


8.1.1 Apart from temperature, write down TWO other factors that the learners should consider to ensure a fair test when choosing which wire to use. (2)

8.1.2 Assuming all other factors are kept constant, state which ONE of the two wires will be the most suitable to use in the heater.

Use suitable calculations to show clearly how you arrive at the answer. (8)

8.2 In the circuit below the reading on ammeter **A** is 0,2 A. The battery has an emf of 9 V and internal resistance *r*.



8.2.1 Calculate the current through the 5,5 Ω resistor. (3)

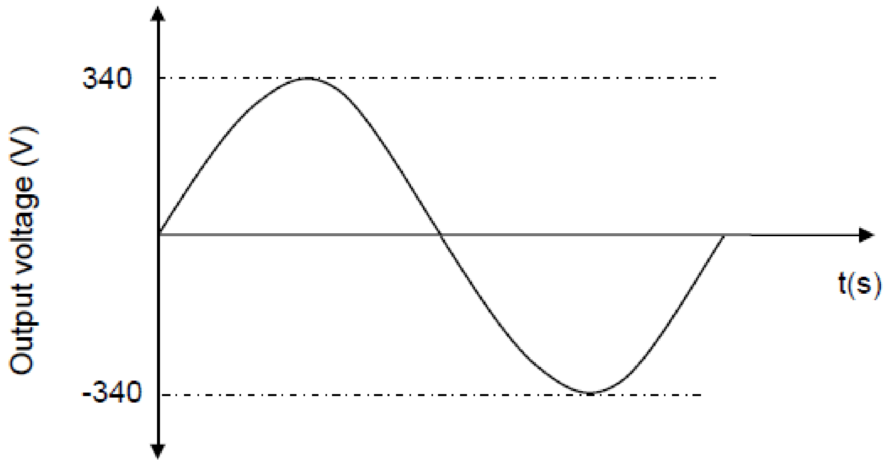
8.2.2 Calculate the internal resistance of the battery. (7)

8.2.3 Will the ammeter reading INCREASE, DECREASE or REMAIN THE SAME if the 5,5 Ω resistor is removed from the circuit? Give a reason for the answer. (2)

[22]

QUESTION 9 (Start on a new page.)

The graph below shows the output voltage from a household AC generator for one cycle of rotation of the coils.



9.1 A 100 W light bulb is connected to this generator and it glows at its maximum brightness. Use the information from the graph to calculate the:

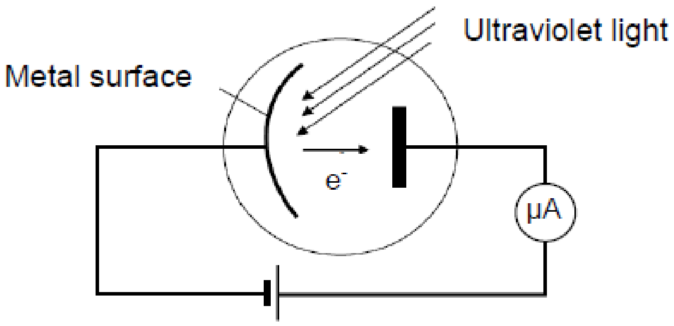
9.1.1 Resistance of the bulb (5)

9.1.2 rms current through the bulb (3)

9.2 Give ONE reason why AC voltage is preferred to DC voltage for everyday use. (1)
[9]

QUESTION 10 (Start on a new page.)

A learner uses photocells to determine the maximum kinetic energy of ejected photoelectrons. One photocell has a caesium cathode and the other has a sodium cathode. Each photocell is radiated by ultraviolet light from the same source as shown below.



The incomplete results obtained are shown in the table below.

NAME OF THE METAL	WORK FUNCTION OF THE METAL (J)	MAXIMUM KINETIC ENERGY OF PHOTOELECTRONS (J)
Caesium	$3,36 \times 10^{-19}$	$2,32 \times 10^{-19}$
Sodium	$3,65 \times 10^{-19}$	E_K

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

10.2 Use the information in the table to calculate the wavelength of the ultraviolet light used in the experiment. (4)

10.3 Calculate the maximum kinetic energy, E_K, of an electron ejected from the sodium metal. (4)

10.4 The intensity of the incident ultraviolet light was then increased.

10.4.1 Give a reason why this change does NOT affect the maximum kinetic energy of the ejected photoelectrons. (1)

10.4.2 How does the increased intensity affect the reading on the ammeter? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

10.4.3 Explain the answer to QUESTION 10.4.2. (2)
[14]

TOTAL: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)

FEBRUARY/MARCH 2015

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. 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 compounds is an aldehyde?

A Pentanal

B Pentan-2-ol

C Pentan-2-one

D Ethyl propanoate (2)

1.2 Consider the reaction represented by the equation below:

$$CH_3CHCH_2 + H_2 \rightarrow CH_3CH_2CH_3$$

This reaction is an example of …

A hydration.

B dehydration.

C substitution.

D hydrogenation. (2)

1.3 Which ONE of the following is a CORRECT description for a 0,1 $mol{\cdot}dm^{-3}$ hydrochloric acid solution?

A Dilute strong acid

B Dilute weak acid

C Concentrated weak acid

D Concentrated strong acid (2)

1.4 Eutrophication involves the following stages:

(i) Increase in growth of algae
(ii) Increase in nitrate concentration
(iii) Death of fish
(iv) Decrease in oxygen concentration

Which ONE of the following CORRECTLY represents the order in which these stages occur?

A (i) (ii) (iii) (iv)

B (i) (ii) (iv) (iii)

C (ii) (i) (iii) (iv)

D (ii) (i) (iv) (iii) (2)

1.5 Consider the reaction represented by the balanced equation below:

$$A_2(g) + B_2(g) \rightarrow 2AB(g)$$

The activation energy for the forward reaction is 180 kJ and that for the reverse reaction is 200 kJ.

The heat of reaction (ΔH) is ...

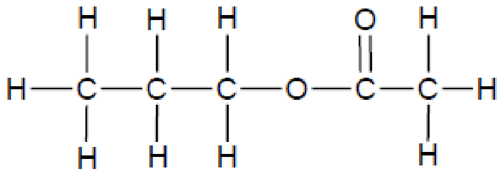
A + 20 kJ.

B - 20 kJ.

C + 380 kJ.

D - 380 kJ. (2)

1.6 Consider the structural formula of a compound below.



Which ONE of the following pairs of reactants can be used to prepare this compound in the laboratory?

A Propanoic acid and ethanol

B Propanoic acid and methanol

C Ethanoic acid and propan-1-ol

D Methanoic acid and propan-1-ol (2)

1.7 The reaction of an acid-base indicator, represented as HIn(aq), with $H_2O(\ell)$ reaches equilibrium according to the following balanced equation:

$$\underset{\text{yellow}}{HIn(aq)} + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \underset{\text{purple}}{In^-(aq)} \qquad \Delta H > 0$$

At equilibrium the colour of the solution is purple.

Which ONE of the following will change the colour of the solution from purple to yellow?

A Add NaOH(aq)

B Add HCℓ(aq)

C Add water

D Increase the temperature (2)

1.8 Which ONE of the following metals will NOT react spontaneously with sulphuric acid?

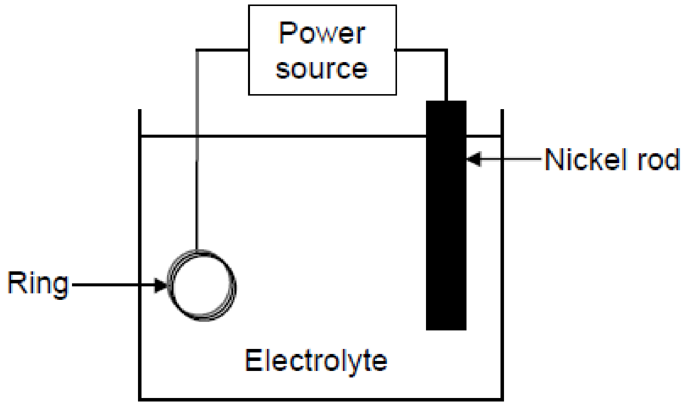
A Zn

B Mg

C Cu

D Fe (2)

1.9 A learner wants to electroplate a copper ring with nickel. He uses the experimental set-up shown in the simplified diagram below.



Which ONE of the following is CORRECT?

	ANODE	CATHODE	ELECTROLYTE
A	Copper ring	Nickel rod	$CuSO_4$
B	Nickel rod	Copper ring	$CuSO_4$
C	Copper ring	Nickel rod	$NiSO_4$
D	Nickel rod	Copper ring	$NiSO_4$

(2)

1.10 Consider the equilibrium constants for the same reaction at two different temperatures below.

298 K: K_c = 0,03

318 K: K_c = 0,005

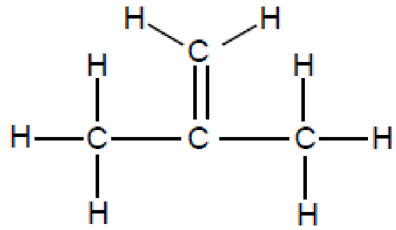
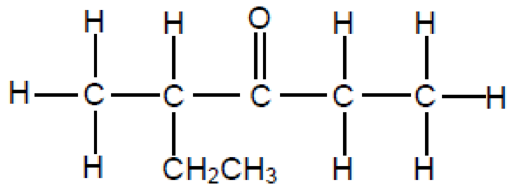
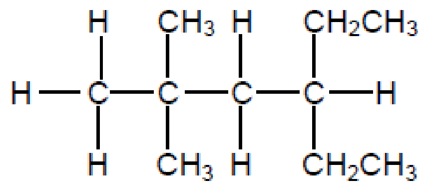
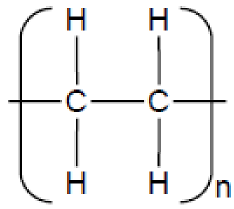
Which ONE of the following is CORRECT?

	HEAT OF REACTION	**YIELD OF PRODUCTS AS THE TEMPERATURE INCREASES**
A	$\Delta H > 0$	Increases
B	$\Delta H < 0$	Decreases
C	$\Delta H > 0$	Decreases
D	$\Delta H < 0$	Remains the same

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A		**B**	2-methylbutanoic acid
C		**D**	
E	But-2-ene	**F**	

2.1 Write down the:

2.1.1 NAME of the functional group of compound **B** (1)

2.1.2 Homologous series to which compound **C** belongs (1)

2.1.3 Type of polymerisation reaction that produces compound **F** (1)

2.2 Write down the IUPAC name of:

2.2.1 The monomer used to prepare compound **F** (1)

2.2.2 Compound **C** (2)

2.2.3 Compound **D** (2)

2.3 Write down the NAME or FORMULA of each product formed during the complete combustion of compound **D**. (2)

2.4 Write down the structural formula of:

2.4.1 Compound **B** (2)

2.4.2 A CHAIN ISOMER of compound **A** (2)

2.5 A laboratory assistant uses bromine water to distinguish between compounds **D** and **E**. She adds bromine water to a sample of each in two different test tubes. She observes that the one compound decolourises the bromine water immediately, whilst the other one only reacts after placing the test tube in direct sunlight.

Write down the:

2.5.1 Letter (**D** or **E**) of the compound that will immediately decolourise the bromine water (1)

2.5.2 Name of the type of reaction that takes place in the test tube containing compound **D** (1)

2.5.3 Structural formula of the organic product formed in the test tube containing compound **E** (2)

[18]

QUESTION 3 (Start on a new page.)

Learners use compounds **A** to **C**, shown in the table below, to investigate a factor which influences the boiling point of organic compounds.

A	$CH_3CH_2CH_2CH_3$
B	$CH_3CH_2CH_2CH_2CH_3$
C	$CH_3CH_2CH_2CH_2CH_2CH_3$

3.1 Which ONE of the compounds (**A**, **B** or **C**) has the highest boiling point? (1)

3.2 For this investigation, write down the:

3.2.1 Independent variable (1)

3.2.2 Dependent variable (1)

3.3 Write down the name of the type of Van der Waals force that occurs between the molecules of compound **B**. (1)

3.4 How will the vapour pressure of 2-methylpentane compare to that of compound **C**? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

The learners now compare the boiling points of compounds **D** and **E**, shown in the table below.

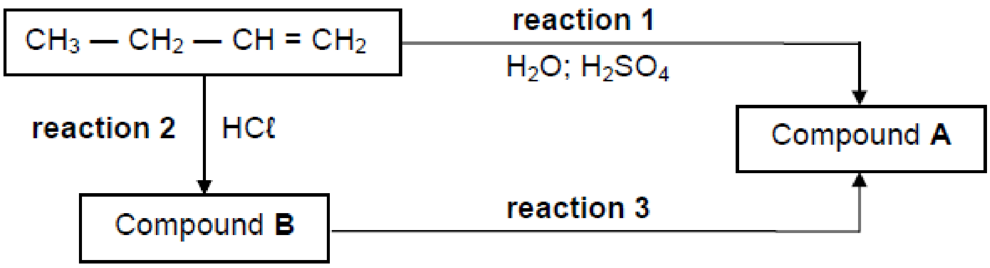
D	$CH_3CH_2CH_2CH_2CH_2OH$
E	$CH_3CH_2CH_2COOH$

3.5 How does the boiling point of compound **D** compare to that of compound **E**? Write down HIGHER THAN, LOWER THAN or EQUAL TO. Fully explain the answer. (4)

[9]

QUESTION 4 (Start on a new page.)

In the flow diagram below, but-1-ene is used as starting material in the preparation of compound **A**.



4.1 Is but-1-ene a SATURATED or UNSATURATED compound? Give a reason for the answer. (2)

4.2 Compound **A** is the major product formed in **reaction 1**.

Write down the:

4.2.1 Structural formula of compound **A** (2)

4.2.2 Type of reaction that takes place (1)

4.3 For compound **B**, write down the:

4.3.1 IUPAC name (2)

4.3.2 Structural formula of the positional isomer (2)

4.4 For **reaction 3**, write down:

4.4.1 TWO reaction conditions needed (2)

4.4.2 The type of reaction that occurs (1)

4.4.3 A balanced equation, using molecular formulae (3)

[15]

QUESTION 5 (Start on a new page.)

A group of learners uses the reaction of EXCESS hydrochloric acid ($HC\ell$) with zinc (Zn) to investigate factors which influence reaction rate. The balanced equation for the reaction is:

$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

They use the same volume of hydrochloric acid and 1,2 g of zinc in each of five experiments. The reaction conditions and temperature readings before and after completion of the reaction in each experiment are summarised in the table below.

Experiment	REACTION CONDITIONS				Time (s)
	Concentration of $HC\ell$ ($mol\cdot dm^{-3}$)	Temperature (°C)		State of division of the 1,2 g of Zn	
		Before	After		
1	0,5	20	34	granules	50
2	0,5	20	35	powder	10
3	0,8	20	36	powder	6
4	0,5	35	50	granules	8
5	0,5	20	34	granules	11

5.1 Is the reaction between hydrochloric acid and zinc EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer by referring to the data in the table. (2)

5.2 Give a reason for the difference in reaction rate observed for **Experiments 1** and **2**. (1)

5.3 The learners compare the results of **Experiments 1** and **3** to draw a conclusion regarding the effect of concentration on reaction rate. Give a reason why this is not a fair comparison. (1)

5.4 How does the rate of the reaction in **Experiment 5** compare to that in **Experiment 1**? Write down FASTER THAN, SLOWER THAN or EQUAL TO.

Write down the factor responsible for the difference in the rate of reaction and fully explain, by referring to the collision theory, how this factor affects reaction rate. (5)

5.5 Calculate the rate at which the hydrochloric acid reacts in **Experiment 4** in $mol\cdot s^{-1}$. (6)

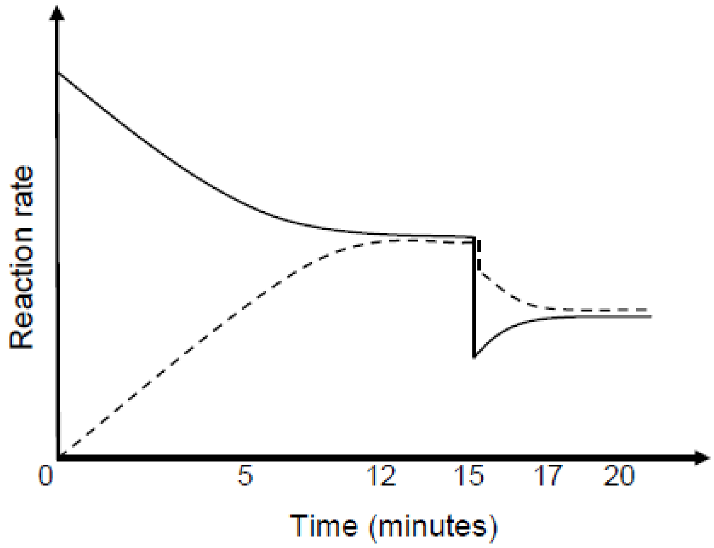
[15]

QUESTION 6 (Start on a new page.)

Pure hydrogen iodide, sealed in a 2 dm^3 container at 721 K, decomposes according to the following balanced equation:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H = +26\ kJ{\cdot}mol^{-1}$$

The graph below shows how reaction rate changes with time for this reversible reaction.



6.1 Write down the meaning of the term *reversible reaction*. (1)

6.2 How does the concentration of the reactant change between the 12th and the 15th minute? Write down only INCREASES, DECREASES or NO CHANGE. (1)

6.3 The rates of both the forward and the reverse reactions suddenly change at t = 15 minutes.

6.3.1 Give a reason for the sudden change in reaction rate. (1)

6.3.2 Fully explain how you arrived at the answer to QUESTION 6.3.1. (3)

The equilibrium constant (K_c) for the forward reaction is 0,02 at 721 K.

6.4 At equilibrium it is found that 0,04 mol HI(g) is present in the container. Calculate the concentration of $H_2(g)$ at equilibrium. (6)

6.5 Calculate the equilibrium constant for the reverse reaction. (1)

6.6 The temperature is now increased to 800 K. How will the value of the equilibrium constant (K_c) for the forward reaction change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[14]

QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid is a diprotic acid.

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Give a reason why sulphuric acid is referred to as *a diprotic acid*. (1)

7.2 The hydrogen carbonate ion <u>can act as both an acid and a base</u>. It reacts with water according to the following balanced equation:

$$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$$

7.2.1 Write down ONE word for the underlined phrase. (1)

7.2.2 $HCO_3^-(aq)$ acts as base in the above reaction. Write down the formula of the conjugate acid of $HCO_3^-(aq)$. (1)

7.3 A learner accidentally spills some sulphuric acid of concentration 6 mol·dm^{-3} from a flask on the laboratory bench. Her teacher tells her to neutralise the spilled acid by sprinkling sodium hydrogen carbonate powder onto it. The reaction that takes place is: (Assume that the H_2SO_4 ionises completely.)

$$H_2SO_4(aq) + 2NaHCO_3(s) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell) + 2CO_2(g)$$

The fizzing, due to the formation of carbon dioxide, stops after the learner has added 27 g sodium hydrogen carbonate to the spilled acid.

7.3.1 Calculate the volume of sulphuric acid that spilled. Assume that all the sodium hydrogen carbonate reacts with all the acid. (6)

The learner now dilutes some of the 6 mol·dm^{-3} sulphuric acid solution in the flask to 0,1 mol·dm^{-3}.

7.3.2 Calculate the volume of the 6 mol·dm^{-3} sulphuric acid solution needed to prepare 1 dm^3 of the dilute acid. (2)

During a titration 25 cm^3 of the 0,1 mol·dm^{-3} sulphuric acid solution is added to an Erlenmeyer flask and titrated with a 0,1 mol·dm^{-3} sodium hydroxide solution.

7.3.3 The learner uses bromothymol blue as indicator. What is the purpose of this indicator? (1)

7.3.4 Calculate the pH of the solution in the flask after the addition of 30 cm^3 of sodium hydroxide. The endpoint of the titration is not yet reached at this point. (8)

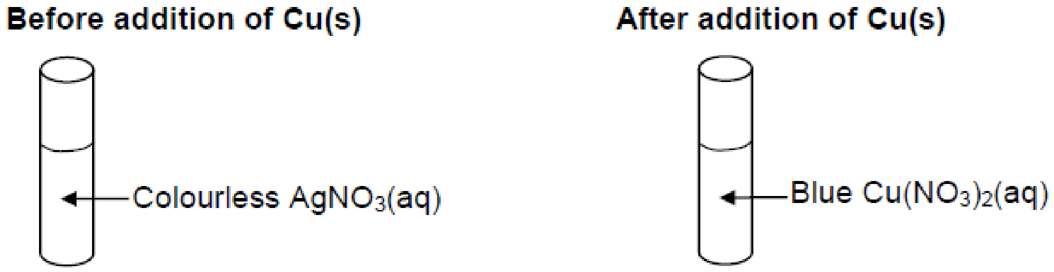
[22]

QUESTION 8 (Start on a new page.)

A learner conducts two experiments to investigate the reaction between copper (Cu) and a silver nitrate solution, $AgNO_3(aq)$.

EXPERIMENT 1

The learner adds a small amount of copper (Cu) powder to a test tube containing silver nitrate solution, $AgNO_3(aq)$. The solution changes from colourless to blue after a while.

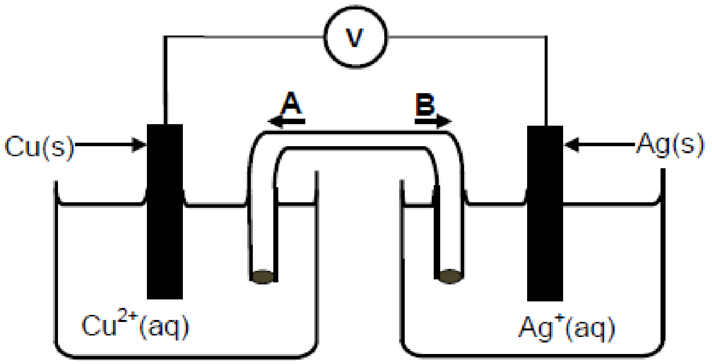


8.1 Define the term *oxidising agent*. (2)

8.2 Explain why the solution turns blue by referring to the relative strength of oxidising agents. (4)

EXPERIMENT 2

The learner now sets up a galvanic cell as shown below. The cell functions under standard conditions.



8.3 Write down the energy conversion that takes place in this cell. (1)

8.4 In which direction (**A** or **B**) will ANIONS move in the salt bridge? (1)

8.5 Calculate the emf of the above cell under standard conditions. (4)

8.6 Write down the balanced equation for the net cell reaction that takes place in this cell. (3)

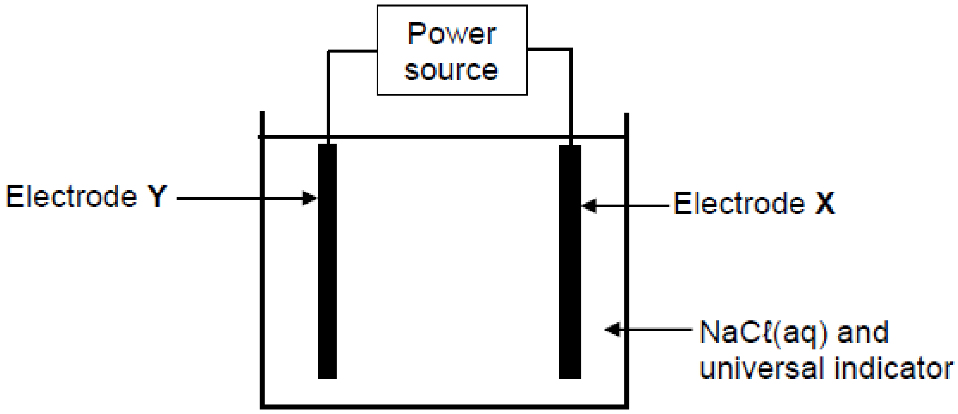
8.7 How will the addition of 100 cm^3 of a 1 $mol\cdot dm^{-3}$ silver nitrate solution to the silver half-cell influence the initial emf of this cell? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[16]

QUESTION 9 (Start on a new page.)

The apparatus below is used to demonstrate the electrolysis of a concentrated sodium chloride solution. Both electrodes are made of carbon. A few drops of universal indicator are added to the electrolyte. The equation for the net cell reaction is:

$$2NaC\ell(aq) + 2H_2O(\ell) \rightarrow C\ell_2(g) + H_2(g) + 2NaOH(aq)$$



Initially the solution has a green colour. Universal indicator becomes red in acidic solutions and purple in alkaline solutions.

9.1 Define the term *electrolyte*. (2)

When the power source is switched on, the colour of the electrolyte around electrode **Y** changes from green to purple.

9.2 Write down the:

9.2.1 Half-reaction that takes place at electrode **Y** (2)

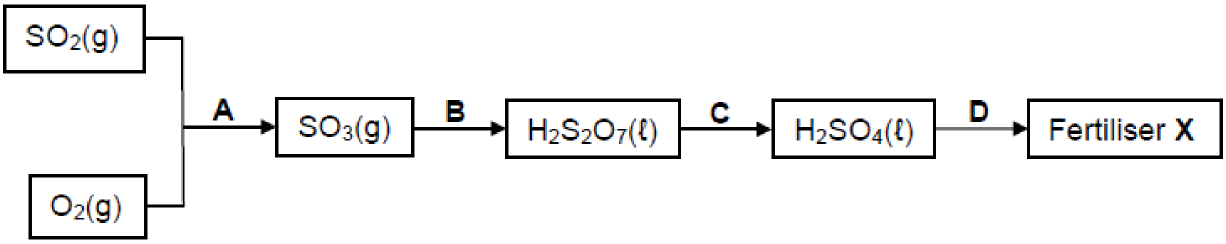
9.2.2 NAME or FORMULA of the gas released at electrode **X** (1)

9.3 Refer to the Table of Standard Reduction Potentials to explain why hydrogen gas, and not sodium, is formed at the cathode of this cell. (2)

[7]

QUESTION 10 (Start on a new page.)

Reactions **A**, **B**, **C** and **D** in the flow diagram below represent the manufacturing of Fertiliser **X**.



10.1 Write down the name of the industrial preparation of sulphuric acid. (1)

10.2 Write down the:

10.2.1 NAME or FORMULA of the catalyst used in reaction **A** (1)

10.2.2 Balanced equation for reaction **C** (3)

10.3 Ammonia is one of the reactants used in reaction **D** to make Fertiliser **X**.

Write down:

10.3.1 A balanced equation for reaction **D** (3)

10.3.2 The NAME of Fertiliser **X** (1)

10.4 Two 50 kg bags, containing fertilisers **P** and **Q** respectively, are labelled as follows:

Fertiliser **P**: 5 : 2 : 3 (25)
Fertiliser **Q**: 1 : 3 : 4 (20)

10.4.1 What do the numbers (25) and (20) on the labels represent? (1)

10.4.2 Using calculations, determine which fertiliser (**P** or **Q**) contains the greater mass of potassium. (4)
[14]

TOTAL: 150

PHYSICAL SCIENCES: PHYSICS (P1)

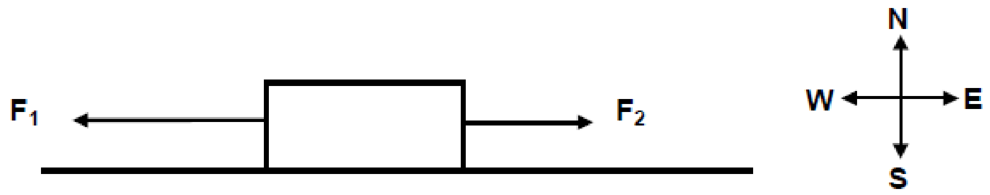
NOVEMBER 2015

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Two forces, $\mathbf{F_1}$ and $\mathbf{F_2}$, are applied on a crate lying on a frictionless, horizontal surface, as shown in the diagram below.

The magnitude of force $\mathbf{F_1}$ is greater than that of force $\mathbf{F_2}$.



The crate will …

A accelerate towards the east.

B accelerate towards the west.

C move at a constant speed towards the east.

D move at a constant speed towards the west. (2)

1.2 A person stands on a bathroom scale that is calibrated in newton, in a stationary elevator. The reading on the bathroom scale is W.

The elevator now moves with a constant upward acceleration of $\frac{1}{4}$g, where g is the gravitational acceleration.

What will the reading on the bathroom scale be now?

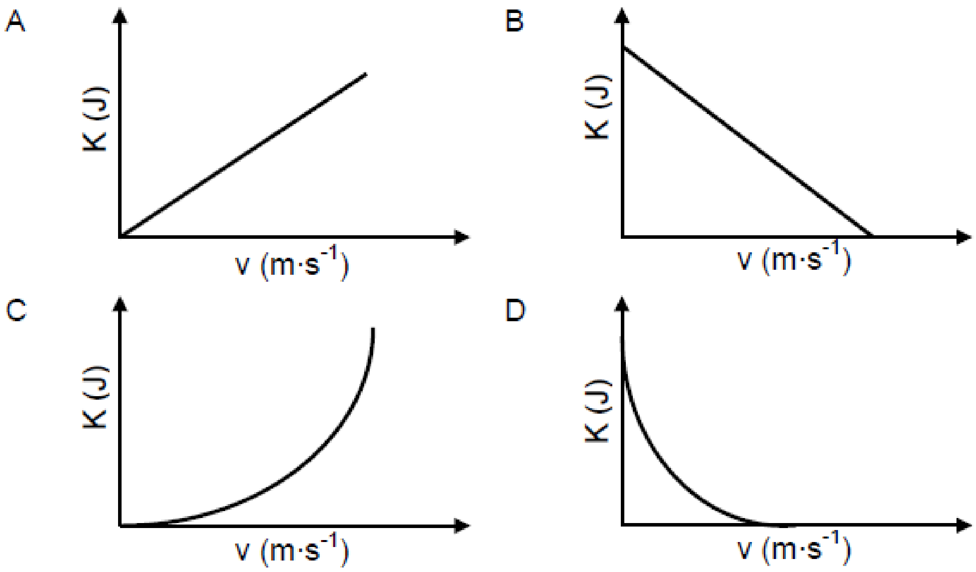
A $\frac{1}{4}W$

B $\frac{3}{4}W$

C W

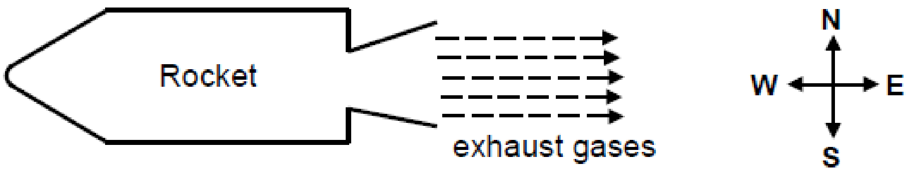
D $\frac{5}{4}W$ (2)

1.3 Which ONE of the graphs below correctly represents the relationship between the kinetic energy (K) of a free-falling object and its speed (v)?



(2)

1.4 The simplified diagram below shows a rocket that has been fired horizontally, accelerating to the west.



Which ONE of the statements below best explains why the rocket accelerates?

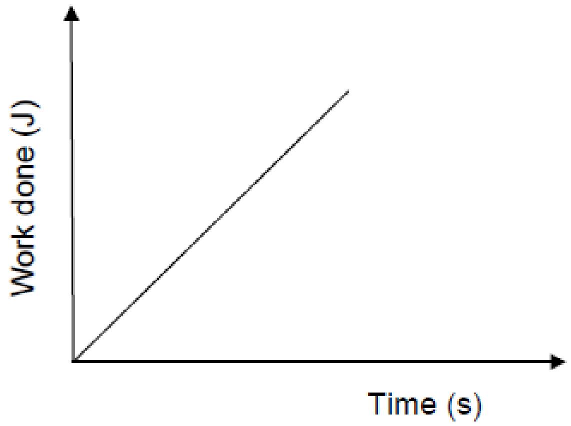
A The speed of the exhaust gases is smaller than the speed of the rocket.

B The pressure of the atmosphere at the back of the rocket is less than at the front.

C The air outside the rocket exerts a greater force on the back of the rocket than at the front.

D The rocket pushes the exhaust gases to the east and the exhaust gases push the rocket to the west. (2)

1.5 The graph below represents the relationship between the work done on an object and the time taken for this work to be done.



The gradient of the graph represents the …

A power.

B momentum.

C kinetic energy.

D potential energy. (2)

1.6 A line emission spectrum is formed when an excited atom moves from a ...

A higher to a lower energy level and releases energy.

B higher to a lower energy level and absorbs energy.

C lower to a higher energy level and releases energy.

D lower to a higher energy level and absorbs energy. (2)

1.7 Two charged spheres of magnitudes 2Q and Q respectively are placed a distance r apart on insulating stands.

If the sphere of charge Q experiences a force **F** to the east, then the sphere of charge 2Q will experience a force …

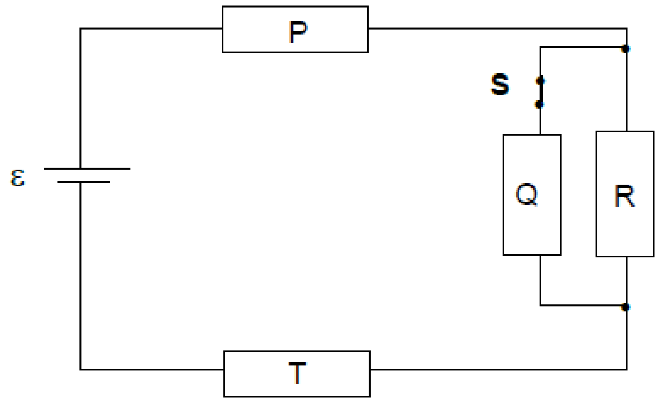
A **F** to the west.

B **F** to the east.

C 2**F** to the west.

D 2**F** to the east. (2)

1.8 The four resistors **P**, **Q**, **R** and **T** in the circuit below are identical. The cell has an emf ε and negligible internal resistance. The switch is initially CLOSED.

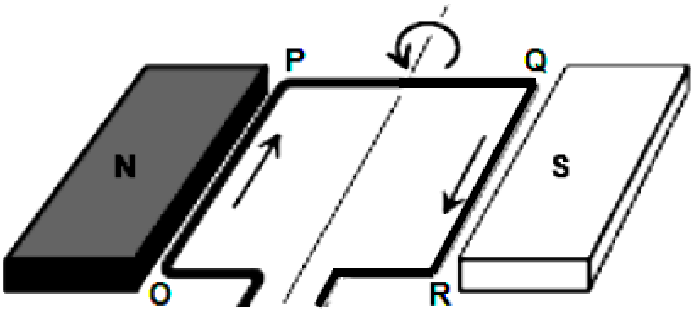


Switch **S** is now OPENED. Which ONE of the following combinations of changes will occur in **P**, **R** and **T**?

	CURRENT IN P	CURRENT IN R	CURRENT IN T
A	Decreases	Remains the same	Decreases
B	Increases	Remains the same	Increases
C	Increases	Increases	Increases
D	Decreases	Increases	Decreases

(2)

1.9 A DC current passes through a rectangular wire loop OPQR placed between two pole pieces of a magnet, as shown below.



Which TWO segments of the loop will experience an electromagnetic force when the loop is in the position above?

A OP and PQ

B QR and RO

C OP and QR

D RO and OP (2)

1.10 When light of a certain wavelength is incident on a metal surface, no electrons are ejected. Which ONE of the following changes may result in electrons being ejected from the metal surface?

A Increase the intensity of the light.

B Use light with a much shorter wavelength.

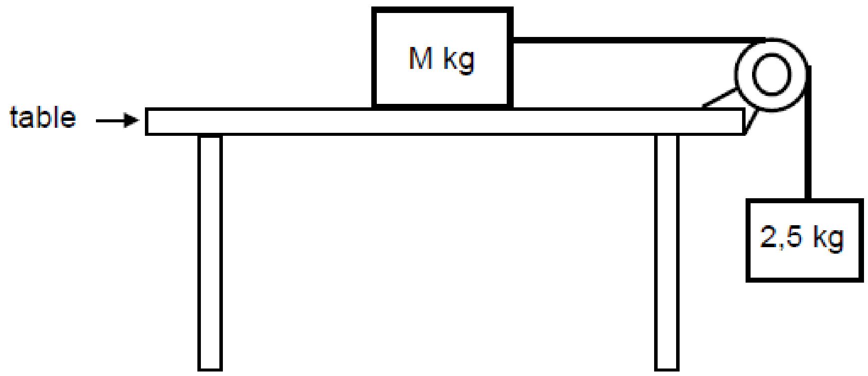
C Use metal with a larger work function.

D Increase the surface area of the metal. (2)
[20]

QUESTION 2 (Start on a new page.)

2.1 Two blocks of mass M kg and 2,5 kg respectively are connected by a light, inextensible string. The string runs over a light, frictionless pulley, as shown in the diagram below.

The blocks are **stationary**.



2.1.1 State Newton's THIRD law in words. (2)

2.1.2 Calculate the tension in the string. (3)

The coefficient of static friction (μ_s) between the unknown mass M and the surface of the table is 0,2.

2.1.3 Calculate the minimum value of M that will prevent the blocks from moving. (5)

The block of unknown mass M is now replaced with a block of mass 5 kg. The 2,5 kg block now accelerates downwards. The coefficient of kinetic friction (μ_k) between the 5 kg block and the surface of the table is 0,15.

2.1.4 Calculate the magnitude of the acceleration of the 5 kg block. (5)

2.2 A small hypothetical planet X has a mass of 6,5 x 10^{20} kg and a radius of 550 km.

Calculate the gravitational force (weight) that planet X exerts on a 90 kg rock on this planet's surface. (4)
[19]

QUESTION 3 (Start on a new page.)

Ball **A** is projected vertically upwards at a velocity of 16 $m \cdot s^{-1}$ from the ground. Ignore the effects of air resistance. **Use the ground as zero reference.**

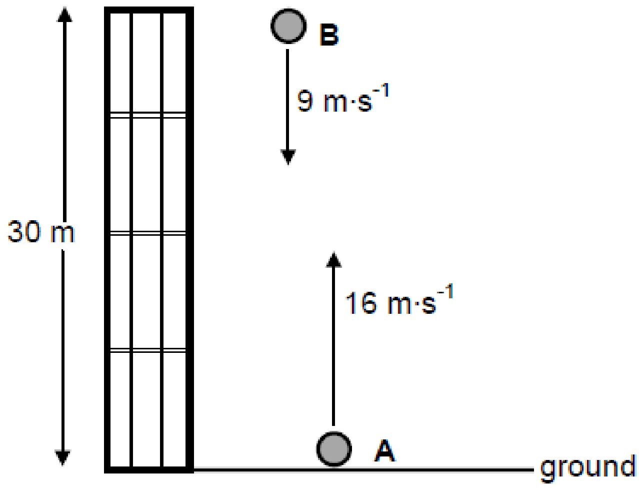
3.1 Calculate the time taken by ball **A** to return to the ground. (4)

3.2 Sketch a velocity-time graph for ball **A**.

Show the following on the graph:

(a) Initial velocity of ball **A**
(b) Time taken to reach the highest point of the motion
(c) Time taken to return to the ground (3)

ONE SECOND after ball **A** is projected upwards, a second ball, **B**, is thrown vertically downwards at a velocity of 9 $m \cdot s^{-1}$ from a balcony 30 m above the ground. Refer to the diagram below.



3.3 Calculate how high above the ground ball **A** will be at the instant the two balls pass each other. (6)

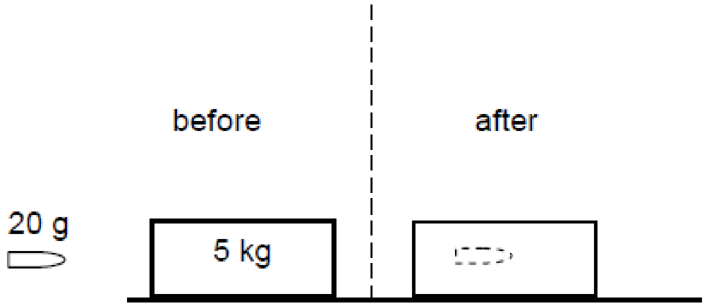
[13]

QUESTION 4 (Start on a new page.)

A bullet of mass 20 g is fired from a stationary rifle of mass 3 kg. Assume that the bullet moves horizontally. Immediately after firing, the rifle recoils (moves back) with a velocity of 1,4 $m \cdot s^{-1}$.

4.1 Calculate the speed at which the bullet leaves the rifle. (4)

The bullet strikes a stationary 5 kg wooden block **fixed** to a flat, horizontal table. The bullet is brought to rest after travelling a distance of 0,4 m **into the block**. Refer to the diagram below.



4.2 Calculate the magnitude of the average force exerted by the block on the bullet. (5)

4.3 How does the magnitude of the force calculated in QUESTION 4.2 compare to the magnitude of the force exerted by the bullet on the block? Write down only LARGER THAN, SMALLER THAN or THE SAME. (1)

[10]

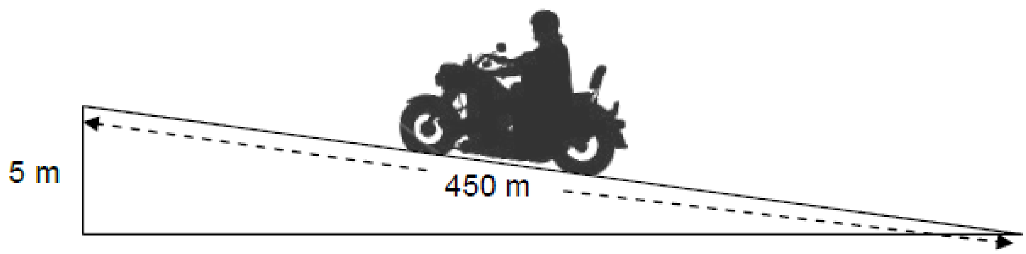
QUESTION 5 (Start on a new page.)

The track for a motorbike race consists of a straight, horizontal section that is 800 m long.

A participant, such as the one in the picture above, rides at a certain average speed and completes the 800 m course in 75 s. To maintain this speed, a constant driving force of 240 N acts on the motorbike.

5.1 Calculate the average power developed by the motorbike for this motion. (3)

Another person practises on the same motorbike on a track with an incline. Starting from rest, the person rides a distance of 450 m up the incline which has a vertical height of 5 m, as shown below.



The total frictional force acting on the motorbike is 294 N. The combined mass of rider and motorbike is 300 kg. The average driving force on the motorbike as it moves up the incline is 350 N. Consider the motorbike and rider as a single system.

5.2 Draw a labelled free-body diagram for the motorbike-rider system on the incline. (4)

5.3 State the WORK-ENERGY theorem in words. (2)

5.4 Use energy principles to calculate the speed of the motorbike at the end of the 450 m ride. (6)

[15]

QUESTION 6 (Start on a new page.)

6.1 The data below was obtained during an investigation into the relationship between the different velocities of a moving sound source and the frequencies detected by a stationary listener for **each** velocity. The effect of wind was ignored in this investigation.

Experiment number	1	2	3	4
Velocity of the sound source ($m \cdot s^{-1}$)	0	10	20	30
Frequency (Hz) of the sound detected by the stationary listener	900	874	850	827

6.1.1 Write down the dependent variable for this investigation. (1)

6.1.2 State the Doppler effect in words. (2)

6.1.3 Was the sound source moving TOWARDS or AWAY FROM the listener? Give a reason for the answer. (2)

6.1.4 Use the information in the table to calculate the speed of sound during the investigation. (5)

6.2 The spectral lines of a distant star are shifted towards the longer wavelengths of light. Is the star moving TOWARDS or AWAY FROM the Earth? (1)

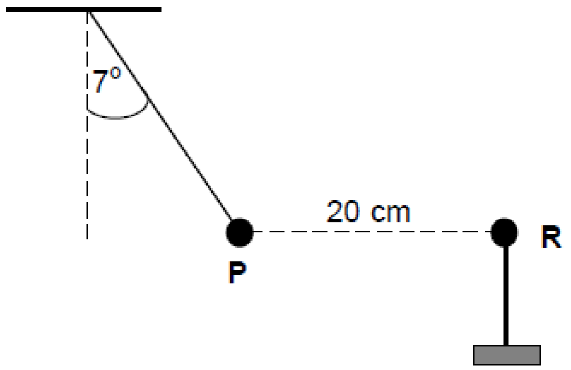
[11]

QUESTION 7 (Start on a new page.)

A very small graphite-coated sphere **P** is rubbed with a cloth. It is found that the sphere acquires a charge of + 0,5 μC.

7.1 Calculate the number of electrons removed from sphere **P** during the charging process. (3)

Now the charged sphere **P** is suspended from a light, inextensible string. Another sphere, **R**, with a charge of – 0,9 μC, on an insulated stand, is brought close to sphere **P**. As a result sphere **P** moves to a position where it is 20 cm from sphere **R**, as shown below. The system is in equilibrium and the angle between the string and the vertical is 7°.



7.2 Draw a labelled free-body diagram showing ALL the forces acting on sphere **P**. (3)

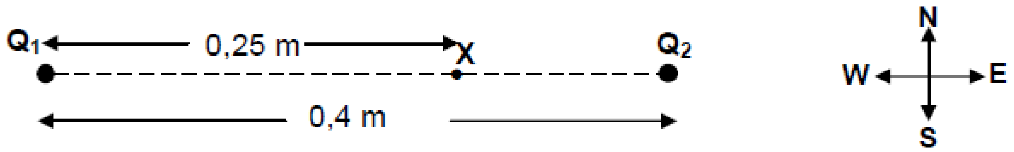
7.3 State Coulomb's law in words. (2)

7.4 Calculate the magnitude of the tension in the string. (5)

[13]

QUESTION 8 (Start on a new page.)

Two charged particles, $\mathbf{Q_1}$ and $\mathbf{Q_2}$, are placed 0,4 m apart along a straight line. The charge on $\mathbf{Q_1}$ is + 2 x 10^{-5} C, and the charge on $\mathbf{Q_2}$ is – 8 x 10^{-6} C. Point **X** is 0,25 m **east** of $\mathbf{Q_1}$, as shown in the diagram below.



Calculate the:

8.1 Net electric field at point **X** due to the two charges (6)

8.2 Electrostatic force that a – 2 x 10^{-9} C charge will experience at point **X** (4)

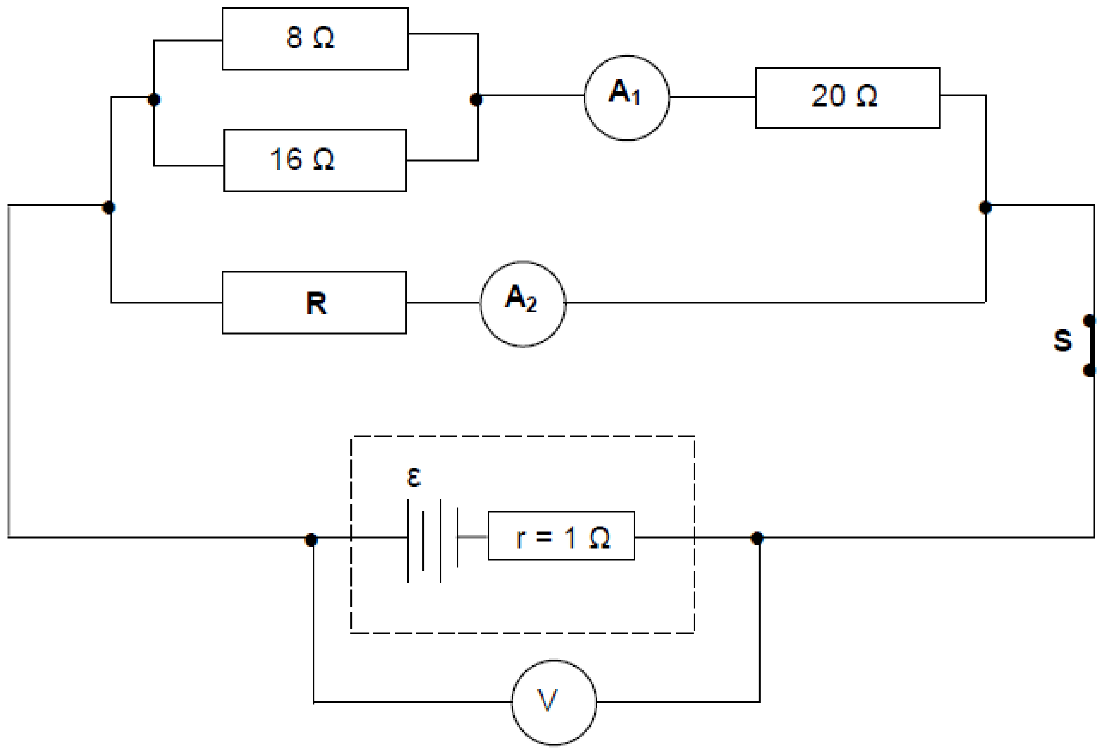
The – 2 x 10^{-9} C charge is replaced with a charge of – 4 x 10^{-9} C at point **X**.

8.3 **Without any further calculation**, determine the magnitude of the force that the – 4 x 10^{-9} C charge will experience at point **X**. (1)

[11]

QUESTION 9 (Start on a new page.)

A battery with an internal resistance of 1 Ω and an unknown emf (ε) is connected in a circuit, as shown below. A high-resistance voltmeter (V) is connected across the battery. **A_1** and **A_2** represent ammeters of negligible resistance.



With switch **S** closed, the current passing through the 8 Ω resistor is 0,5 A.

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

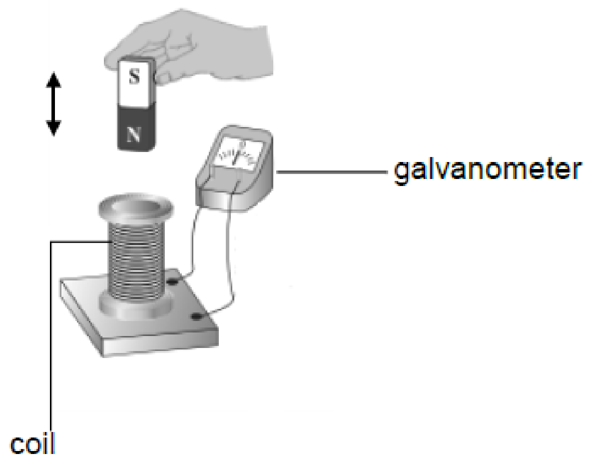
9.2 Calculate the reading on ammeter **A_1**. (4)

9.3 If device **R** delivers power of 12 W, calculate the reading on ammeter **A_2**. (5)

9.4 Calculate the reading on the voltmeter when switch **S** is open. (3)
[14]

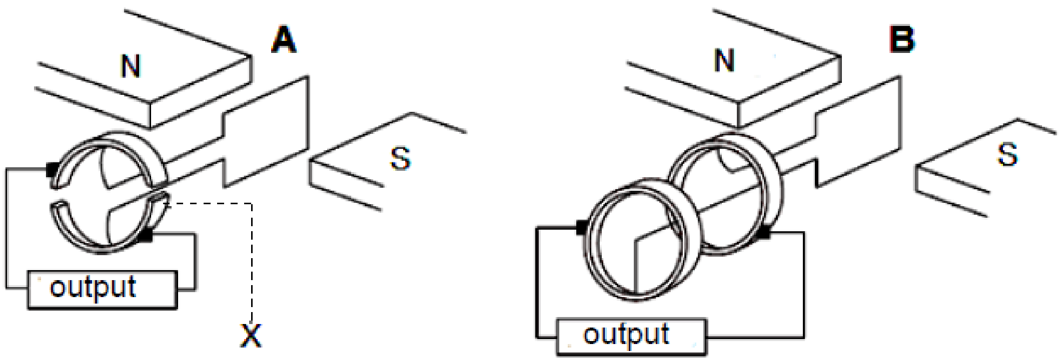
QUESTION 10 (Start on a new page.)

10.1 A teacher demonstrates how current can be obtained using a bar magnet, a coil and a galvanometer. The teacher moves the bar magnet up and down, as shown by the arrow in the diagram below.



10.1.1 Briefly describe how the magnet must be moved in order to obtain a LARGE deflection on the galvanometer. (2)

The two devices, **A** and **B**, below operate on the principle described in QUESTION 10.1.1 above.



10.1.2 Write down the name of the principle. (1)

10.1.3 Write down the name of part **X** in device **A**. (1)

10.2 A 220 V, AC voltage is supplied from a wall socket to an electric kettle of resistance 40,33 Ω. Wall sockets provide rms voltages and currents.

Calculate the:

10.2.1 Electrical energy consumed by the kettle per second (4)

10.2.2 Maximum (peak) current through the kettle (3)

[11]

QUESTION 11 (Start on a new page.)

In an experiment to demonstrate the photoelectric effect, light of different wavelengths was shone onto a metal surface of a photoelectric cell. The maximum kinetic energy of the emitted electrons was determined for the various wavelengths and recorded in the table below.

INVERSE OF WAVELENGTH $\frac{1}{\lambda}$ (× 10^6 m^{-1})	MAXIMUM KINETIC ENERGY $E_{k(max)}$ (× 10^{-19} J)
5,00	6,60
3,30	3,30
2,50	1,70
2,00	0,70

11.1 What is meant by the term *photoelectric effect?* (2)

11.2 Draw a graph of $E_{k(max)}$ (y-axis) versus $\frac{1}{\lambda}$ (x-axis) ON THE ATTACHED ANSWER SHEET. (3)

11.3 USE THE GRAPH to determine:

11.3.1 The threshold frequency of the metal in the photoelectric cell (4)

11.3.2 Planck's constant (4)
[13]

TOTAL: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2015

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following pairs of reactants is used in a reaction during the contact process?

A $N_2(g)$ and $H_2(g)$

B $SO_2(g)$ and $O_2(g)$

C $NH_3(g)$ and $O_2(g)$

D $H_2SO_4(\ell)$ and $NH_3(g)$ (2)

1.2 The rate of a chemical reaction is most correctly defined as the ...

A time taken for a reaction to occur.

B speed at which a reaction takes place.

C change in the amount of reactants or products.

D change in the concentration of reactants or products per unit time. (2)

1.3 Consider the reaction represented by the balanced equation below.

$$H_3PO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + H_2PO_4^-(aq)$$

Which ONE of the following is a conjugate acid-base pair?

A $H_3O^+(aq)$ and $H_2O(\ell)$

B $H_3PO_4(aq)$ and $H_2O(\ell)$

C $H_3PO_4(aq)$ and $H_3O^+(aq)$

D $H_3O^+(aq)$ and $H_2PO_4^-(aq)$ (2)

1.4 Which ONE of the following compounds has dipole-dipole forces between its molecules?

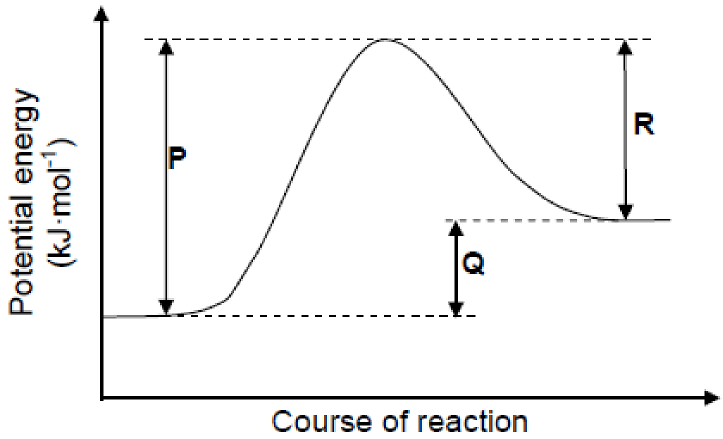
A Ethanal

B Ethane

C Ethene

D Ethyne (2)

1.5 The energy changes represented by **P**, **Q** and **R** on the potential energy graph below take place during a reversible chemical reaction.



Which ONE of the following changes will decrease both **P** and **R**, but leave **Q** unchanged?

A A decrease in volume

B The addition of a catalyst

C A decrease in temperature

D A decrease in concentration (2)

1.6 Which ONE of the following is a product formed during the hydrolysis of bromoethane?

A Water

B Ethene

C Ethanol

D Bromine (2)

1.7 Which ONE of the following is the EMPIRICAL FORMULA of 1,2-dichloroethane?

A $CHC\ell$

B $CH_2C\ell$

C $CHC\ell_2$

D $C_2H_4C\ell_2$ (2)

1.8 The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$C\ell_2(g) + H_2O(\ell) \rightleftharpoons C\ell^-(aq) + C\ell O^-(aq) + 2H^+(aq)$$

Which ONE of the following reagents will favour the forward reaction when added?

A Hydrogen

B Sodium chloride

C Hydrogen chloride

D Sodium hydroxide (2)

1.9 The following half-reactions take place in a galvanic cell:

$$Co^{3+} + e^- \rightleftharpoons Co^{2+}$$
$$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$$

Which ONE of the following is the cell notation for this cell?

A $A\ell \mid A\ell^{3+} \parallel Co^{3+}, Co^{2+}$

B $A\ell \mid A\ell^{3+} \parallel Co^{3+}, Co^{2+} \mid Pt$

C $A\ell \mid A\ell^{3+} \parallel Co^{2+}, Co^{3+} \mid Pt$

D $Pt \mid Co^{2+}, Co^{3+} \parallel A\ell^{3+} \mid A\ell$ (2)

1.10 Chlorine gas ($C\ell_2$) is bubbled through a potassium iodide solution (KI). The reducing agent in this reaction is:

A Potassium ions

B Chlorine gas

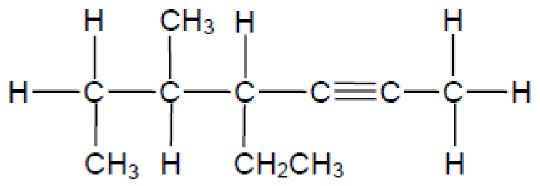
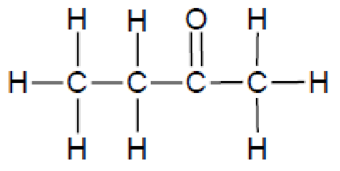
C Iodide ions

D Chloride ions (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **D** in the table below represent four organic compounds.

A		**B**	
C	CH_3CH_2CHO	**D**	Butane

Use the information in the table to answer the questions that follow.

2.1 Write down the:

2.1.1 Letter that represents a ketone (1)

2.1.2 Structural formula of the functional group of compound **C** (1)

2.1.3 General formula of the homologous series to which compound **A** belongs (1)

2.1.4 IUPAC name of compound **A** (3)

2.1.5 IUPAC name of compound **B** (2)

2.2 Compound **D** is a gas used in cigarette lighters.

2.2.1 To which homologous series does compound **D** belong? (1)

2.2.2 Write down the STRUCTURAL FORMULA and IUPAC NAME of a structural isomer of compound **D**. (4)

2.2.3 Is the isomer in QUESTION 2.2.2 a CHAIN, POSITIONAL or FUNCTIONAL isomer? (1)

2.3 Compound **D** reacts with bromine (Br_2) to form 2-bromobutane.

Write down the name of the:

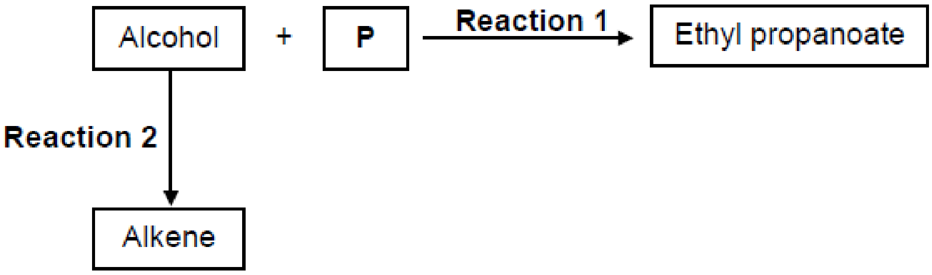
2.3.1 Homologous series to which 2-bromobutane belongs (1)

2.3.2 Type of reaction that takes place (1)

[16]

QUESTION 3 (Start on a new page.)

3.1 The flow diagram below shows two organic reactions. The letter **P** represents an organic compound.



Use the information in the flow diagram to answer the questions that follow.

Write down the:

3.1.1 Type of reaction of which **Reaction 1** is an example (1)

3.1.2 STRUCTURAL FORMULA of the functional group of ethyl propanoate (1)

3.1.3 IUPAC name of compound **P** (1)

Reaction 2 takes place in the presence of an acid catalyst and heat.

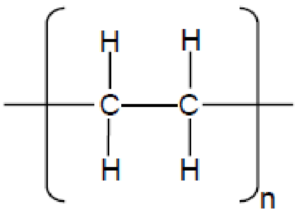
Write down the:

3.1.4 Type of reaction of which **Reaction 2** is an example (1)

3.1.5 NAME or FORMULA of the acid catalyst (1)

3.1.6 STRUCTURAL FORMULA of the alkene (2)

3.2 The condensed formula of a polymer is shown below.



Write down the:

3.2.1 STRUCTURAL FORMULA of the monomer that is used to prepare the above polymer (2)

3.2.2 Type of polymerisation reaction (ADDITION or CONDENSATION) that is used to prepare this polymer (1)

[10]

QUESTION 4 (Start on a new page.)

Four compounds of comparable molecular mass are used to investigate the effect of functional groups on vapour pressure. The results obtained are shown in the table below.

COMPOUND		VAPOUR PRESSURE (kPa at 20 °C)
A	Butane	204
B	Propan-2-one	24,6
C	Propan-1-ol	2
D	Ethanoic acid	1,6

4.1 Define the term *functional group* of an organic compound. (2)

4.2 Which ONE of the compounds (**A**, **B**, **C** or **D**) in the table has the:

4.2.1 Highest boiling point
(Refer to the vapour pressures in the table to give a reason for the answer.) (2)

4.2.2 Weakest intermolecular forces (1)

4.3 Refer to the type of intermolecular forces to explain the difference between the vapour pressure of compound **A** and compound **B**. (3)

4.4 The vapour pressures of compounds **C** and **D** are much lower than those of compounds **A** and **B**. Name the type of intermolecular force in **A** and **B** that is responsible for this difference. (1)

4.5 Briefly explain the difference in vapour pressure between compound **C** and compound **D**. (2)

4.6 During a combustion reaction in a closed container of adjustable volume, 8 cm^3 of compound **A** (butane) reacts in excess oxygen according to the following balanced equation:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$

If the initial volume of the oxygen in the container was 60 cm^3, calculate the TOTAL volume of the gases that are present in the container at the end of the reaction. All the gases in the container are at the same temperature and pressure. (5)

[16]

QUESTION 5 (Start on a new page.)

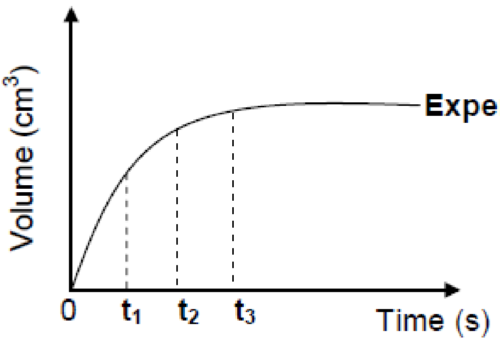
Dilute acids, indicated in the table below, react with EXCESS zinc in each of the three experiments to produce hydrogen gas. The zinc is completely covered with the acid in each experiment.

EXPERIMENT	DILUTE ACID
1	100 cm^3 of 0,1 $mol\cdot dm^{-3}$ H_2SO_4
2	50 cm^3 of 0,2 $mol\cdot dm^{-3}$ H_2SO_4
3	100 cm^3 of 0,1 $mol\cdot dm^{-3}$ HCl

The volume of hydrogen gas produced is measured in each experiment.

5.1 Name TWO essential apparatuses needed to determine the rate of hydrogen production. (2)

The graph below was obtained for **Experiment 1**.



Use this graph and answer the questions that follow.

5.2 At which time (t_1, t_2 or t_3) is the:

5.2.1 Reaction rate the highest (1)

5.2.2 Mass of zinc present in the flask the smallest (1)

5.3 In which time interval, **between t_1 and t_2** OR **between t_2 and t_3**, does the largest volume of hydrogen gas form per second? (1)

5.4 Redraw the graph for **Experiment 1** in the ANSWER BOOK.

On the same set of axes, sketch the graphs that will be obtained for **Experiments 2** and **3**. Clearly label the three graphs as **EXPERIMENT 1**, **EXPERIMENT 2** and **EXPERIMENT 3**. (4)

5.5 The initial mass of zinc used in each experiment is 0,8 g. The balanced equation for the reaction in **Experiment 3** is:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

5.5.1 Calculate the mass of zinc present in the flask after completion of the reaction in **Experiment 3**. (5)

5.5.2 How will the mass of zinc present in the flask after completion of the reaction in **Experiment 2** compare to the answer to QUESTION 5.5.1? Write down only LARGER THAN, SMALLER THAN or EQUAL TO. (1)
[15]

QUESTION 6 (Start on a new page.)

An unknown gas, $X_2(g)$, is sealed in a container and allowed to form $X_3(g)$ at 300 °C. The reaction reaches equilibrium according to the following balanced equation:

$$3X_2(g) \rightleftharpoons 2X_3(g)$$

6.1 How will the rate of formation of $X_3(g)$ compare to the rate of formation of $X_2(g)$ at equilibrium? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

The reaction mixture is analysed at regular time intervals. The results obtained are shown in the table below.

TIME (s)	$[X_2]$ ($mol \cdot dm^{-3}$)	$[X_3]$ ($mol \cdot dm^{-3}$)
0	0,4	0
2	0,22	0,120
4	0,08	0,213
6	0,06	0,226
8	0,06	0,226
10	0,06	0,226

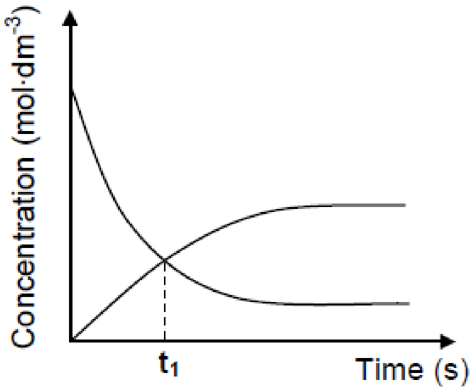
6.2 Calculate the equilibrium constant, K_c, for this reaction at 300 °C. (4)

6.3 More $X_3(g)$ is now added to the container.

6.3.1 How will this change affect the amount of $X_2(g)$? Write down INCREASES, DECREASES or REMAINS THE SAME. (1)

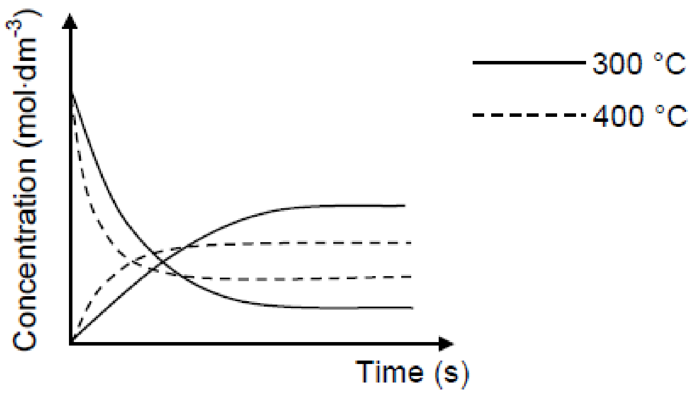
6.3.2 Use Le Chatelier's principle to explain the answer to QUESTION 6.3.1. (2)

The curves on the set of axes below (not drawn to scale) was obtained from the results in the table on page 10.



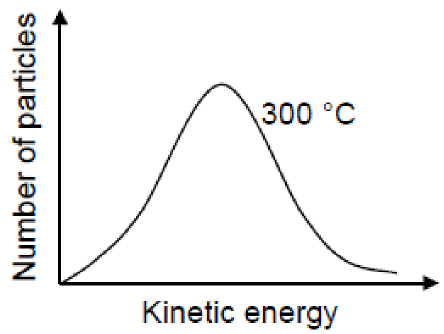
6.4 How does the rate of the forward reaction compare to that of the reverse reaction at t_1? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

The reaction is now repeated at a temperature of 400 °C. The curves indicated by the dotted lines below were obtained at this temperature.



6.5 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Fully explain how you arrived at the answer. (4)

The Maxwell-Boltzmann distribution curve below represents the number of particles against kinetic energy at 300 °C.



6.6 Redraw this curve in the ANSWER BOOK. On the same set of axes, sketch the curve that will be obtained at 400 °C. Clearly label the curves as **300 °C** and **400 °C** respectively. (2)

[15]

QUESTION 7 (Start on a new page.)

7.1 Ammonium chloride crystals, $NH_4C\ell(s)$, dissolve in water to form ammonium and chloride ions. The ammonium ions react with water according to the balanced equation below:

$$NH_4^+(aq) + H_2O(\ell) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$$

7.1.1 Write down the name of the process described by the underlined sentence. (1)

7.1.2 Is ammonium chloride ACIDIC or BASIC in aqueous solution? Give a reason for the answer. (2)

7.2 A certain fertiliser consists of 92% ammonium chloride. A sample of mass x g of this fertiliser is dissolved in 100 cm^3 of a 0,10 $mol{\cdot}dm^{-3}$ sodium hydroxide solution, NaOH(aq). The NaOH is in excess.

The balanced equation for the reaction is:

$$NH_4C\ell(s) + NaOH(aq) \rightarrow NH_3(g) + H_2O(\ell) + NaC\ell(aq)$$

7.2.1 Calculate the number of moles of sodium hydroxide in which the sample is dissolved. (3)

During a titration, 25 cm^3 of the excess sodium hydroxide solution is titrated with a 0,11 $mol{\cdot}dm^{-3}$ hydrochloric acid solution, $HC\ell(aq)$. At the endpoint it is found that 14,55 cm^3 of the hydrochloric acid was used to neutralise the sodium hydroxide solution according to the following balanced equation:

$$HC\ell(aq) + NaOH(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

7.2.2 Calculate the mass x (in grams) of the fertiliser sample used. (8)

7.3 Calculate the pH of a 0,5 $mol{\cdot}dm^{-3}$ sodium hydroxide solution at 25 °C. (4)

[18]

QUESTION 8 (Start on a new page.)

Learners are given the following two unknown half-cells:

Half-cell 1: Q^{2+} (aq) | Q(s)

Half-cell 2: Pt | R_2(g) | R^-(aq)

During an investigation to identify the two half-cells, the learners connect each half-cell alternately to a Cd^{2+}(aq) | Cd(s) half-cell under standard conditions. For each combination of two half-cells, they write down the net cell reaction and measure the cell potential.

The results obtained for the two half-cell combinations are given in the table below.

COMBINATION	NET CELL REACTION	CELL POTENTIAL
I	$\mathbf{Q}^{2+}$(aq) + Cd(s) → Cd^{2+}(aq) + **Q**(s)	0,13 V
II	$\mathbf{R}_2$(g) + Cd(s) → Cd^{2+}(aq) + 2$\mathbf{R}^-$(aq)	1,76 V

8.1 Write down THREE conditions needed for these cells to function as standard cells. (3)

8.2 For **Combination I**, identify:

8.2.1 The anode of the cell (1)

8.2.2 **Q** by using a calculation (5)

8.3 For **Combination II**, write down the:

8.3.1 Oxidation half-reaction (2)

8.3.2 NAME or FORMULA of the metal used in the cathode compartment (1)

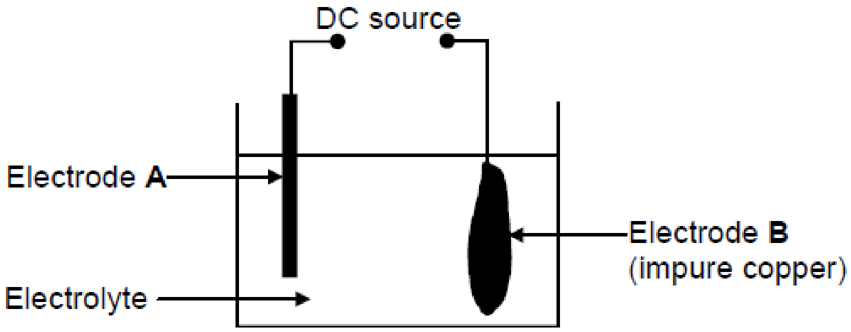
8.4 Arrange the following species in order of INCREASING oxidising ability:

Q^{2+} ; R_2 ; Cd^{2+}

Explain fully how you arrived at the answer. A calculation is NOT required. (4)
[16]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrochemical cell used for the purification of copper.



9.1 Define the term *electrolysis*. (2)

9.2 Give a reason why a direct-current (DC) source is used in this experiment. (1)

9.3 Write down the half-reaction which takes place at electrode **A**. (2)

9.4 Due to small amounts of zinc impurities in the impure copper, the electrolyte becomes contaminated with Zn^{2+} ions.

Refer to the attached Table of Standard Reduction Potentials to explain why the Zn^{2+} ions will not influence the purity of the copper obtained during this process. (3)

9.5 After the purification of the impure copper was completed, it was found that 2,85 x 10^{-2} moles of copper were formed.

The initial mass of electrode **B** was 2,0 g. Calculate the percentage of copper that was initially present in electrode **B**. (4)

[12]

QUESTION 10 (Start on a new page.)

Ammonia is an important fertiliser. Large amounts are prepared from hydrogen and nitrogen in industry.

10.1 For the industrial preparation of ammonia, write down:

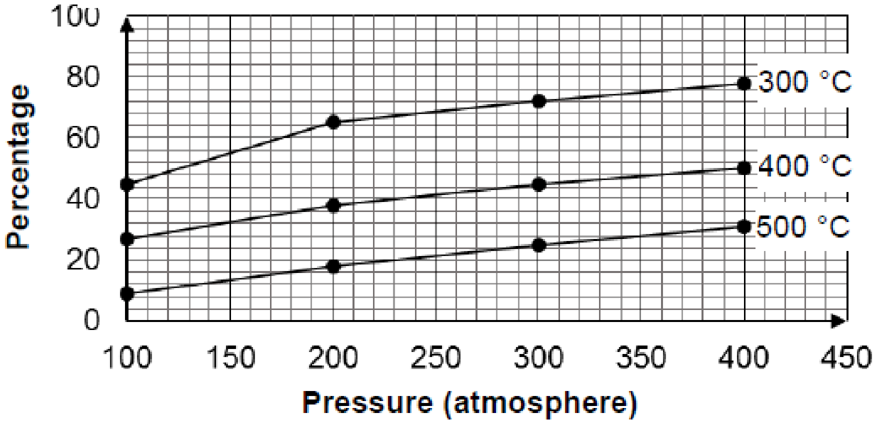
10.1.1 The name of the process used (1)

10.1.2 A balanced equation for the reaction that occurs (3)

10.1.3 The source of nitrogen (1)

10.2 The yield of ammonia changes with temperature and pressure during its industrial preparation. The graphs below show how the percentage of ammonia in the reaction mixture that leaves the reaction vessel varies under different conditions.

GRAPHS OF THE PERCENTAGE OF AMMONIA IN THE REACTION MIXTURE VERSUS PRESSURE



10.2.1 Use the appropriate graph to estimate the percentage of ammonia present in the reaction mixture at 240 atmosphere and 400 °C. (1)

10.2.2 State TWO advantages of using high pressure in the preparation of ammonia. (2)

10.2.3 The advantage of using a low temperature is the large percentage of ammonia formed. What is the disadvantage of using a low temperature? (1)

10.3 Ammonia is also used in the preparation of other fertilisers such as ammonium nitrate. Calculate the mass of nitrogen in a 50 kg bag of pure ammonium nitrate fertiliser. (3)

[12]

TOTAL: 150

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2016

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A net force **F** which acts on a body of mass *m* causes an acceleration *a*. If the same net force **F** is applied to a body of mass 2*m*, the acceleration of the body will be …

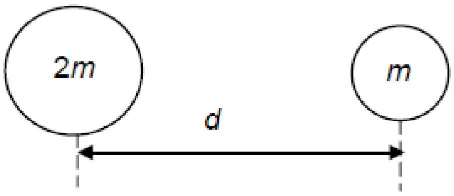
A ¼a

B ½a

C 2a

D 4a (2)

1.2 Two objects of masses 2*m* and *m* are arranged as shown in the diagram below.



Which ONE of the changes below will produce the GREATEST increase in the gravitational force exerted by the one mass on the other?

A Double the larger mass.

B Halve the smaller mass.

C Double the distance between the masses.

D Halve the distance between the masses. (2)

1.3 The statements below describe the motion of objects.

(i) A feather falls from a certain height inside a vacuum tube.

(ii) A box slides along a smooth horizontal surface at constant speed.

(iii) A steel ball falls through the air in the absence of air friction.

Which of the following describes UNIFORMLY ACCELERATED motion CORRECTLY?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii) (2)

1.4 Airbags in modern cars provide more safety during an accident.

The statements below are made by a learner to explain how airbags can ensure better safety in a collision.

(i) The time of impact increases.

(ii) The impact force decreases.

(iii) The impulse increases.

Which of the statements above are CORRECT?

A (i) only

B (ii) only

C (ii) and (iii) only

D (i) and (ii) only (2)

1.5 The work done by a constant force F applied to an object to increase the object's speed from v to $2v$ is W.

The work done by the same force to increase the speed of the object from 0 to v will be ...

A ⅓W

B ½W

C 2W

D 3W (2)

1.6 Light reaching the Earth from a galaxy moving away is shifted towards …

A greater velocities.

B higher frequencies.

C longer wavelengths.

D shorter wavelengths. (2)

1.7 P, Q and R are three charged spheres. When P and Q are brought near each other, they experience an attractive force. When Q and R are brought near each other, they experience a repulsive force.

Which ONE of the following is TRUE?

A P and R have charges with the same sign.

B P and R have charges with opposite signs.

C P, Q and R have charges with the same sign.

D P, Q and R have equal charges. (2)

1.8 The minimum value of the resistance that can be obtained by connecting two 4 Ω resistors is ...

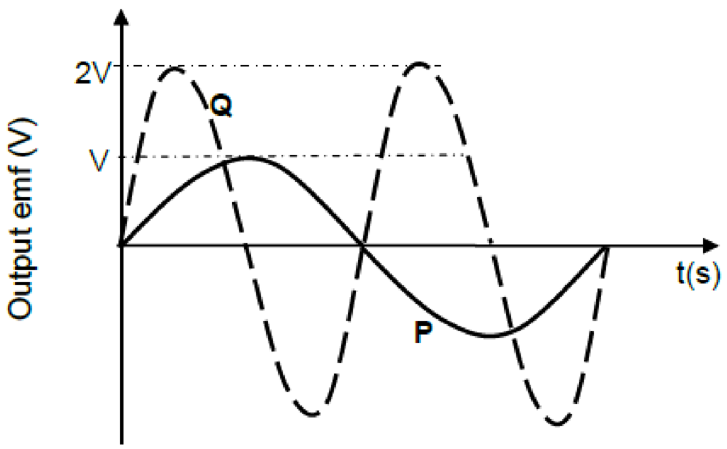
A 1 Ω.

B 2 Ω.

C 3 Ω.

D 8 Ω. (2)

1.9 Graph **P** represents the output emf of an AC generator. Graph **Q** is the output emf after a change has been made using the SAME generator.



Which ONE of the following changes has been made to the generator to produce graph **Q**?

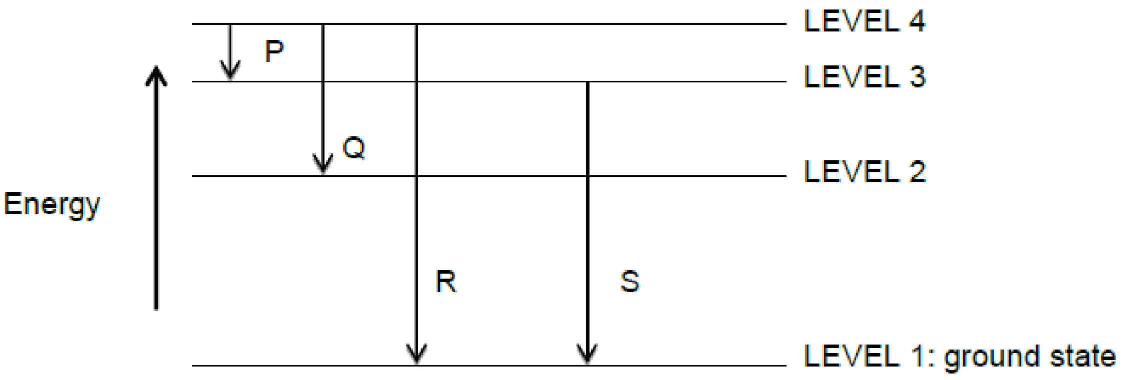
A The number of turns of the coil has been doubled.

B The surface area of the coil has been doubled.

C The speed of rotation has been doubled.

D The strength of the magnetic field has been doubled. (2)

1.10 The possible atomic transitions in an excited atom of an element are shown below.



Which transition will produce the spectral line with the longest wavelength?

A P

B Q

C R

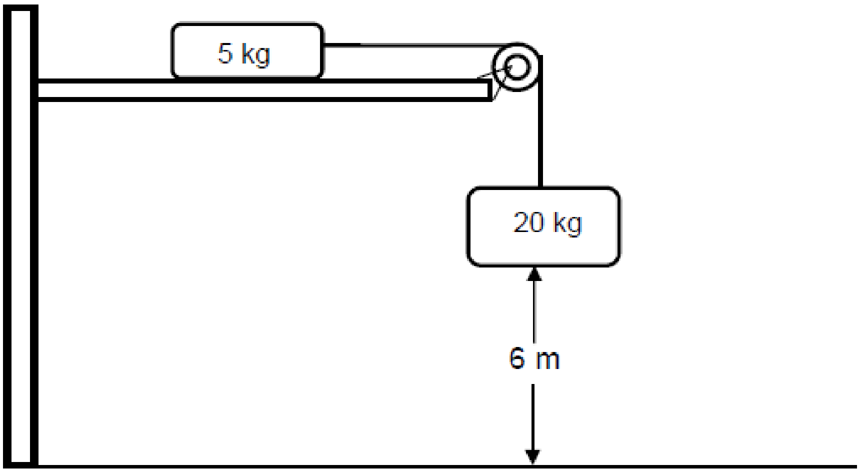
D S (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 A 5 kg mass and a 20 kg mass are connected by a light inextensible string which passes over a light frictionless pulley. Initially, the 5 kg mass is held stationary on a horizontal surface, while the 20 kg mass hangs vertically downwards, 6 m above the ground, as shown in the diagram below.

The diagram is not drawn to scale.



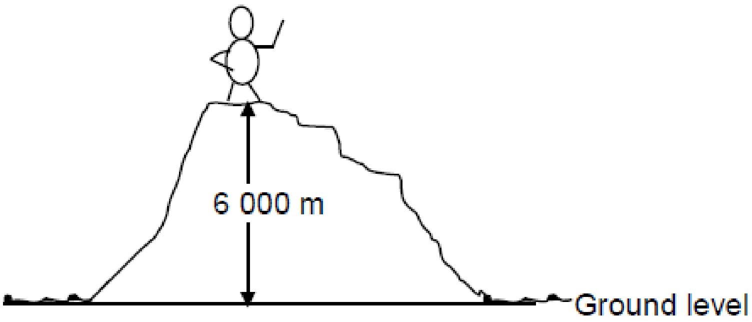
When the *stationary* 5 kg mass is released, the two masses begin to move. The coefficient of kinetic friction, μ_k, between the 5 kg mass and the horizontal surface is 0,4. Ignore the effects of air friction.

2.1.1 Calculate the acceleration of the 20 kg mass. (5)

2.1.2 Calculate the speed of the 20 kg mass as it strikes the ground. (4)

2.1.3 At what minimum distance from the pulley should the 5 kg mass be placed initially, so that the 20 kg mass just strikes the ground? (1)

2.2 A person of mass 60 kg climbs to the top of a mountain which is 6 000 m above ground level.



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

2.2.2 Calculate the *difference* in the weight of the climber at the top of the mountain and at ground level. (6)
[18]

QUESTION 3 (Start on a new page.)

A man throws ball **A** downwards with a speed of 2 $m \cdot s^{-1}$ from the edge of a window, 45 m above a dam of water. One second later he throws a second ball, ball **B**, downwards and observes that both balls strike the surface of the water in the dam at the same time. Ignore air friction.

3.1 Calculate the:

3.1.1 Speed with which ball **A** hits the surface of the water (3)

3.1.2 Time it takes for ball **B** to hit the surface of the water (3)

3.1.3 Initial velocity of ball **B** (5)

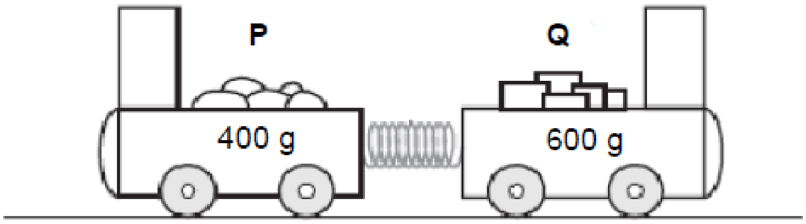
3.2 On the same set of axes, sketch a velocity versus time graph for the motion of balls **A** and **B**. Clearly indicate the following on your graph:

- Initial velocities of both balls **A** and **B**
- The time of release of ball **B**
- The time taken by both balls to hit the surface of the water (5)

[16]

QUESTION 4 (Start on a new page.)

The diagram below shows two trolleys, **P** and **Q**, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of **P** and **Q** are 400 g and 600 g respectively.



When the trolleys are released, it takes 0,3 s for the spring to unwind to its natural length. Trolley **Q then** moves to the right at 4 m·s^{-1}.

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

4.2 Calculate the:

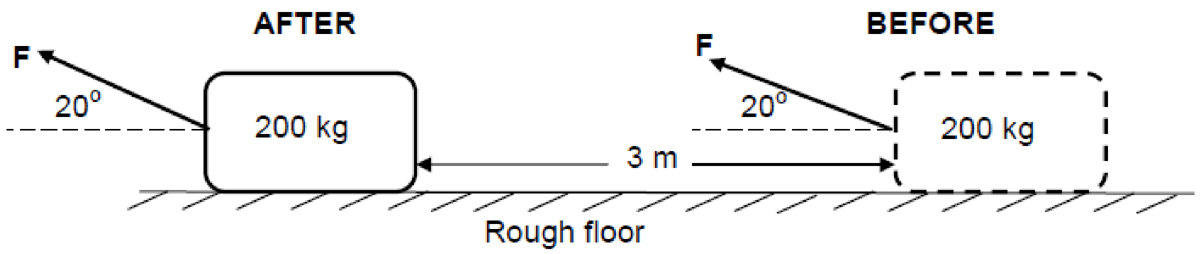
4.2.1 Velocity of trolley **P** after the trolleys are released (4)

4.2.2 Magnitude of the average force exerted by the spring on trolley **Q** (4)

4.3 Is this an elastic collision? Only answer YES or NO. (1)
[11]

QUESTION 5 (Start on a new page.)

A constant force **F**, applied at an angle of 20° above the horizontal, pulls a 200 kg block, over a distance of 3 m, on a rough, horizontal floor as shown in the diagram below.



The coefficient of kinetic friction, μ_k, between the floor surface and the block is 0,2.

5.1 Give a reason why the coefficient of kinetic friction has no units. (1)

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

5.3 Draw a free-body diagram indicating ALL the forces acting on the block while it is being pulled. (4)

5.4 Show that the work done by the kinetic frictional force (W_{fk}) on the block can be written as W_{fk} = (-1 176 + 0,205 **F**) J. (4)

5.5 Calculate the magnitude of the force **F** that has to be applied so that the net work done by all forces on the block is zero. (4)
[15]

QUESTION 6 (Start on a new page.)

Reflection of sound waves enables bats to hunt for moths. The sound wave produced by a bat has a frequency of 222 kHz and a wavelength of $1,5 \times 10^{-3}$ m.

6.1 Calculate the speed of this sound wave through the air. (3)

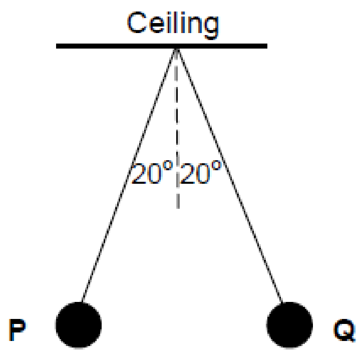
6.2 A stationary bat sends out a sound signal and receives the same signal reflected from a moving moth at a frequency of 230,3 kHz.

6.2.1 Is the moth moving TOWARDS or AWAY FROM the bat? (1)

6.2.2 Calculate the magnitude of the velocity of the moth, assuming that the velocity is constant. (6)
[10]

QUESTION 7 (Start on a new page.)

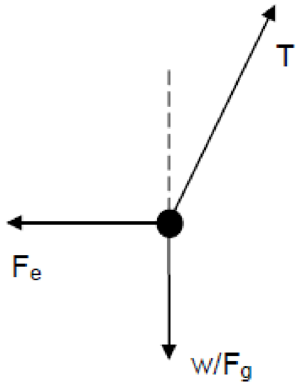
Two identical spherical balls, **P** and **Q**, each of mass 100 g, are suspended at the same point from a ceiling by means of identical light, inextensible insulating strings. Each ball carries a charge of +250 nC. The balls come to rest in the positions shown in the diagram below.



7.1 In the diagram, the angles between each string and the vertical are the same. Give a reason why the angles are the same. (1)

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

7.3 The free-body diagram, not drawn to scale, of the forces acting on ball **P** is shown below.



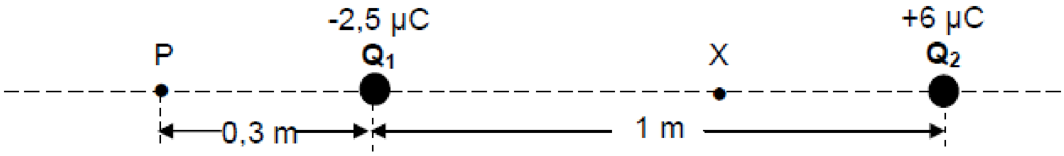
Calculate the:

7.3.1 Magnitude of the tension (T) in the string (3)

7.3.2 Distance between balls **P** and **Q** (5)
[11]

QUESTION 8 (Start on a new page.)

A sphere **Q_1**, with a charge of -2,5 μC, is placed 1 m away from a second sphere **Q_2**, with a charge +6 μC. The spheres lie along a straight line, as shown in the diagram below. Point **P** is located a distance of 0,3 m to the left of sphere **Q_1**, while point **X** is located between **Q_1** and **Q_2**. The diagram is not drawn to scale.

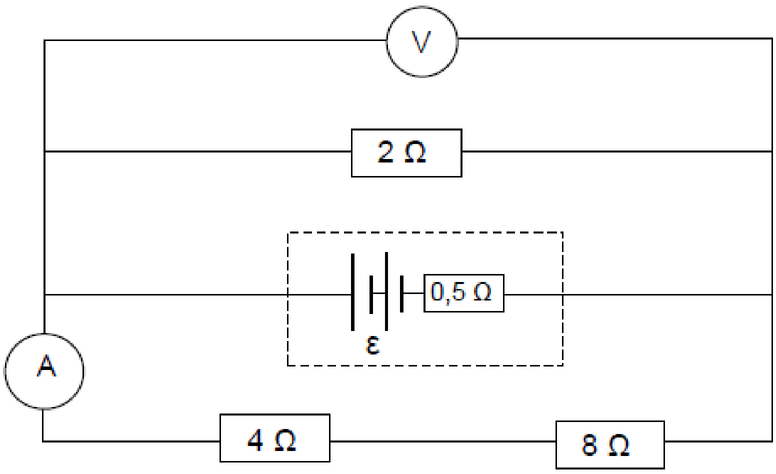


8.1 Show, with the aid of a VECTOR DIAGRAM, why the net electric field at point **X** *cannot be zero.* (4)

8.2 Calculate the net electric field at point **P**, due to the two charged spheres **Q_1** and **Q_2**. (6)
[10]

QUESTION 9 (Start on a new page.)

A battery of an unknown emf and an internal resistance of 0,5 Ω is connected to three resistors, a high-resistance voltmeter and an ammeter of negligible resistance, as shown below.



The reading on the ammeter is 0,2 A.

9.1 Calculate the:

9.1.1 Reading on the voltmeter (3)

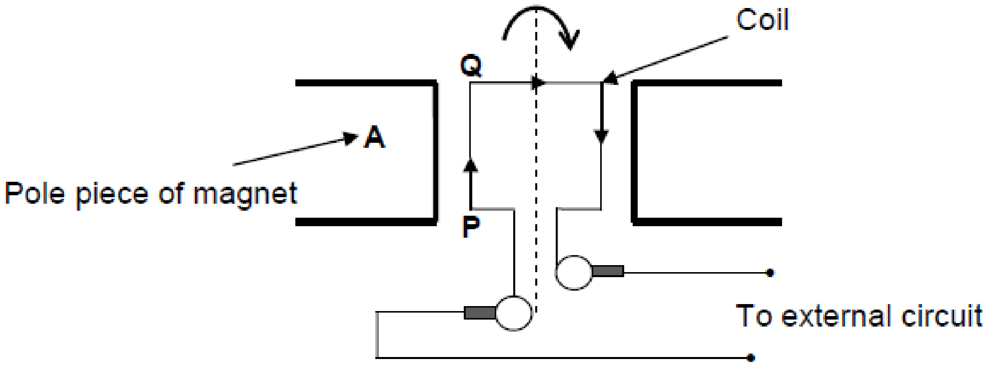
9.1.2 Total current supplied by the battery (4)

9.1.3 Emf of the battery (5)

9.2 How would the voltmeter reading change if the 2 Ω resistor is removed from the circuit? Write down INCREASE, DECREASE or REMAIN THE SAME. Explain the answer. (3)
[15]

QUESTION 10 (Start on a new page.)

10.1 A simplified sketch of an AC generator is shown below.



The coil of the generator rotates clockwise between the pole pieces of two magnets. At a particular instant, the current in the segment **PQ** has the direction shown above.

10.1.1 Identify the magnetic pole **A**.
Only write NORTH POLE or SOUTH POLE. (1)

10.1.2 The coil is rotated through 180°.

Will the direction of the current in segment **PQ** be from **P** to **Q** or **Q** to **P**? (1)

10.2 An electrical device is connected to a generator which produces an rms potential difference of 220 V. The maximum current passing through the device is 8 A.

Calculate the:

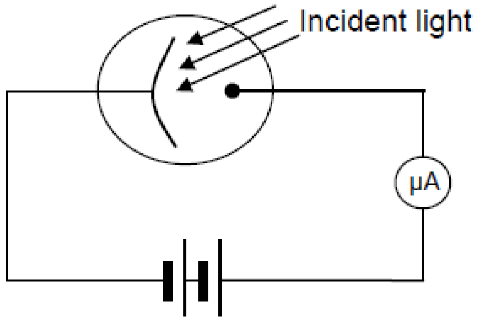
10.2.1 Resistance of the device (5)

10.2.2 Energy the device consumes in two hours (5)
[12]

QUESTION 11 (Start on a new page.)

An investigation was conducted to determine the effects of changes in frequency AND intensity on the current generated in a photoelectric cell when light is incident on it.

The apparatus used in the investigation is shown in the simplified diagram below.



The results of the experiment are shown in the table below.

EXPERIMENT	FREQUENCY (Hz)	INTENSITY (Cd)	CURRENT (μA)
A	$4,00 \times 10^{14}$	10	0
B	$4,50 \times 10^{14}$	10	0
C	$5,00 \times 10^{14}$	10	0
D	$5,01 \times 10^{14}$	10	20
E	$5,01 \times 10^{14}$	20	40
F	$6,50 \times 10^{14}$	10	30

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

11.2 Identify an independent variable. (1)

The threshold frequency for the metal used in the photocell is $5,001 \times 10^{14}$ Hz.

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

11.4 Calculate the maximum speed of an emitted electron in experiment **F**. (5)

In experiments **D** and **E**, the current doubled when the intensity was doubled at the same frequency.

11.5 What conclusion can be made from this observation? (2)
[12]

TOTAL: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)

FEBRUARY/MARCH 2016

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following compounds is an aldehyde?

A CH_3COCH_3

B CH_3CH_2CHO

C CH_3CH_2COOH

D $CH_3CH_2CH_2OH$ (2)

1.2 The equation below represents the decomposition of calcium carbonate.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Which ONE of the following factors will increase the initial rate of decomposition of calcium carbonate?

A Pressure

B Temperature

C Concentration

D Mass of $CaCO_3(s)$ (2)

1.3 Consider the cell notation of the galvanic cell below.

$$Zn \,|\, Zn^{2+} \,\|\, Cu^{2+} \,|\, Cu$$

Which ONE of the following statements regarding this cell is TRUE?

A Copper is formed at the cathode.

B Copper is formed at the anode.

C Zinc is formed at the anode.

D Zinc is formed at the cathode. (2)

1.4 Which ONE of the following compounds will react with sodium hydroxide (NaOH) in a neutralisation reaction?

A CH_3CHO

B CH_3COOH

C CH_3COCH_3

D CH_3CH_2OH (2)

1.5 Consider the reactant **Y** in the following reaction:

$$\mathbf{Y} + H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$$

The formula of **Y** is:

A PO_4^{3-}

B $H_2PO_4^-$

C HPO_4^{2-}

D H_3PO_4 (2)

1.6 A gardener needs a fertiliser with the highest percentage of the relevant nutrient to obtain a green lawn.

Which ONE of the following NPK fertilisers will give the best results?

A 8 : 1 : 5

B 7 : 1 : 1

C 3 : 2 : 3

D 3 : 1 : 5 (2)

1.7 The activation energy for a certain reaction is 50 $kJ \cdot mol^{-1}$. Energy is absorbed when this reaction takes place.

Which ONE of the following is CORRECT for the REVERSE reaction?

	ACTIVATION ENERGY (E_A)	HEAT OF REACTION (ΔH)
A	$E_A > 50\ kJ \cdot mol^{-1}$	$\Delta H > 0$
B	$E_A > 50\ kJ \cdot mol^{-1}$	$\Delta H < 0$
C	$E_A < 50\ kJ \cdot mol^{-1}$	$\Delta H < 0$
D	$E_A < 50\ kJ \cdot mol^{-1}$	$\Delta H > 0$

(2)

1.8 Which ONE of the following pairs of compounds are FUNCTIONAL isomers?

A Methanol and methanal

B Butane and 2-methylpropane

C Propan-1-ol and propan-2-ol

D Propanoic acid and methyl ethanoate (2)

1.9 The balanced equations for three reactions at equilibrium in a closed container are given below.

(i) $C_2H_4(g) + H_2(g) \rightleftharpoons C_2H_6(g)$

(ii) $Fe_3O_4(s) + 4H_2(g) \rightleftharpoons 3Fe(s) + 4H_2O(g)$

(iii) $SO_3(g) + NO(g) \rightleftharpoons NO_2(g) + SO_2(g)$

In which reaction(s) will the equilibrium position shift when the volume of the reaction vessel is decreased at constant temperature?

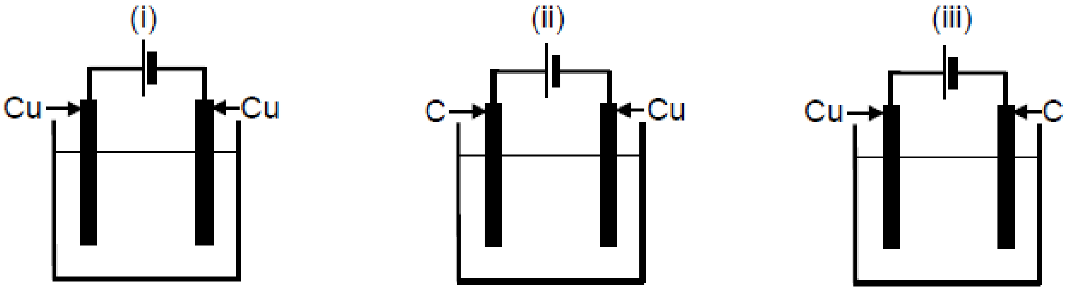
A (i) only

B (i) and (ii) only

C (i) and (iii) only

D (i), (ii) and (iii) (2)

1.10 In each of the electrolytic cells below, copper(II) sulphate is used as the electrolyte. The electrodes are either carbon (C) or copper (Cu).



In which cell(s) will the concentration of the electrolyte remain constant during electrolysis?

A (i) only

B (i) and (ii) only

C (i) and (iii) only

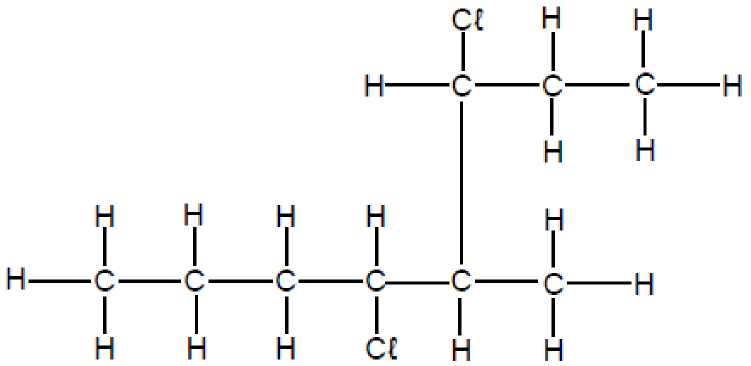
D (ii) and (iii) only (2)

[20]

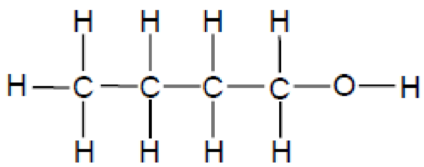
QUESTION 2 (Start on a new page.)

2.1 Consider the organic compounds represented by the letters **A** to **C** below.

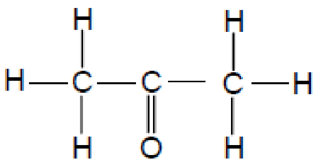
A



B



C



Write down the:

2.1.1 Name of the homologous series to which compound **C** belongs (1)

2.1.2 IUPAC name of compound **A** (3)

2.1.3 Structural formula of a tertiary alcohol that is a structural isomer of compound **B** (2)

2.2 An alcohol and methanoic acid are heated in the presence of concentrated sulphuric acid to form an ester.

2.2.1 What is the role of the concentrated sulphuric acid in this reaction? (1)

2.2.2 Write down the NAME or FORMULA of the inorganic product formed. (1)

The ester contains 6,67% hydrogen (H), 40% carbon (C) and 53,33% oxygen (O). The molar mass of the ester is 60 $g \cdot mol^{-1}$.

Use a calculation to determine its:

2.2.3 Empirical formula (5)

2.2.4 Molecular formula (3)

Write down the:

2.2.5 Structural formula of methanoic acid (1)

2.2.6 IUPAC name of the ester (2)

[19]

QUESTION 3 (Start on a new page.)

3.1 Define the term *boiling point.* (2)

3.2 What is the relationship between strength of intermolecular forces and boiling point? (1)

The relationship between strength of intermolecular forces and boiling point is investigated using four organic compounds from different homologous series. The compounds and their boiling points are given in the table below.

COMPOUND		BOILING POINT (°C)
A	Propane	-42
B	Propan-2-one	56
C	Propan-1-ol	97
D	Propanoic acid	141

3.3 Refer to the TYPE and the STRENGTH of intermolecular forces to explain the difference in boiling points between:

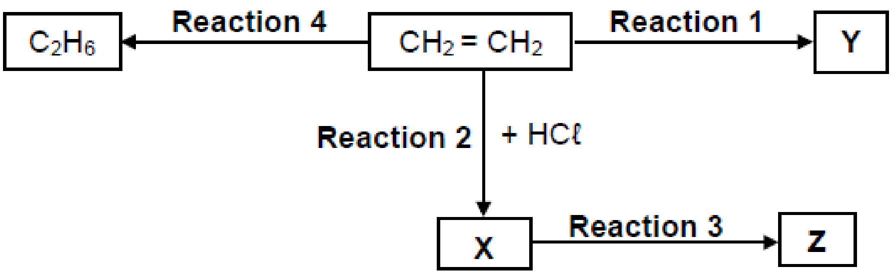
3.3.1 Compounds **A** and **B** (3)

3.3.2 Compounds **C** and **D** (3)

3.4 Is compound **B** a GAS or a LIQUID at room temperature? (1)
[10]

QUESTION 4 (Start on a new page.)

The flow diagram below shows different organic reactions using $CH_2 = CH_2$ as the starting reactant. **X**, **Y** and **Z** represent different organic compounds.



4.1 During **Reaction 1**, $CH_2 = CH_2$ undergoes polymerisation to form compound **Y**.

For this reaction, write down the:

4.1.1 Type of polymerisation (1)

4.1.2 NAME of compound **Y** (1)

4.2 For **Reaction 2**, write down the:

4.2.1 IUPAC name of compound **X** (2)

4.2.2 Type of addition reaction of which this is an example (1)

4.3 During **Reaction 3**, compound **X** reacts with excess hot water.

Write down the:

4.3.1 STRUCTURAL FORMULA of compound **Z** (2)

4.3.2 NAME or FORMULA of the INORGANIC product (1)

4.4 **Reaction 4** is an addition reaction.

4.4.1 Is C_2H_6 a SATURATED or an UNSATURATED compound? Give a reason for the answer. (2)

4.4.2 Write down the NAME or FORMULA of the INORGANIC reactant needed for this reaction. (1)

4.4.3 Using molecular formulae, write down a balanced equation for the complete combustion of C_2H_6. (3)

[14]

QUESTION 5 (Start on a new page.)

NOTE: The graph for QUESTION 5.3.2 must be drawn on the GRAPH SHEET attached at the end of the QUESTION PAPER.

Methanol and hydrochloric acid react according to the following balanced equation:

$$CH_3OH(aq) + HC\ell(aq) \rightarrow CH_3C\ell(aq) + H_2O(\ell)$$

5.1 State TWO factors that can INCREASE the rate of this reaction. (2)

5.2 Define the term *reaction rate*. (2)

5.3 The rate of the reaction between methanol and hydrochloric acid is investigated. The concentration of $HC\ell(aq)$ was measured at different time intervals. The following results were obtained:

TIME (MINUTES)	$HC\ell$ CONCENTRATION ($mol \cdot dm^{-3}$)
0	1,90
15	1,45
55	1,10
100	0,85
215	0,60

5.3.1 Calculate the average reaction rate, in $(mol \cdot dm^{-3}) \cdot min^{-1}$ during the first 15 minutes. (3)

5.3.2 Use the data in the table to draw a graph of concentration versus time on the attached GRAPH SHEET.
NOTE: The graph is not a straight line.
(ATTACH THIS GRAPH SHEET TO YOUR ANSWER BOOK.) (3)

5.3.3 From the graph, determine the concentration of $HC\ell(aq)$ at the 40^{th} minute. (1)

5.3.4 Use the collision theory to explain why the reaction rate decreases with time. Assume that the temperature remains constant. (3)

5.3.5 Calculate the mass of $CH_3C\ell(aq)$ in the flask at the 215^{th} minute. The volume of the reagents remains $60\ cm^3$ during the reaction. (5)
[19]

QUESTION 6 (Start on a new page.)

Initially, 2,2 g of pure $CO_2(g)$ is sealed in an empty 5 dm^3 container at 900 °C.

6.1 Calculate the initial concentration of $CO_2(g)$. (4)

6.2 Give a reason why equilibrium will not be established. (1)

$CaCO_3(s)$ is now added to the 2,2 g $CO_2(g)$ in the container and after a while equilibrium is established at 900 °C according to the following balanced equation:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

The equilibrium constant for this reaction at 900 °C is 0,0108.

6.3 Give a reason why this reaction will only reach equilibrium in a SEALED container. (1)

6.4 Calculate the minimum mass of $CaCO_3(s)$ that must be added to the container to achieve equilibrium. (7)

6.5 How will EACH of the following changes affect the amount of $CO_2(g)$? Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.5.1 More $CaCO_3(s)$ is added at 900 °C (1)

6.5.2 The pressure is increased (1)

6.6 It is found that the equilibrium constant (K_c) for this reaction is 2,6 x 10^{-6} at 727 °C. Is the reaction EXOTHERMIC or ENDOTHERMIC? Fully explain how you arrived at the answer. (4)
[19]

QUESTION 7 (Start on a new page.)

7.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.2 Carbonated water is an aqueous solution of carbonic acid, H_2CO_3. $H_2CO_3(aq)$ ionises in two steps when it dissolves in water.

7.2.1 Write down the FORMULA of the conjugate base of $H_2CO_3(aq)$. (1)

7.2.2 Write down a balanced equation for the first step in the ionisation of carbonic acid. (3)

7.2.3 The pH of a carbonic acid solution at 25 °C is 3,4. Calculate the hydroxide ion concentration in the solution. (5)

7.3 **X** is a monoprotic acid.

7.3.1 State the meaning of the term *monoprotic*. (1)

7.3.2 A sample of acid **X** is titrated with a standard sodium hydroxide solution using a suitable indicator.

At the endpoint it is found that 25 cm^3 of acid **X** is neutralised by 27,5 cm^3 of the sodium hydroxide solution of concentration 0,1 $mol{\cdot}dm^{-3}$.

Calculate the concentration of acid **X**. (5)

7.3.3 The concentration of H_3O^+ ions in the sample of acid **X** is $2,4 \times 10^{-4}$ $mol{\cdot}dm^{-3}$.

Is acid **X** a WEAK or a STRONG acid? Explain the answer by referring to the answer in QUESTION 7.3.2. (3)

[20]

QUESTION 8 (Start on a new page.)

An electrochemical cell consisting of half-cells **A** and **B** is assembled under standard conditions as shown below.

Half-cell **A**	Pt, $C\ell_2$ (101,3 kPa) | $C\ell^-$ (1 mol·dm^{-3})
Half-cell **B**	Mg^{2+} (1 mol·dm^{-3}) | Mg(s)

8.1 At which half-cell, **A** or **B**, are electrons released into the external circuit? (1)

8.2 Write down the:

8.2.1 Reduction half-reaction that takes place in this cell (2)

8.2.2 NAME or FORMULA of the substance whose oxidation number DECREASES (1)

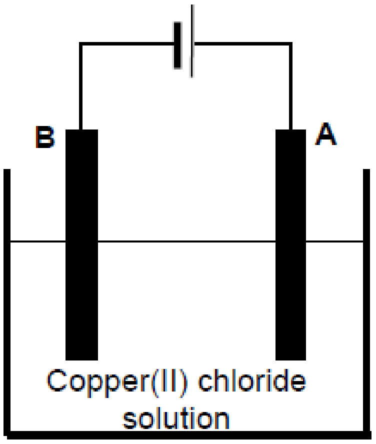
8.3 Calculate the initial cell potential of this cell when it is in operation. (4)

8.4 Write down an observation that will be made in half-cell **B** as the cell operates. Give a reason for the answer. (2)

[10]

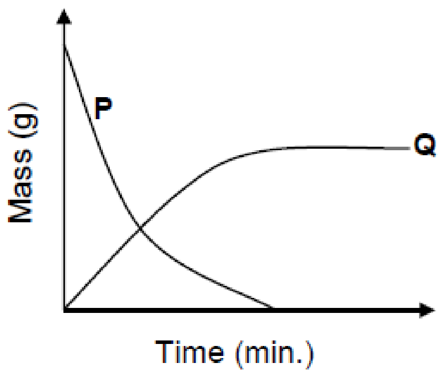
QUESTION 9 (Start on a new page.)

The electrochemical cell below is set up to demonstrate the purification of copper.



9.1 Write down the type of electrochemical cell illustrated above. (1)

The graphs below show the change in mass of the electrodes whilst the cell is in operation.



9.2 Define a *reducing agent* in terms of electron transfer. (2)

9.3 Which graph represents the change in mass of electrode **A**? (1)

9.4 Write down the half-reaction that takes place at electrode **A**. (2)

9.5 Electrodes **A** and **B** are now replaced by graphite electrodes. It is observed that chlorine gas ($C\ell_2$) is released at one of the electrodes.

At which electrode (**A** or **B**) is chlorine gas formed? Fully explain how it is formed. (3)
[9]

QUESTION 10 (Start on a new page.)

Ammonium nitrate is an important fertiliser. It is produced by reacting nitric acid with ammonia. Both nitric acid and ammonia are prepared on a large scale in industry.

10.1 Write down the name of the industrial preparation of nitric acid. (1)

10.2 The catalytic oxidation of ammonia is one of the steps in the process named in QUESTION 10.1.

Write down the NAMES or FORMULAE of the TWO products formed in this step. (2)

10.3 Write down a balanced equation for the preparation of ammonium nitrate. (3)

10.4 Calculate the mass, in kilogram, of ammonium nitrate that can be made from $6,8 \times 10^4$ kg of ammonia and excess nitric acid.
(One mole of ammonia produces one mole of ammonium nitrate.) (3)

10.5 Ammonium nitrate is often mixed with potassium chloride and ammonium phosphate. Give a reason why it is mixed with these compounds. (1)
[10]

TOTAL: 150

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2016

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 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.

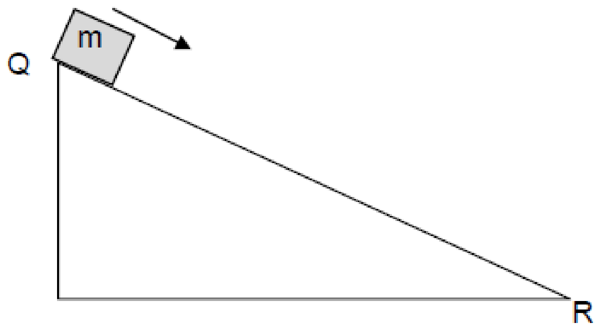
Which ONE of the following is CORRECT for the second bottle compared to the first bottle for the same momentum change?

	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.

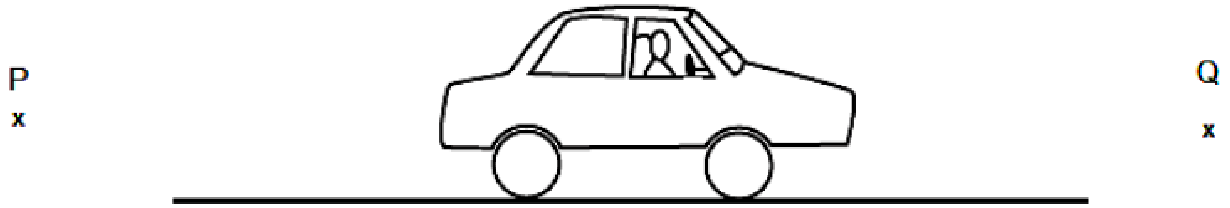


Which ONE of the statements regarding the total mechanical energy and the kinetic energy of the block at points **Q** and **R** respectively is CORRECT?

	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.

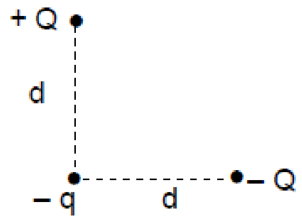


Which ONE of the following CORRECTLY describes the frequency of the sound heard by **P** and **Q**, *compared to that heard by the driver*?

	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.



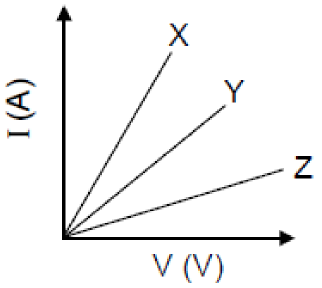
Which ONE of the following arrows CORRECTLY shows the direction of the net force acting on charge – q due to the presence of charges + Q and – Q?

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

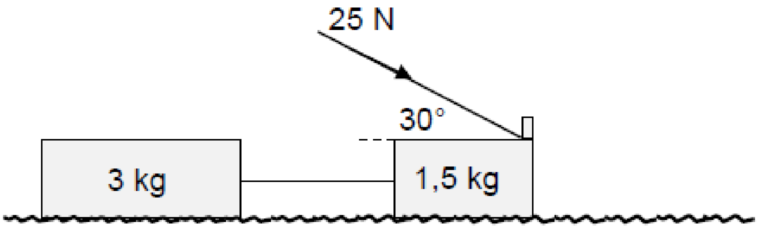
D twice the energy (2)

[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 (μ_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:

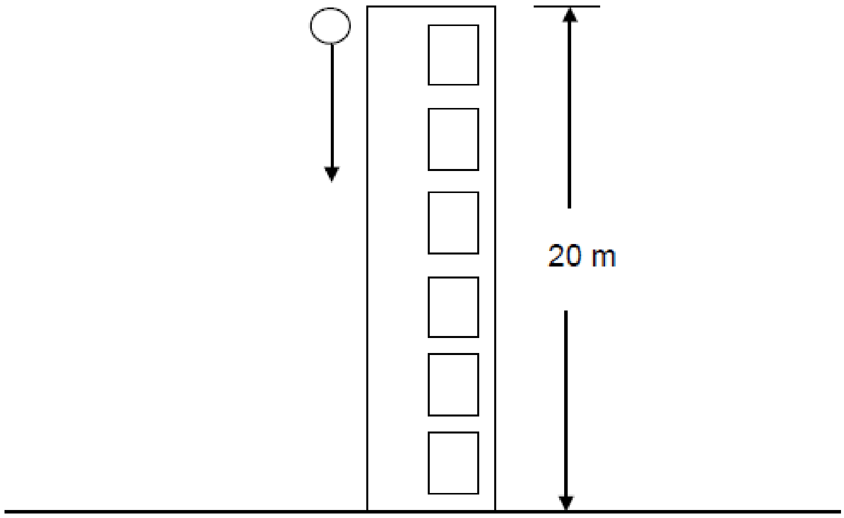
2.4.1 Kinetic frictional force acting on the 1,5 kg block (3)

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)

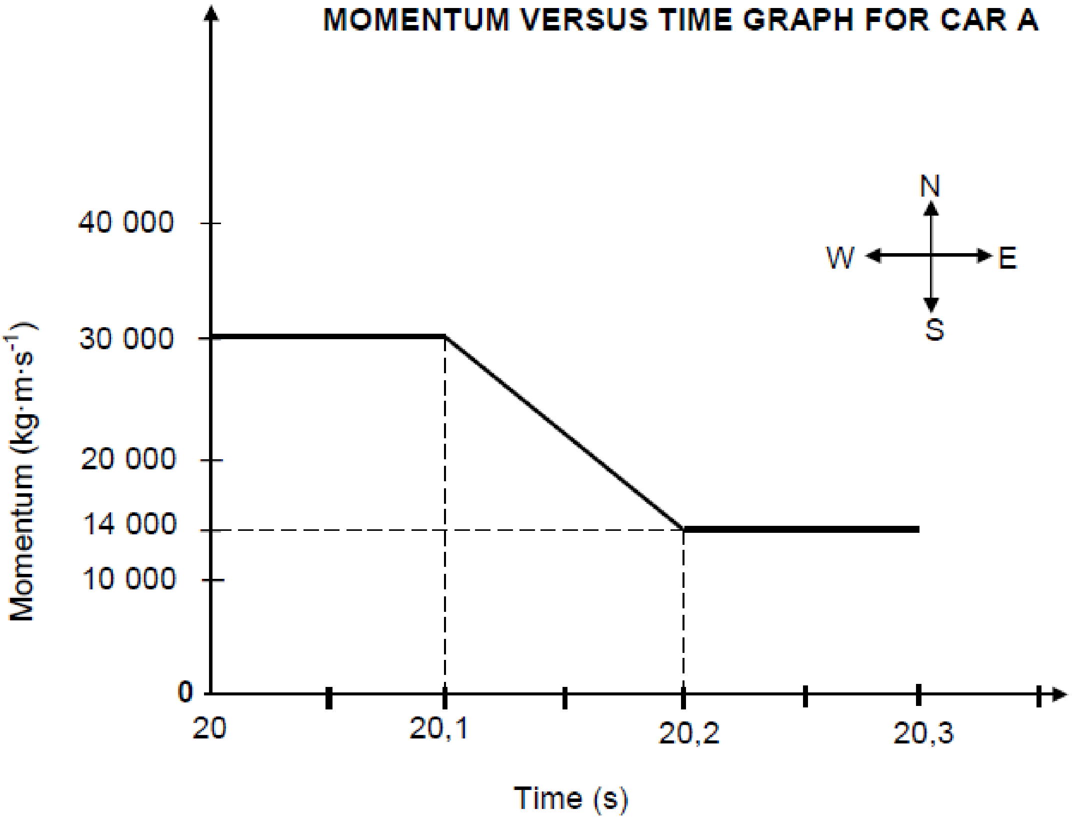
3.2.2 Time it takes the ball to reach the ground (3)

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)

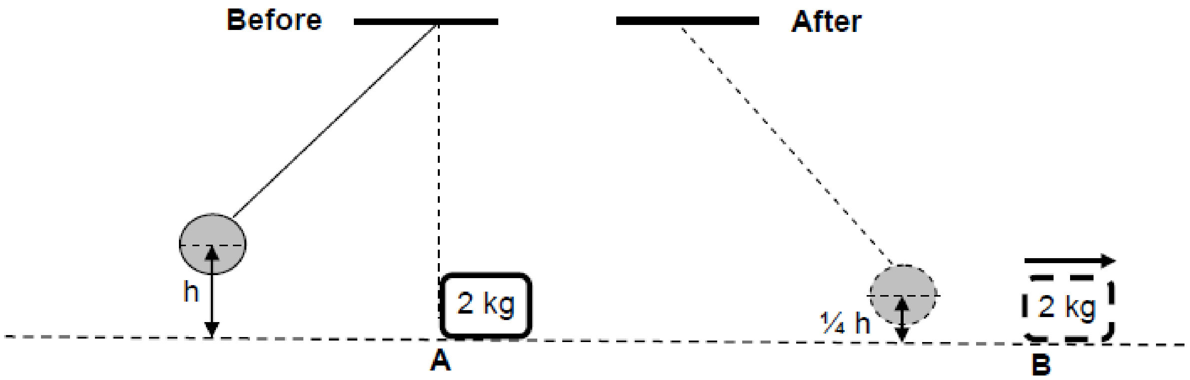
[13]

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.



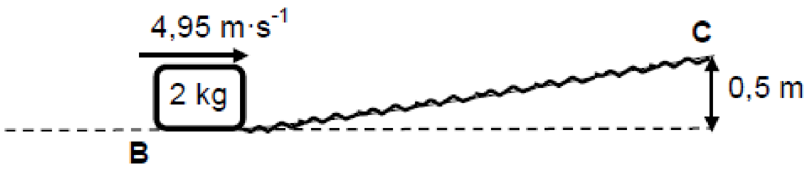
Immediately after the collision the 2 kg block begins to move from **A** to **B** at a constant speed of 4,95 $m \cdot s^{-1}$.
Ignore frictional effects and assume that no loss of mechanical energy occurs during the collision.

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.

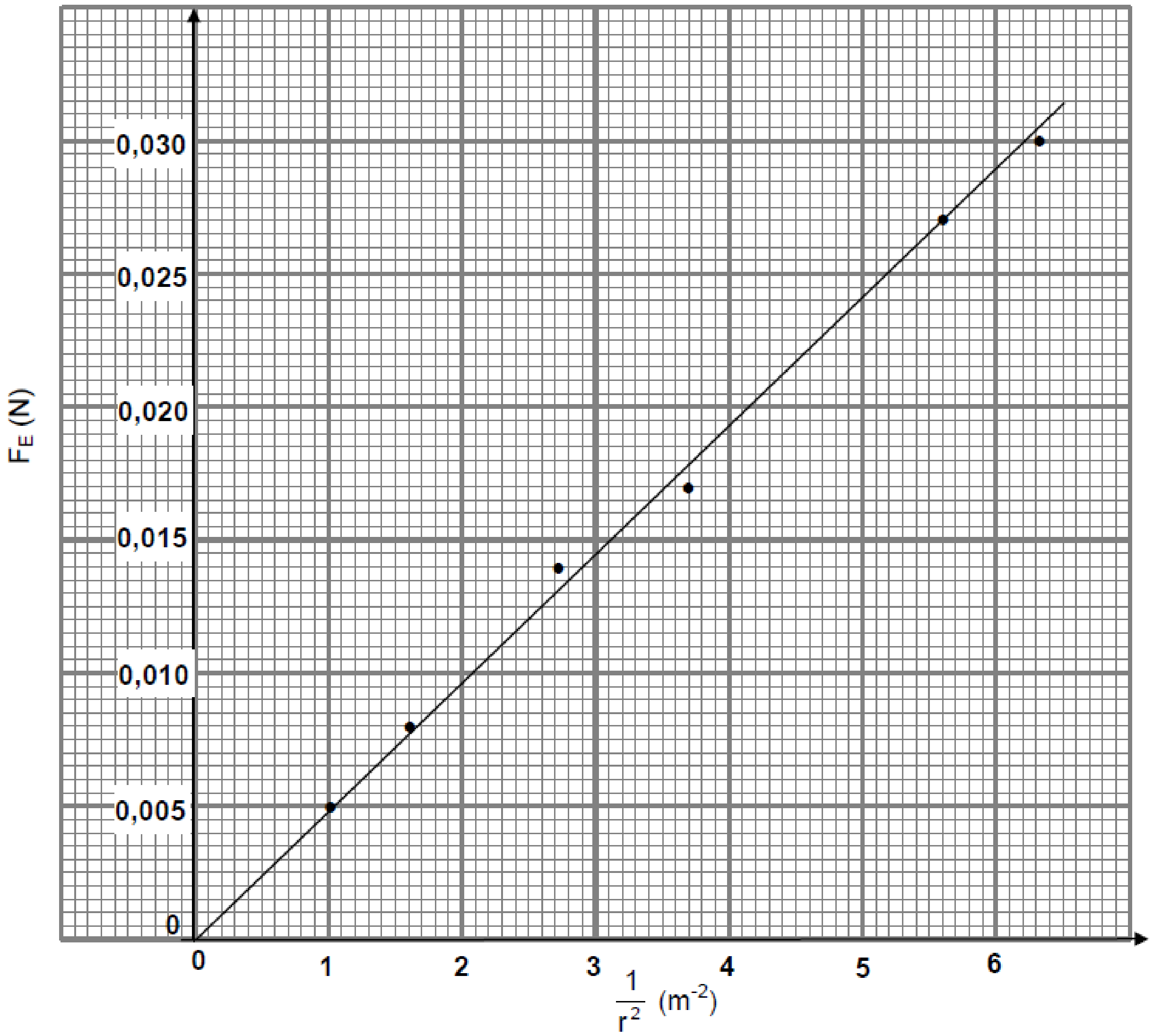
Explain, in terms of the frequencies of the spectral lines, how it is possible to conclude that the star is moving away from the Earth. (2)

[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)

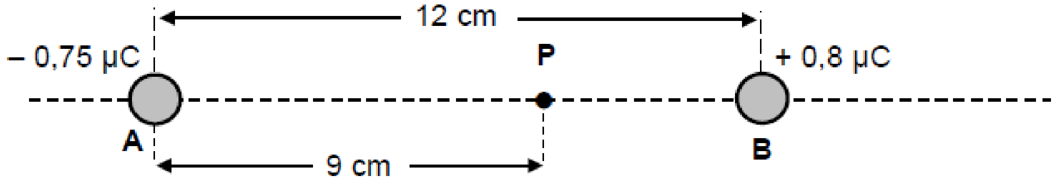
7.1.3 What relationship between the electrostatic force F_E and the square of the distance, r^2, between the charged spheres can be deduced from the graph? (1)

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)

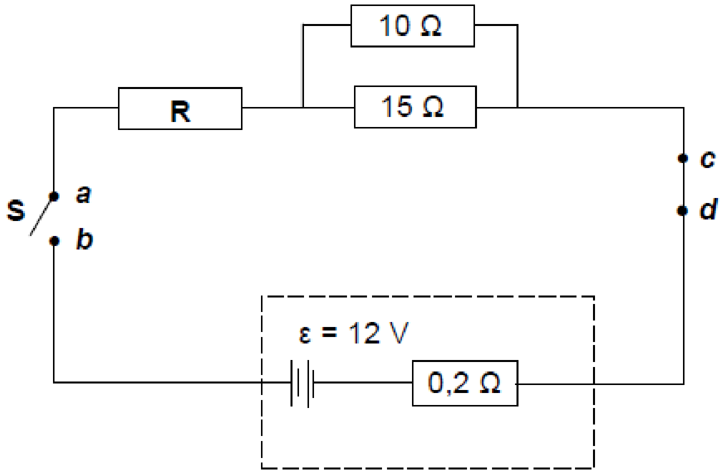
Sphere **A** is placed 12 cm away from another charged sphere, **B**, along a straight line in a vacuum, as shown below. Sphere **B** carries a charge of +0,8 μC. Point **P** is located 9 cm to the right of sphere **A**.



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:

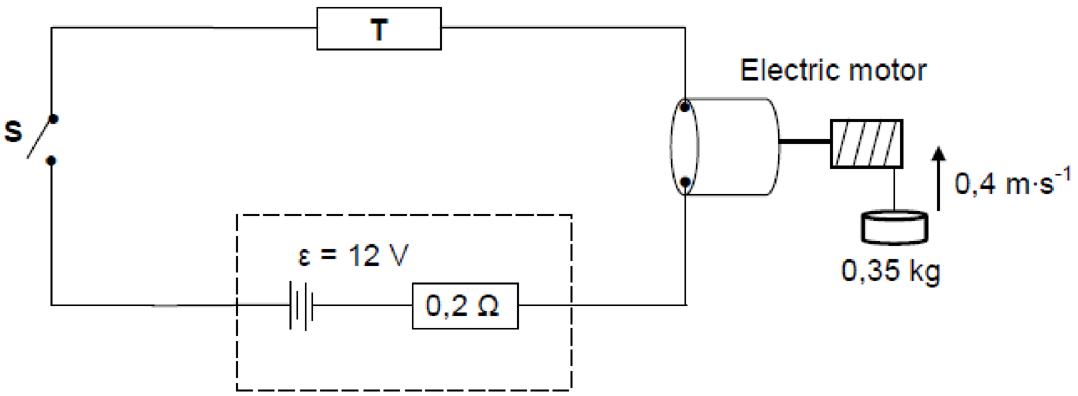
8.1.4 Current in the battery (3)

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.

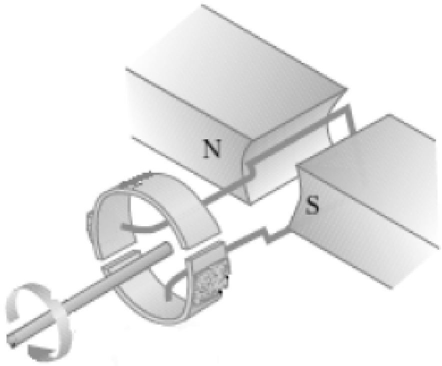
Calculate the value of:

8.2.1 **X** (3)

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

QUESTION 9 (Start on a new page.)

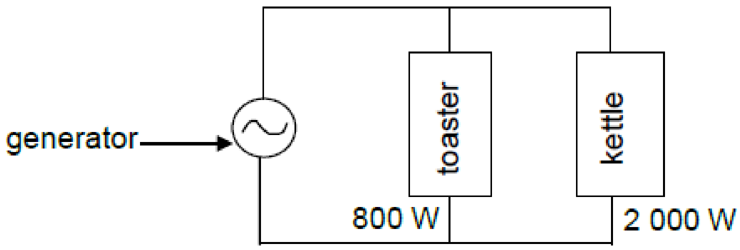
9.1 A generator is shown below. Assume that the coil is in a vertical position.



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.

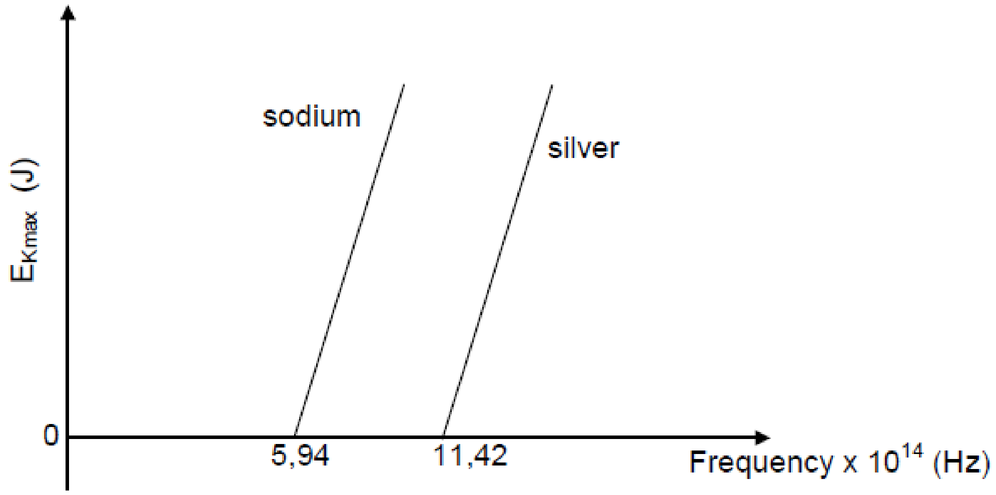
Calculate the:

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 470×10^{-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

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2016

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?

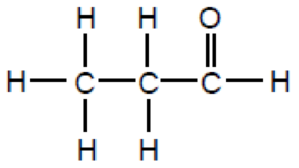
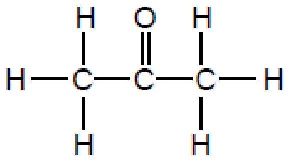
A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$

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-}

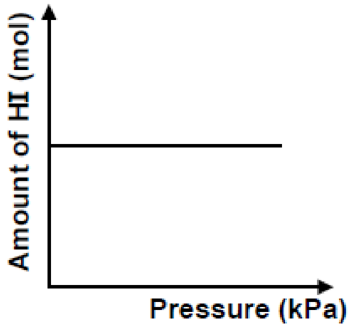
D H_2CO_3 and HCO_3^- (2)

1.8 The reaction between hydrogen gas and iodine gas reaches equilibrium in a closed container according to the following balanced equation:

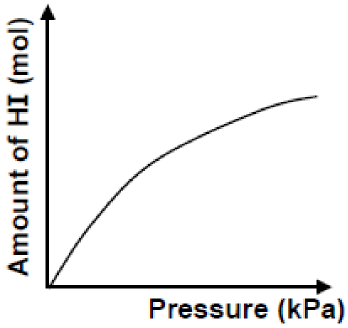
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

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?

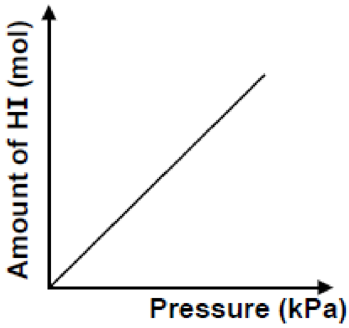
A



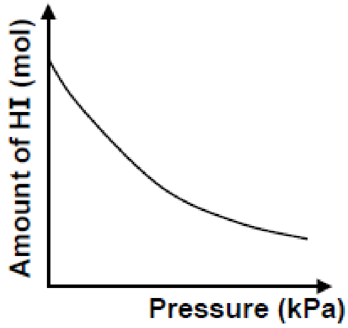
B



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?

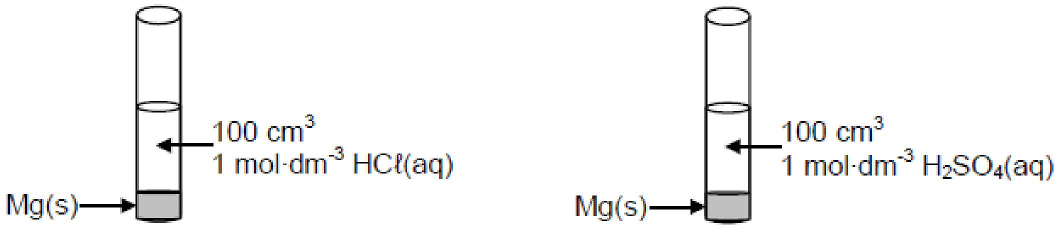
A $Ag \rightarrow Ag^{+} + e^{-}$

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

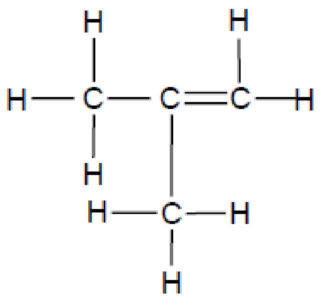
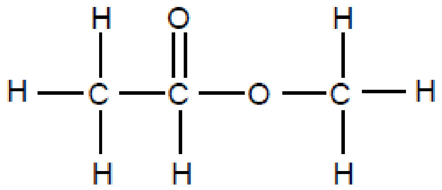
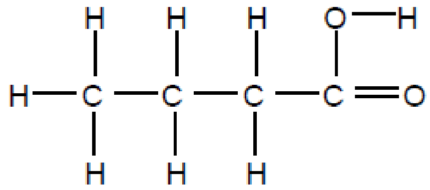
C **III** only

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.

$$C_{10}H_{22} \rightarrow \mathbf{X} + C_4H_{10}$$

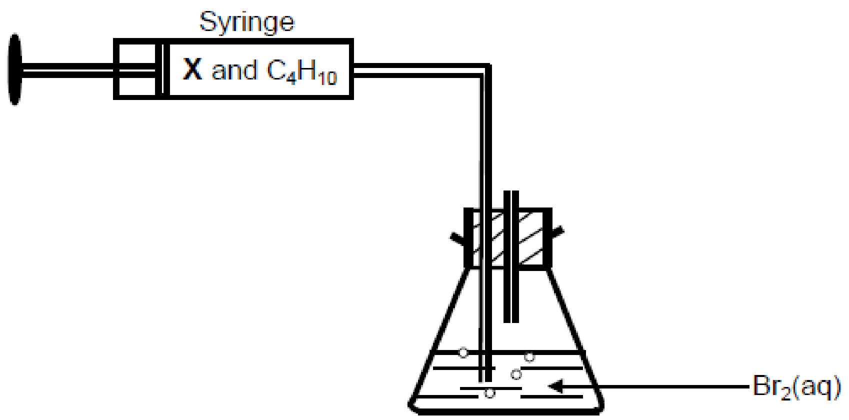
4.1 Write down:

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)

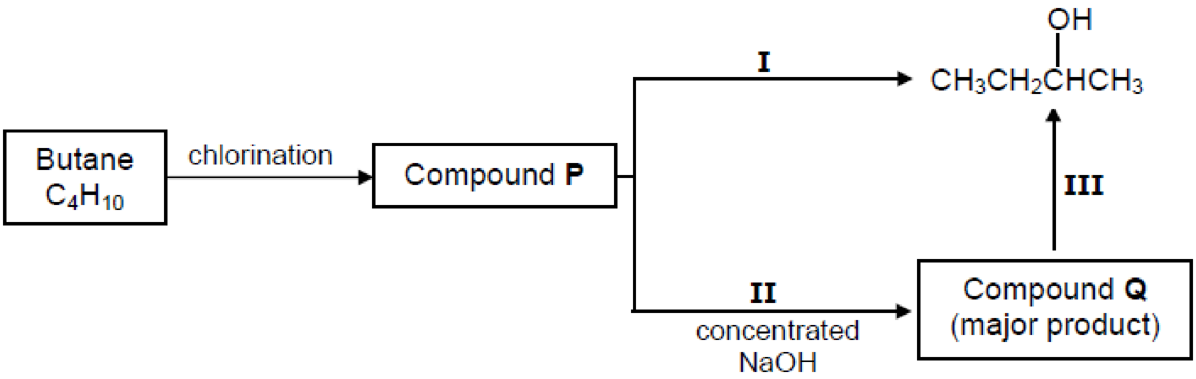
4.2 A mixture of the two gases, compound **X** and butane, is bubbled through bromine water, $Br_2(aq)$, in a conical flask, as illustrated below. THE REACTION IS CARRIED OUT IN A DARKENED ROOM.



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 (ΔH) is −196 kJ.

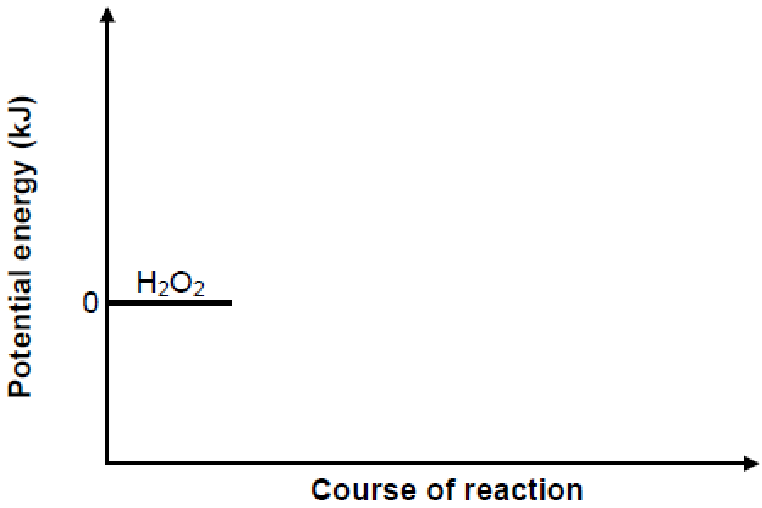
5.1.1 Define the term *activation energy*. (2)

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.)



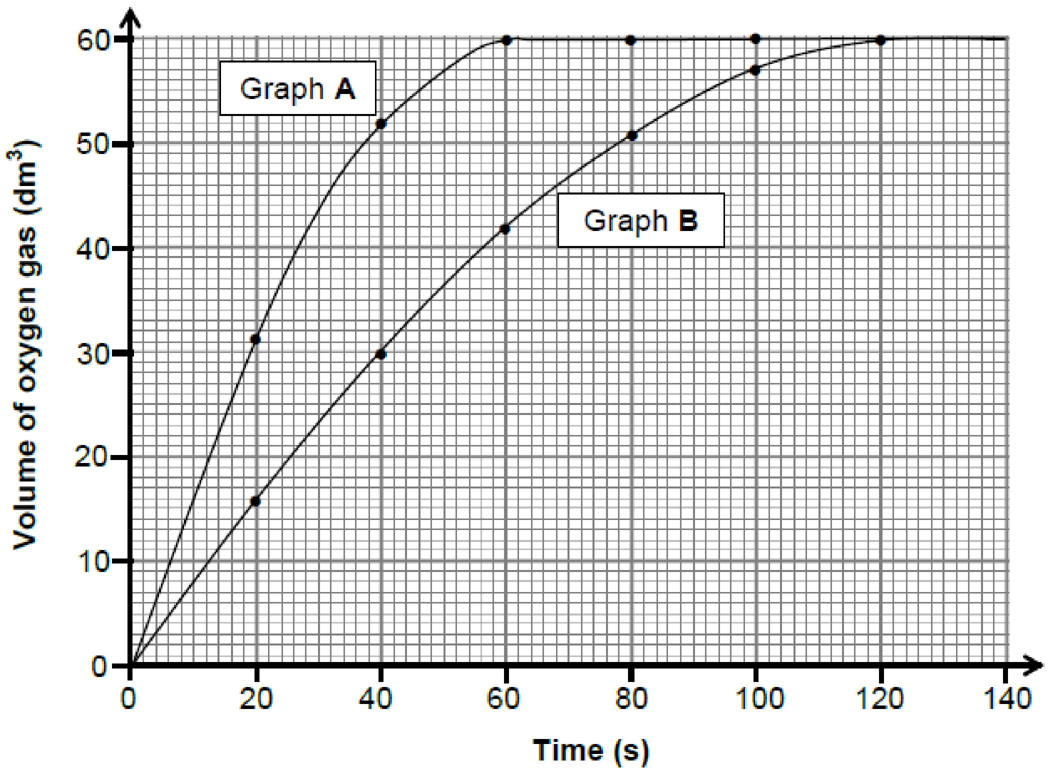
(3)

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.



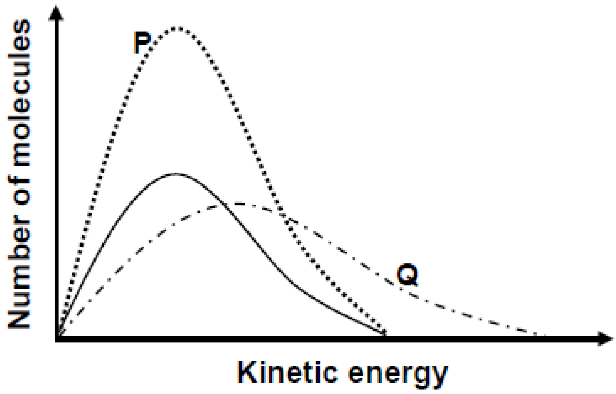
5.2.1 Calculate the average rate of the reaction (in $dm^3 \cdot s^{-1}$) between t = 10 s and t = 40 s for graph **A**. (3)

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)

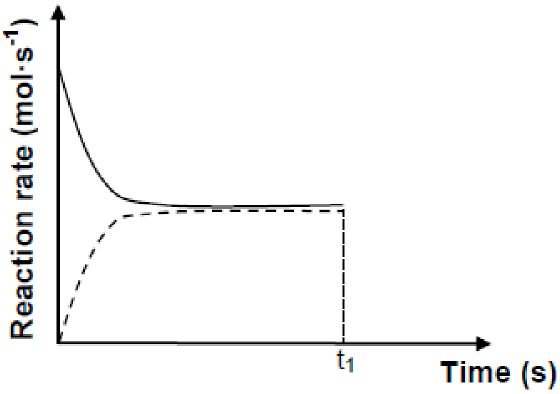
6.2 How will EACH of the following changes affect the number of moles of $H_2S(g)$ at equilibrium?

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 ($NH_4Cℓ$) 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 $H_2SO_4(ℓ)$ 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:

$$H_2SO_4(aq) + 2NaOH(s) \rightarrow Na_2SO_4(aq) + 2H_2O(ℓ)$$

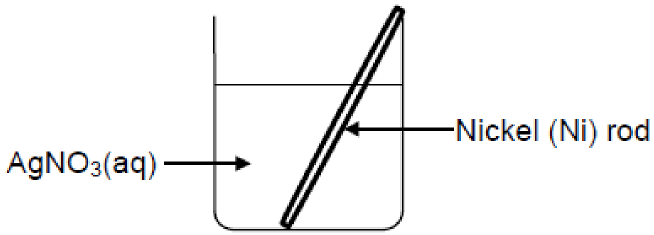
After completion of the reaction, the pH of the solution was found to be 1,3. Assume complete ionisation of H_2SO_4.

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.



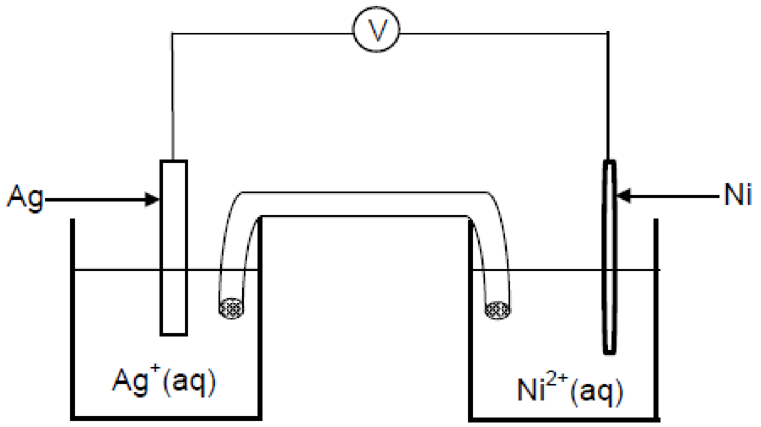
Write down the:

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)

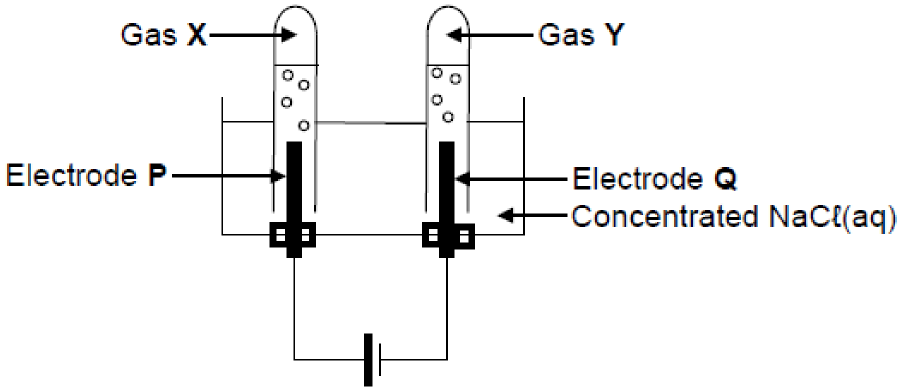
8.2.3 Calculate the initial reading on the voltmeter if the cell functions under standard conditions. (4)

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)

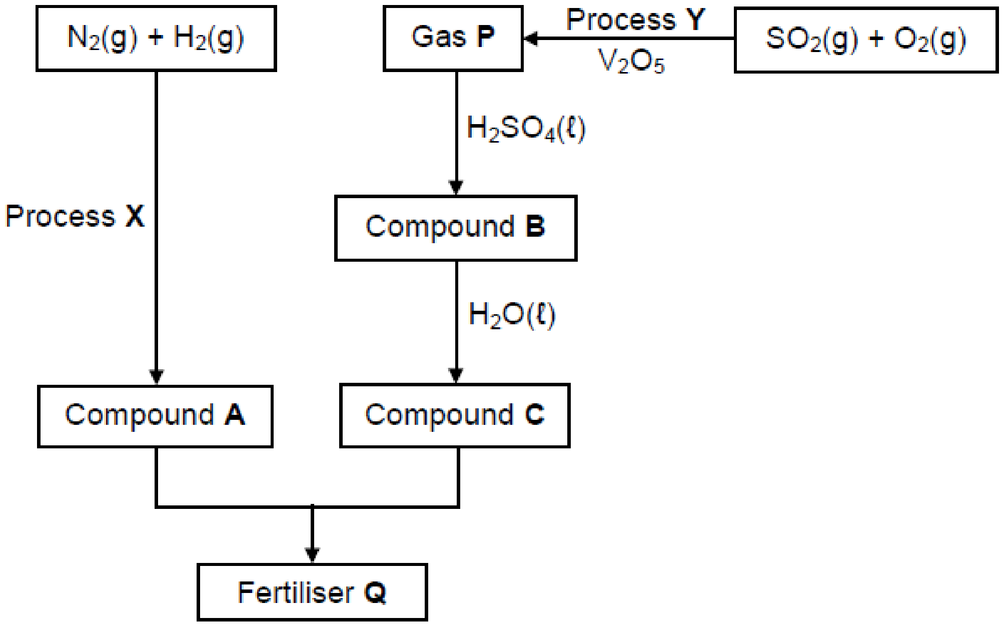
9.3.3 Reduction half-reaction (2)

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)

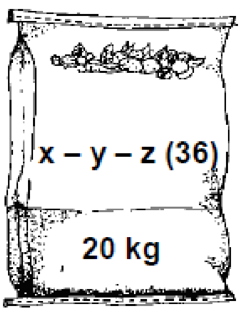
10.1.2 Name of process **Y** (1)

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

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2017

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 According to Newton's Second Law of Motion, the acceleration of an object is …

A independent of its mass.

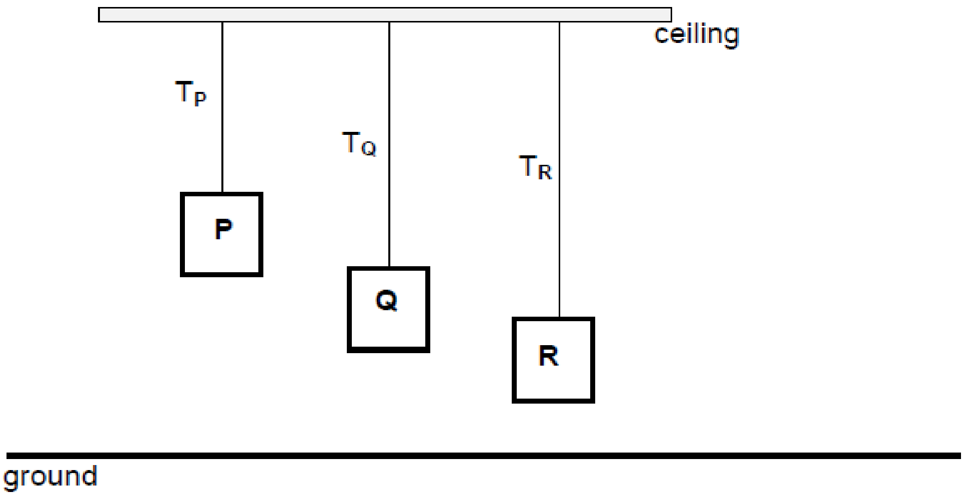
B always equal to its mass.

C directly proportional to its mass.

D inversely proportional to its mass. (2)

1.2 The diagram below shows three blocks, **P**, **Q** and **R**, suspended from a ceiling. The blocks are *identical*, *stationary* and have the *same mass* but are at different heights above the ground.

The connecting strings are massless and inextensible. The tensions in the strings attached to blocks **P**, **Q** and **R** are T_P, T_Q and T_R respectively.



Which ONE of the following statements about the tensions is CORRECT?

A $T_P > T_Q > T_R$

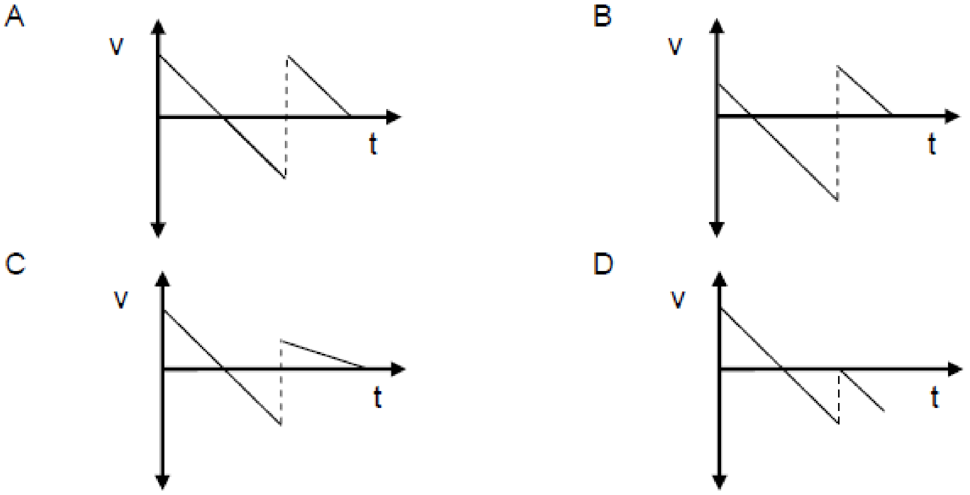
B $T_P < T_Q < T_R$

C $T_P = T_Q = T_R$

D $T_P > T_Q$ and $T_Q < T_R$ (2)

1.3 A ball is projected vertically upwards from the ground. It returns to the ground, makes an elastic collision with the ground and then bounces to a maximum height. Ignore air resistance.

Which ONE of the following velocity-time graphs CORRECTLY describes the motion of the ball?



(2)

1.4 When the velocity of a moving object is *doubled*, the …

A net work done by the object is doubled.

B kinetic energy of the object is doubled.

C potential energy of the object is doubled.

D linear momentum of the object is doubled. (2)

1.5 The net work required to stop a moving object is equal to the …

A inertia of the object.

B change in kinetic energy of the object.

C change in momentum of the object.

D change in impulse of the object. (2)

1.6 A stationary observer is listening to the sound coming from a sound source. The listener hears a sound of a lower pitch when compared to that produced by the source.

What can you conclude about the source from this observation?

A The source is at rest.

B The source is moving towards the listener.

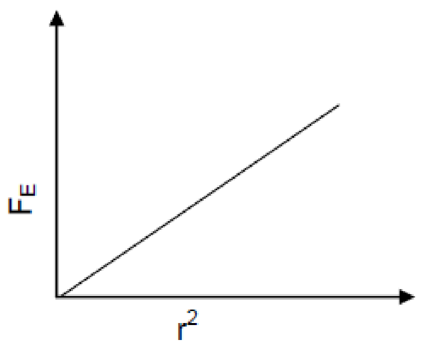
C The source is moving away from the listener.

D There is an obstacle between the source and the listener. (2)

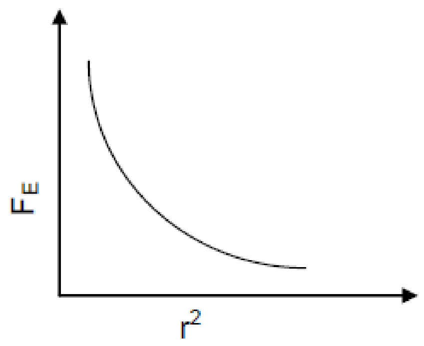
1.7 Two charged particles are placed a distance, r, apart. The electrostatic force exerted by one charged particle on the other is F_E.

Which ONE of the graphs below CORRECTLY represents the relationship between the electrostatic force, F_E, and the square of the distance, r^2, between the two charges?

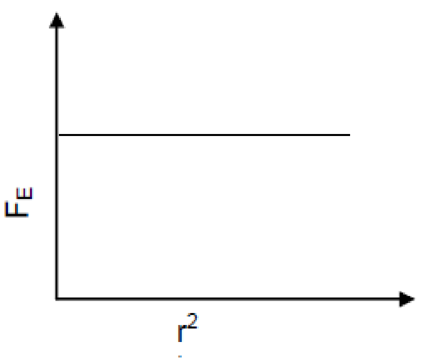
A



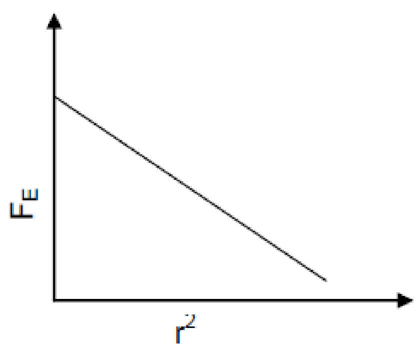
B



C



D

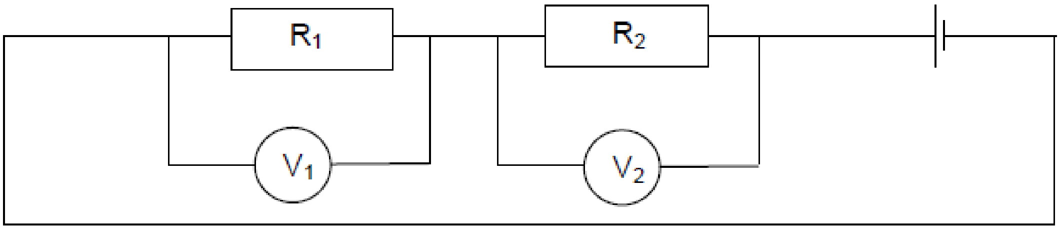


(2)

1.8 In the circuit diagram below, the resistance of resistor R_1 is TWICE the resistance of resistor R_2.

The two resistors are connected in series and identical high-resistance voltmeters are connected across each resistor.

The readings on the voltmeters are V_1 and V_2 respectively.



Which ONE of the following statements concerning the voltmeter readings is CORRECT?

A $V_1 = 2V_2$

B $V_1 = ½V_2$

C $V_1 = ¼V_2$

D $2V_1 = V_2$ (2)

1.9 In a DC generator the current to the external circuit is delivered through the …

A coils.

B battery.

C slip rings.

D split rings (commutators). (2)

1.10 In an experiment on the photoelectric effect, the frequency of the incident light is high enough to cause the removal of electrons from the surface of the metal.

The number of electrons ejected from the metal surface is proportional to the …

A kinetic energy of the electrons.

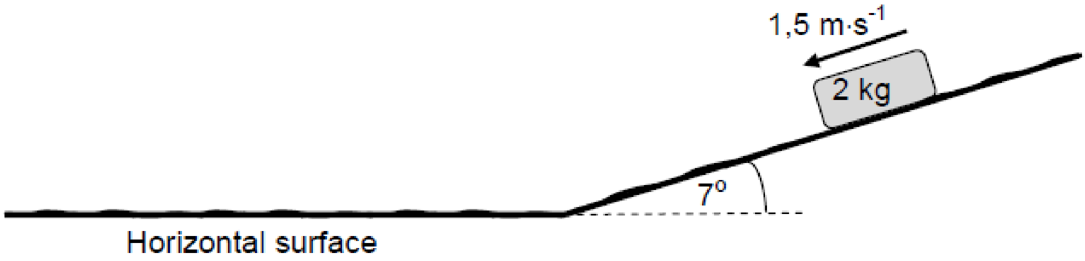
B number of incident photons.

C work function of the metal.

D frequency of the incident light. (2)
[20]

QUESTION 2 (Start on a new page.)

In the diagram below, a small object of mass 2 kg is sliding *at a constant velocity* of 1,5 m·s^{-1} down a rough plane inclined at 7° to the horizontal surface.



At the bottom of the plane, the object continues sliding onto the rough horizontal surface *and eventually comes to a stop*.

The coefficient of kinetic friction between the object and the surface is *the same for both the inclined surface and the horizontal surface.*

2.1 Write down the magnitude of the net force acting on the object. (1)

2.2 Draw a labelled free-body diagram for the object while it is on the inclined plane. (3)

2.3 Calculate the:

2.3.1 Magnitude of the frictional force acting on the object while it is sliding down the inclined plane (3)

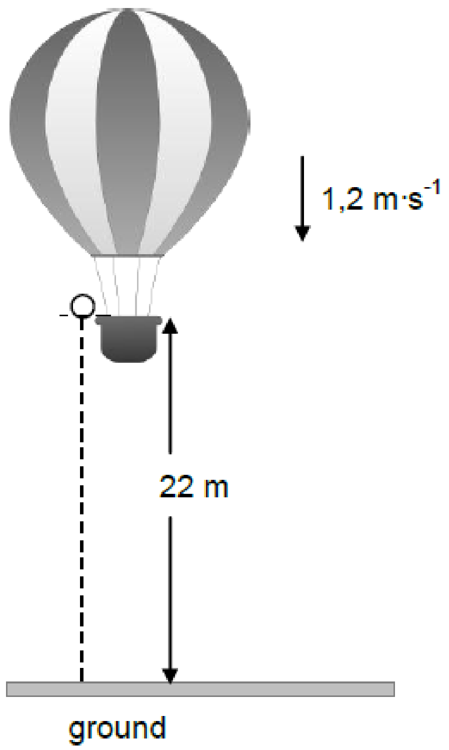
2.3.2 Coefficient of kinetic friction between the object and the surfaces (3)

2.3.3 Distance the object travels on the horizontal surface before it comes to a stop (5)

[15]

QUESTION 3 (Start on a new page.)

A hot-air balloon moves vertically downwards at a constant velocity of 1,2 $m \cdot s^{-1}$. When it reaches a height of 22 m from the ground, a ball is dropped from the balloon. Refer to the diagram below.



Assume that the dropping of the ball has no effect on the speed of the hot-air balloon. Ignore air friction for the motion of the ball.

3.1 Explain the term *projectile motion*. (2)

3.2 Is the hot-air balloon in free fall? Give a reason for the answer. (2)

3.3 Calculate the time it takes for the ball to hit the ground after it is dropped. (4)

When the ball lands on the ground, it is in contact with the ground for 0,3 s and then it bounces vertically upwards with a speed of 15 $m \cdot s^{-1}$.

3.4 Calculate how high the balloon is from the ground when the ball reaches its maximum height after the first bounce. (6)

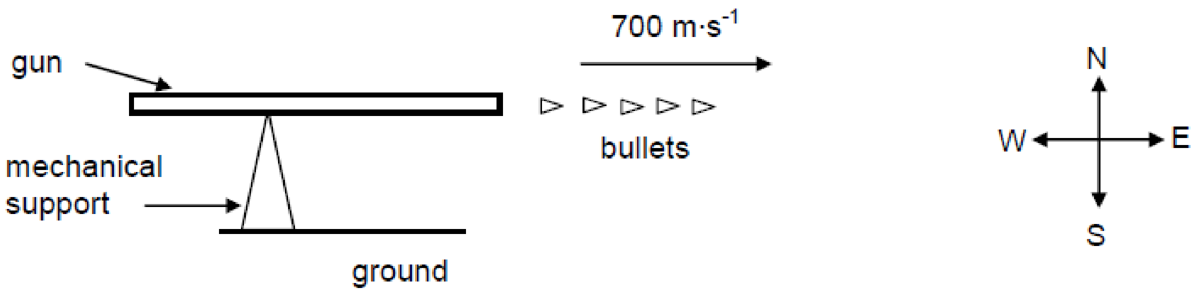
[14]

QUESTION 4 (Start on a new page.)

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

4.2 The diagram below shows a gun mounted on a mechanical support which is fixed to the ground. The gun is capable of firing bullets rapidly in a horizontal direction.

Each bullet travels at a speed of 700 $m \cdot s^{-1}$ in an easterly direction when it leaves the gun.
(Take the initial velocity of a bullet, before being fired, as zero.)



The gun fires 220 bullets per minute. The mass of each bullet is 0,03 kg.

Calculate the:

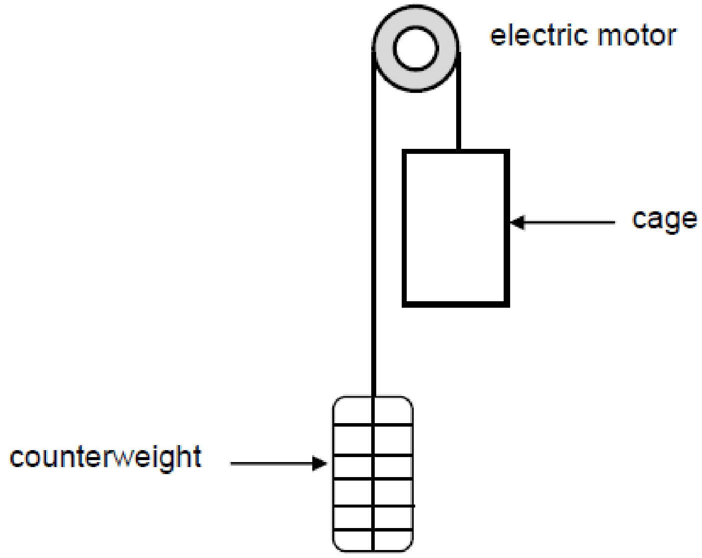
4.2.1 Magnitude of the momentum of each bullet when it leaves the gun (3)

4.2.2 The net average force that each bullet exerts on the gun (5)

4.3 Without any further calculation, write down the net average horizontal force that the mechanical support exerts on the gun. (2)
[12]

QUESTION 5 (Start on a new page.)

A lift arrangement comprises an electric motor, a cage and its counterweight. The counterweight moves vertically downwards as the cage moves upwards. The cage and counterweight move at the same constant speed. Refer to the diagram below.



The cage, carrying passengers, moves vertically upwards at a constant speed, covering 55 m in 3 minutes. The counterweight has a mass of 950 kg. The total mass of the cage and passengers is 1 200 kg. The electric motor provides the power needed to operate the lift system. Ignore the effects of friction.

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

5.2 Calculate the work done by the:

5.2.1 Gravitational force on the cage (3)

5.2.2 Counterweight on the cage (2)

5.3 Calculate the average power required by the motor to operate the lift arrangement in 3 minutes. Assume that there are no energy losses due to heat and sound. (6)

[13]

QUESTION 6 (Start on a new page.)

6.1 A sound source is moving at constant velocity past a stationary observer. The frequency detected as the source approaches the observer is 2 600 Hz. The frequency detected as the source moves away from the observer is 1 750 Hz.

Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1.1 Name the phenomenon that describes the apparent change in frequency detected by the observer. (1)

6.1.2 State ONE practical application of the phenomenon in QUESTION 6.1.1 in the field of medicine. (1)

6.1.3 Calculate the speed of the moving source. (6)

6.1.4 Will the observed frequency INCREASE, DECREASE or REMAIN THE SAME if the velocity of the source increased as it:

(a) Moves towards the observer (1)

(b) Moves away from the observer (1)

6.2 Spectral lines of star **X** at an observatory are observed to be *red shifted.*

6.2.1 Explain the term *red shifted* in terms of wavelength. (2)

6.2.2 Will the frequency of the light observed from the star INCREASE, DECREASE or REMAIN THE SAME? (1)

[13]

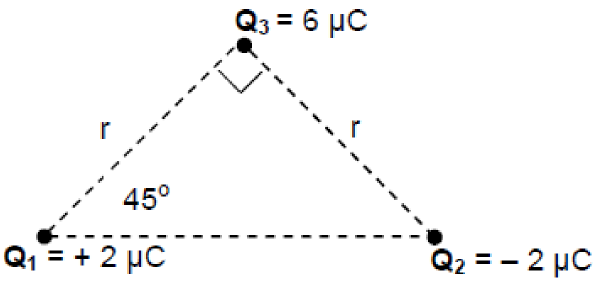
QUESTION 7 (Start on a new page.)

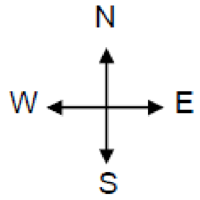
7.1 A metal sphere A, suspended from a wooden beam by means of a non-conducting string, has a charge of +6 μC.

7.1.1 Were electrons ADDED TO or REMOVED FROM the sphere to obtain this charge? Assume that the sphere was initially neutral. (1)

7.1.2 Calculate the number of electrons added to or removed from the sphere. (3)

7.2 Point charges Q_1, Q_2 and Q_3 are arranged at the corners of a right-angled triangle, as shown in the diagram below.





The charges on Q_1 and Q_2 are + 2 μC and – 2 μC respectively and the magnitude of the charge on Q_3 is 6 μC.

The distance between Q_1 and Q_3 is r. The distance between Q_2 and Q_3 is also r.

The charge Q_3 experiences a resultant electrostatic force of 0,12 N to the west.

7.2.1 Without calculation, identify the sign (positive or negative) on the charge Q_3. (1)

7.2.2 Draw a vector diagram to show the electrostatic forces acting on Q_3 due to charges Q_1 and Q_2 respectively. (2)

7.2.3 Write down an expression, in terms of r, for the horizontal component of the electrostatic force exerted on Q_3 by Q_1. (3)

7.2.4 Calculate the distance r. (4)

7.3 The magnitude of the electric field is 100 $N \cdot C^{-1}$ at a point which is 0,6 m away from a point charge Q.

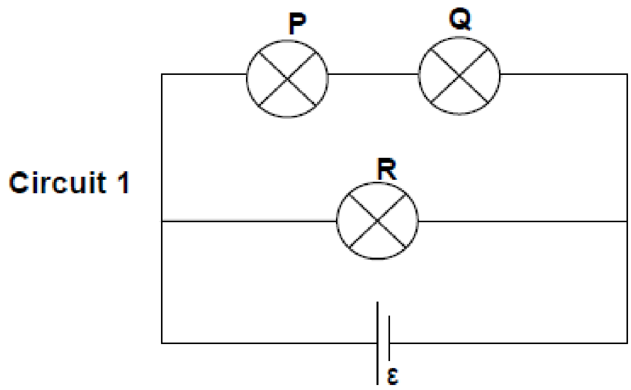
7.3.1 Define the term *electric field at a point* in words. (2)

7.3.2 Calculate the distance from point charge Q at which the magnitude of the electric field is 50 $N \cdot C^{-1}$. (5)

[21]

QUESTION 8 (Start on a new page).

8.1 In Circuit 1 below three identical light bulbs, **P**, **Q** and **R**, with the same resistance, are connected to a battery with emf ε and negligible internal resistance.



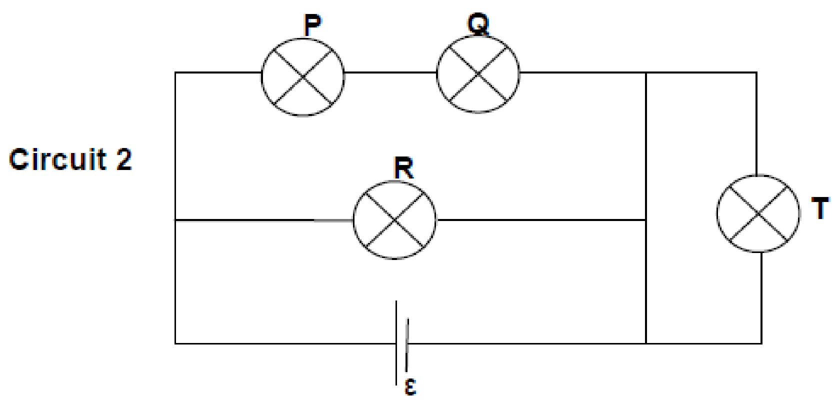
8.1.1 How does the brightness of bulb **P** compare with that of bulb **Q**?

Give a reason for the answer. (2)

8.1.2 How does the brightness of bulb **P** compare with that of bulb **R**?

Give a reason for the answer. (2)

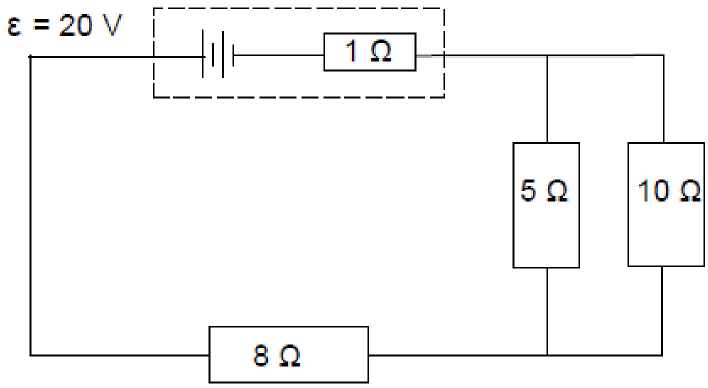
A fourth, identical bulb **T**, with the same resistance as the other three, is connected to the circuit by means of an ordinary wire of negligible resistance, as shown in Circuit 2 below.



8.1.3 How does the brightness of bulb **T** compare with that of bulb **R**?

Give a reason for the answer. (2)

8.2 A battery with an emf of 20 V and an internal resistance of 1 Ω is connected to three resistors, as shown in the circuit below.



Calculate the:

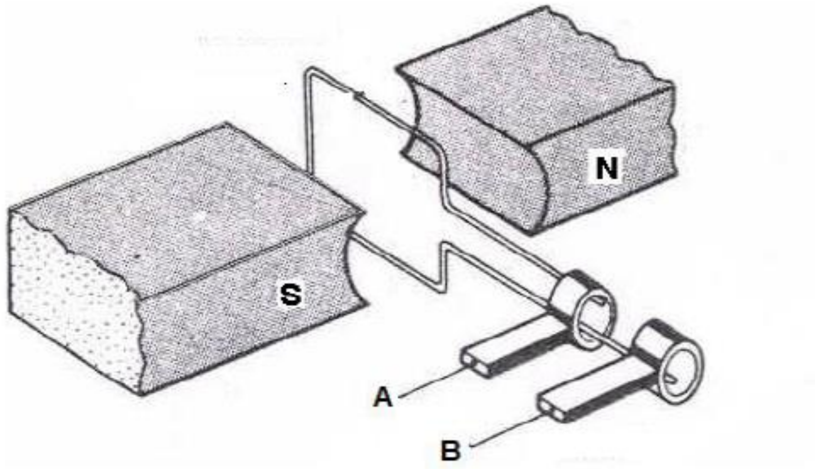
8.2.1 Current in the 8 Ω resistor (6)

8.2.2 Potential difference across the 5 Ω resistor (4)

8.2.3 Total power supplied by the battery (3)
[19]

QUESTION 9 (Start on a new page.)

The diagram below shows a simplified version of an AC generator.



9.1 Name the component in this arrangement that makes it different from a DC generator. (1)

9.2 Sketch a graph of induced emf versus time for TWO complete rotations of the coil. (2)

A practical version of the generator above has a large number of turns of the coil and it produces an rms potential difference of 240 V.

9.3 State TWO ways in which the induced emf can be increased. (2)

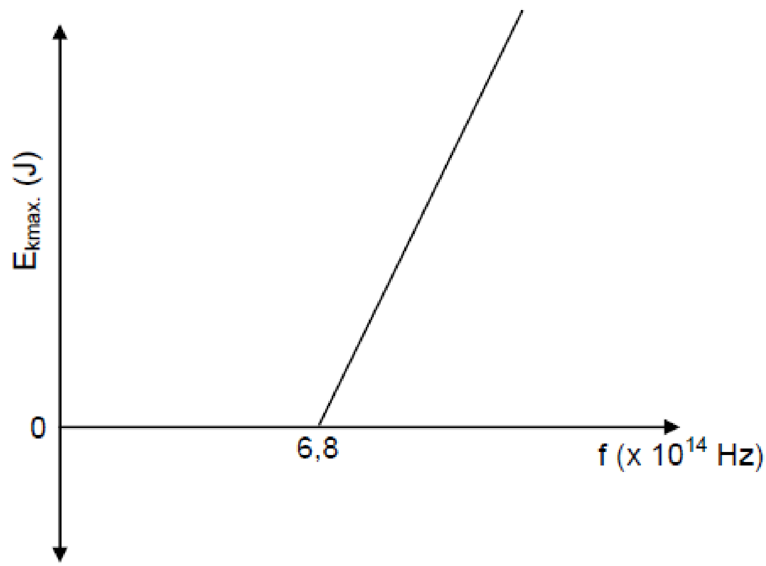
9.4 Define the term *root mean square (rms) value* of an AC potential difference. (2)

9.5 The practical version of the generator above is connected across an appliance rated at 1 500 W.

Calculate the rms current passing through the appliance. (3)
[10]

QUESTION 10 (Start on a new page.)

The graph below is obtained for an experiment on the photoelectric effect using different frequencies of light and a given metal plate.



The threshold frequency for the metal is 6,8 x 10^{14} Hz.

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

In the experiment, the brightness of the light incident on the metal surface is increased.

10.2 State how this change will influence the speed of the photoelectrons emitted.

Choose from INCREASES, DECREASES or REMAINS UNCHANGED. (1)

10.3 Show by means of a calculation whether the photoelectric effect will be OBSERVED or NOT OBSERVED, if monochromatic light with a wavelength of 6 x 10^{-7} m is used in this experiment. (5)

One of the radiations used in this experiment has a frequency of 7,8 x 10^{14} Hz.

10.4 Calculate the maximum speed of an ejected photoelectron. (5)
[13]

TOTAL: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)

FEBRUARY/MARCH 2017

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 Which ONE of the following is the product formed in the Haber process?

A Nitrogen

B Ammonia

C Nitric acid

D Sulphuric acid (2)

1.2 A carbonyl group is the functional group of …

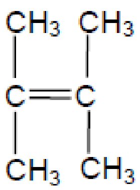
A alcohols.

B ketones.

C haloalkanes.

D carboxylic acids. (2)

1.3 Consider the structure of an organic compound below.



The IUPAC name of this compound is …

A 2,3-dimethylbut-2-ene.

B 2,2-dimethylbut-2-ene.

C 1,1,2-trimethylprop-1-ene.

D 1,1,2,2-tetramethylethene. (2)

1.4 Consider the reaction represented below.

$$CH_3CH_2CH_2CH_2CH_3 \longrightarrow CH_3CHCH_2 + \mathbf{X}$$

Which ONE of the following CORRECTLY gives the type of reaction that takes place and the IUPAC name of product **X**?

	Type of reaction	Product X
A	Elimination	Ethane
B	Elimination	Ethene
C	Addition	Ethane
D	Addition	Ethene

(2)

1.5 Consider the following balanced equation of a chemical reaction:

$$2NaC\ell + 2H_2O \rightarrow C\ell_2 + H_2 + 2NaOH$$

Which ONE of the following statements about the reaction is correct?

The reaction takes place in a/an …

A galvanic cell and absorbs energy.

B galvanic cell and releases energy.

C electrolytic cell and absorbs energy.

D electrolytic cell and releases energy. (2)

1.6 The following equation represents the reaction taking place in an electrochemical cell:

$$Ni(s) + Pb^{2+}(aq) \rightarrow Ni^{2+}(aq) + Pb(s)$$

The flow of electrons through the external circuit of this cell is from …

A Pb at the anode to Ni at the cathode.

B Pb at the cathode to Ni at the anode.

C Ni at the cathode to Pb at the anode.

D Ni at the anode to Pb at the cathode. (2)

1.7 A solution has a pH = 1. This solution …

A contains no OH^- ions.

B neutralises a hydrochloric acid solution of pH = 1.

C contains a higher concentration of H_3O^+ ions than OH^- ions.

D contains a higher concentration of OH^- ions than H_3O^+ ions. (2)

1.8 A potential energy diagram can be used to show the activation energy (E_A) and the heat of reaction (ΔH) of a reaction.

Which ONE of the following combinations of values of E_A and ΔH CANNOT be obtained for any reaction?

	E_A (kJ·mol^{-1})	ΔH (kJ·mol^{-1})
A	50	-100
B	50	+100
C	100	+50
D	100	-50

(2)

1.9 Initially, 2 mol CO(g) and 2 mol H_2(g) are sealed in a container. The reaction reaches equilibrium according to the following balanced equation:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium the amount of CH_3OH(g) in the mixture will be …

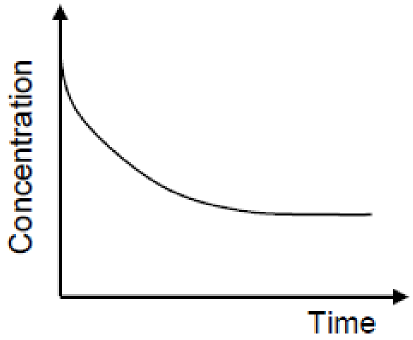
A 1 mol.

B 2 mol.

C less than 1 mol.

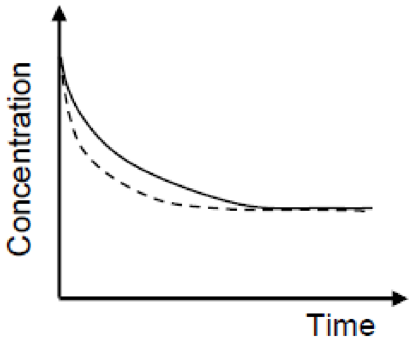
D greater than 1 mol. (2)

1.10 The graph below represents the change in concentration of a reactant against time for a chemical reaction.

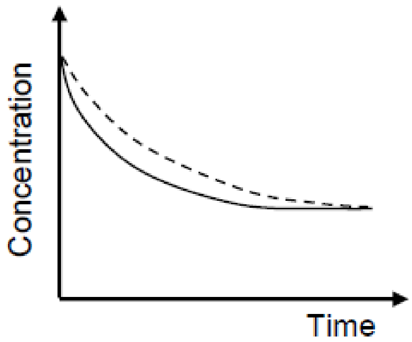


In which ONE of the following graphs does the dotted line show the effect of a catalyst on this reactant?

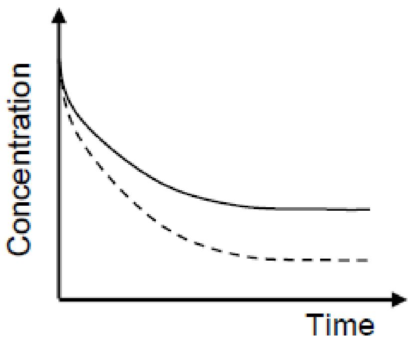
A



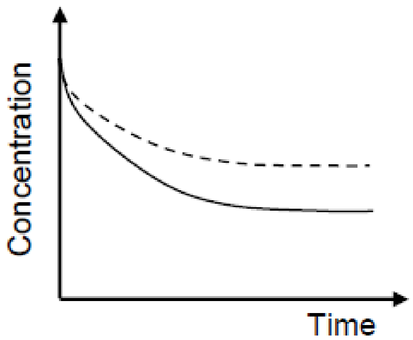
B



C



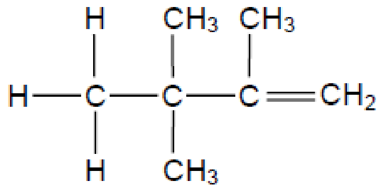
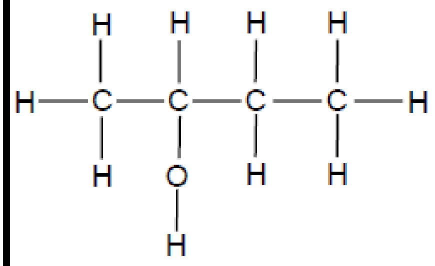
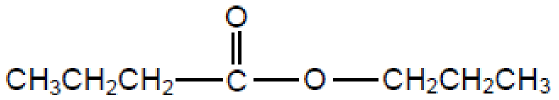
D



(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	$CH_3CH_2CH_2CHO$	**B**	
C	C_4H_8O	**D**	C_3H_8O
E		**F**	

2.1 Write down the letter that represents EACH of the following:

2.1.1 A hydrocarbon (1)

2.1.2 An alcohol (1)

2.1.3 An ester (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **A** (1)

2.2.2 Compound **B** (3)

2.3 Compound **C** is a functional isomer of compound **A**. Write down the structural formula of compound **C**. (2)

2.4 Compound **D** is used as one of the reactants to prepare compound **F**. Write down the:

2.4.1 Type of reaction which takes place to prepare compound **F** (1)

2.4.2 IUPAC name of compound **D** (2)

2.4.3 Structural formula of the other organic reactant used (2)

2.4.4 IUPAC name of compound **F** (2)
[16]

QUESTION 3 (Start on a new page.)

Learners investigate factors which influence the boiling points of alcohols.

They use equal volumes of each of the alcohols and heat them separately in a water bath. The temperature at which each boils is measured. The results obtained are shown in the table below.

ALCOHOLS	BOILING POINTS OF ALCOHOLS (°C)
Butan-1-ol	117,7
Pentan-1-ol	138,5
Hexan-1-ol	157,0

3.1 Define the term *boiling point*. (2)

3.2 What property of alcohols requires them to be heated in a water bath? (1)

3.3 The boiling points of the alcohols are compared with each other.

3.3.1 What structural requirements must the alcohols meet to make it a fair comparison? (2)

3.3.2 Fully explain the trend in the boiling points. (3)

3.4 How will the boiling point of hexan-1-ol be affected if the volume of hexan-1-ol used is doubled? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

3.5 In another investigation the learners compare the boiling points of hexan-1-ol and hexanal.

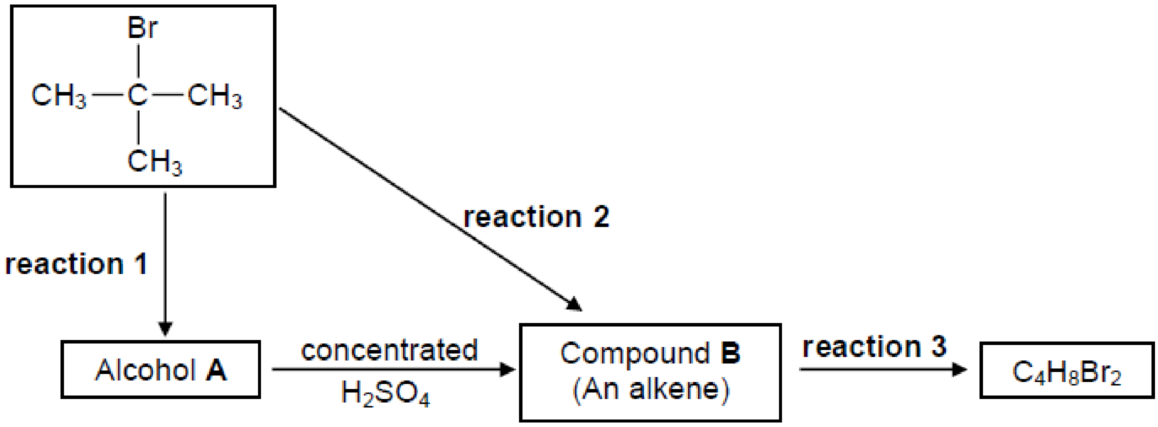
3.5.1 Write down the independent variable for this comparison. (1)

3.5.2 They find that the boiling point of hexan-1-ol is higher than that of hexanal.

Fully explain this observation. (4)
[14]

QUESTION 4 (Start on a new page.)

4.1 Consider the reactions represented in the flow diagram below.



Write down the:

4.1.1 Type of reaction represented by **reaction 1** (1)

4.1.2 NAME or FORMULA of the inorganic reactant needed for **reaction 1** (1)

4.1.3 Type of alcohol (PRIMARY, SECONDARY or TERTIARY) of which alcohol **A** is an example (1)

4.1.4 Type of reaction represented by **reaction 2** (1)

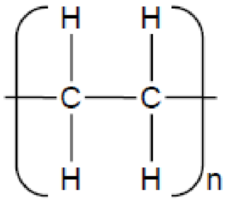
4.1.5 IUPAC name of compound **B** (2)

4.1.6 Type of addition reaction represented by **reaction 3** (1)

4.1.7 Balanced equation for **reaction 3** using structural formulae (4)

4.2 A wide range of synthetic polymers are produced by combining large numbers of similar small organic molecules bonded to each other in a repeating pattern.

Polymer **C** below is an example of such a polymer.



Polymer C

Write down:

4.2.1 ONE word for the underlined phrase (1)

4.2.2 The homologous series to which the 'small organic molecules' used to produce polymer **C** belong (1)

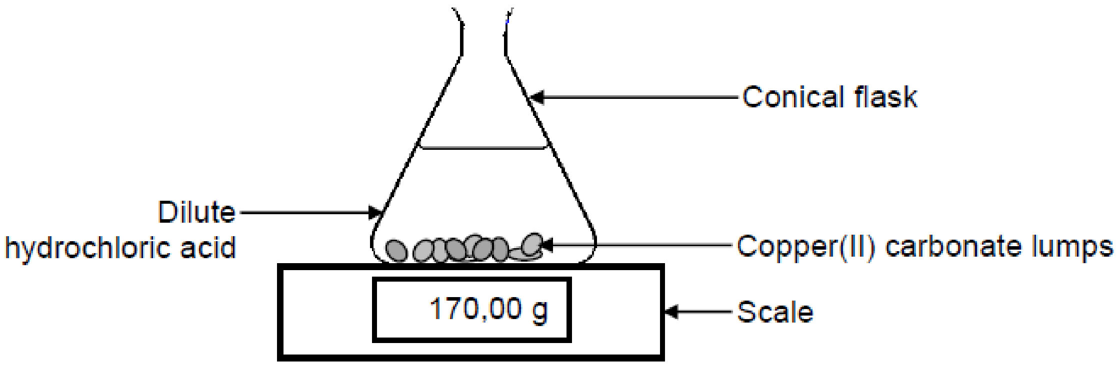
4.2.3 The type of polymerisation which takes place to produce polymer **C** (1)
[14]

QUESTION 5 (Start on a new page.)

The reaction of copper(II) carbonate with excess dilute hydrochloric acid is used to investigate the rate of reaction. The balanced equation for the reaction is:

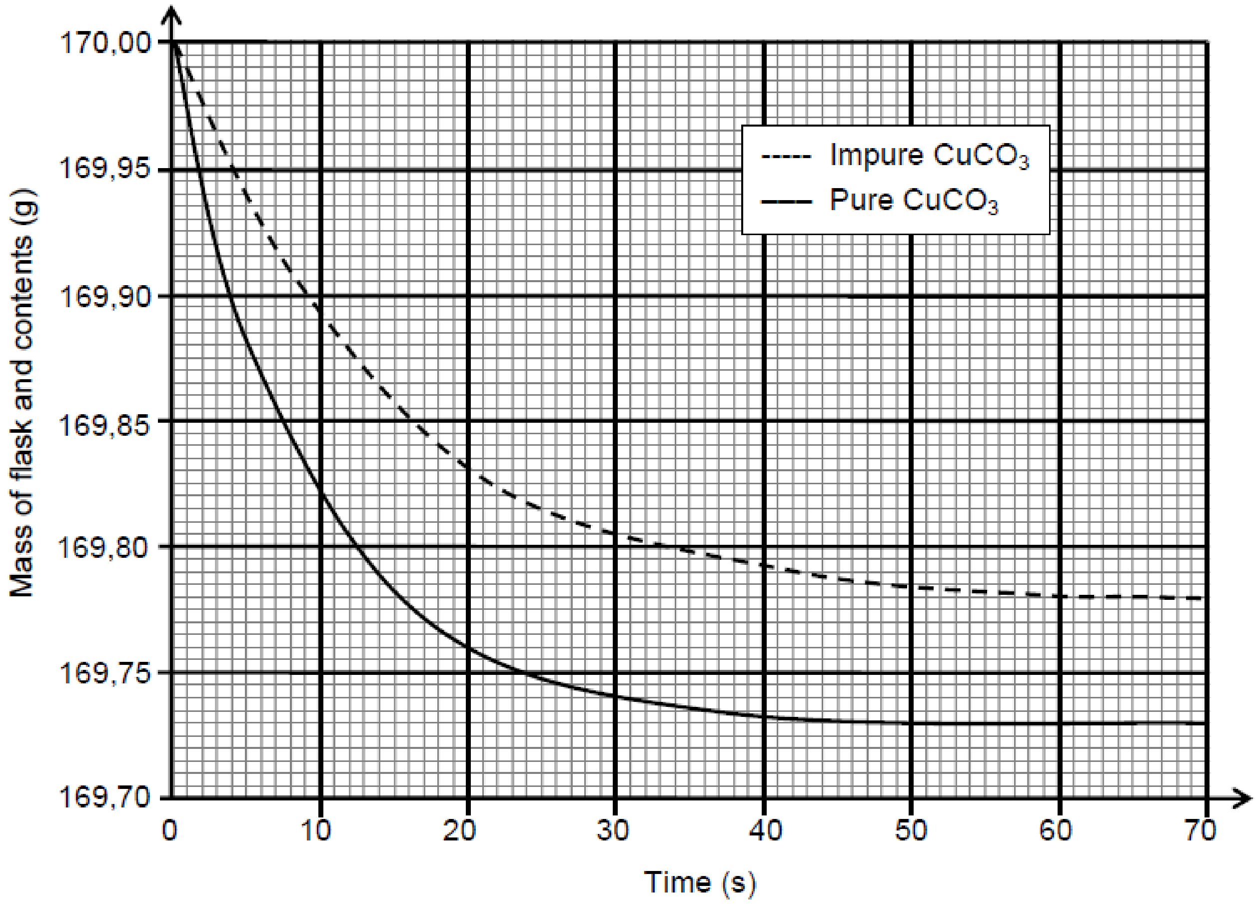
$$CuCO_3(s) + 2HC\ell(aq) \rightarrow CuC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

The apparatus used is illustrated below.



5.1 State TWO ways in which the rate of the reaction above can be increased. (2)

During the investigation, samples of both PURE and IMPURE copper(II) carbonate of EQUAL mass are used. The graphs below are obtained from the results.



5.2 Write down the reaction time for the reaction of the pure $CuCO_3$ with HCℓ. (1)

5.3 Assume that all the gas formed during the two reactions escape from the flask and that the impurities do not react.

Calculate the:

5.3.1 Average rate of the reaction of the pure sample over the first 20 s (3)

5.3.2 Percentage purity of the impure sample (4)

5.3.3 Maximum volume of $CO_2(g)$ produced during the reaction of the pure sample of $CuCO_3$ if the reaction takes place at STANDARD CONDITIONS (3)

5.4 Sketch a graph of the volume of gas produced versus time for the reaction of the pure $CuCO_3$. Indicate the reaction time on the x-axis. (2)

[15]

QUESTION 6 (Start on a new page.)

Hydrogen and iodine are sealed in a 2 dm^3 container. The reaction is allowed to reach equilibrium at 700 K according to the following balanced equation:

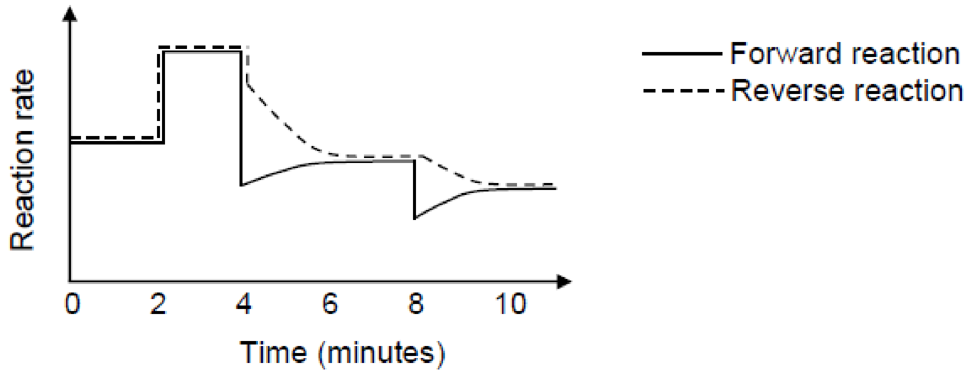
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

6.1 Give a reason why changes in pressure will have no effect on the equilibrium position. (1)

6.2 At equilibrium, 0,028 mol $H_2(g)$ and 0,017 mol $I_2(g)$ are present in the container.

Calculate the initial mass of $I_2(g)$, in grams, that was sealed in the container, if K_c for the reaction is 55,3 at 700 K. (9)

The reaction rate versus time graph below represents different changes made to the equilibrium mixture.



6.3 What do the parallel lines in the first two minutes indicate? (1)

6.4 State TWO possible changes that could be made to the reaction conditions at t = 2 minutes. (2)

6.5 The temperature of the equilibrium mixture was changed at t = 4 minutes.

6.5.1 Is the forward reaction EXOTHERMIC or ENDOTHERMIC?

Fully explain the answer. (3)

6.5.2 How will this change influence the K_c value? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

6.6 What change was made to the equilibrium mixture at t = 8 minutes? (1)

[18]

QUESTION 7 (Start on a new page.)

The K_a values for two weak acids, oxalic acid and carbonic acid, are as follows:

NAME	FORMULA	K_a
Oxalic acid	$(COOH)_2$	$5,6 \times 10^{-2}$
Carbonic acid	H_2CO_3	$4,3 \times 10^{-7}$

7.1 Define the term *weak acid.* (2)

7.2 Which acid, OXALIC ACID or CARBONIC ACID, is stronger? Give a reason for the answer. (2)

7.3 Oxalic acid ionises in water according to the following balanced equation:

$$(COOH)_2(s) + 2H_2O(\ell) \rightleftharpoons (COO)_2^{2-}(aq) + 2H_3O^+(aq)$$

Write down the FORMULAE of the TWO bases in this equation. (2)

7.4 Learners prepare 2 dm^3 of a sodium hydroxide solution of concentration 0,1 $mol{\cdot}dm^{-3}$.

Calculate the pH of the solution. (4)

7.5 During a titration of the sodium hydroxide solution in QUESTION 7.4 with dilute oxalic acid, the learners find that 25,1 cm^3 of the NaOH(aq) neutralises exactly 14,2 cm^3 of the $(COOH)_2$(aq).

The balanced equation for the reaction is as follows:

$$2NaOH(aq) + (COOH)_2(aq) \rightarrow (COO)_2Na_2(aq) + 2H_2O(\ell)$$

7.5.1 Calculate the concentration of the oxalic acid solution. (5)

The following indicators are available for the titration:

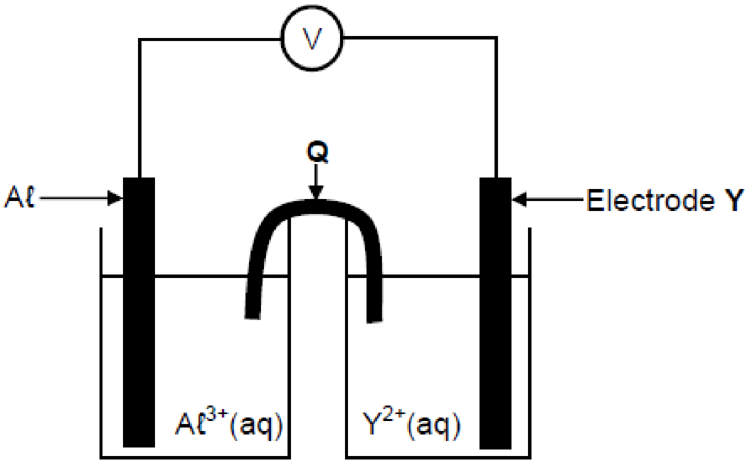
INDICATOR	pH RANGE
A	3,1–4,4
B	6,0–7,6
C	8,3–10,0

7.5.2 Which ONE of the indicators above is most suitable for this titration? Give a reason for the answer. (2)

[17]

QUESTION 8 (Start on a new page.)

In the electrochemical cell shown below an aluminium electrode and another metal electrode, **Y**, are used.



8.1 Write down the:

8.1.1 Name of component **Q** (1)

8.1.2 Type of electrochemical cell represented above (1)

It is found that the mass of the aluminium electrode increases whilst the cell is functioning.

8.2 How will EACH of the following change while the cell is functioning? Choose from INCREASES, DECREASES or REMAINS THE SAME.

8.2.1 The concentration of $A\ell^{3+}(aq)$ (1)

8.2.2 The concentration of $Y^{2+}(aq)$ (1)

8.3 Write down the:

8.3.1 Half-reaction that takes place at electrode **Y** (2)

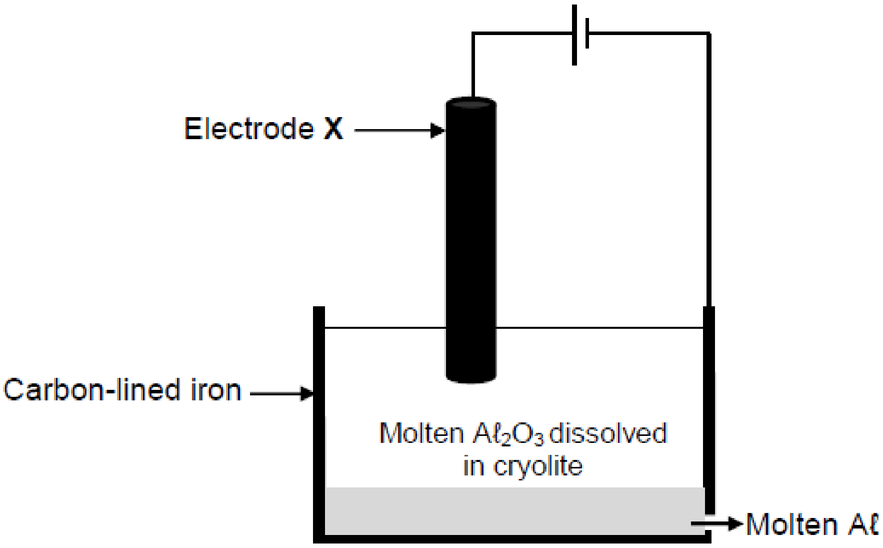
8.3.2 Cell notation of the cell (3)

8.4 The initial emf of this cell measured under standard conditions is 0,7 V.

Identify metal **Y** by means of a calculation. (5)
[14]

QUESTION 9 (Start on a new page.)

The simplified diagram below shows an electrolytic cell used in the industrial extraction of aluminium ($A\ell$) from aluminium oxide at temperatures as high as 1 000 °C. Electrode **X** is a carbon rod.



The cell reaction that takes place is as follows:

$$2A\ell_2O_3(\ell) \rightarrow 4A\ell(\ell) + 3O_2(g)$$

9.1 Write down the name of the ore used as source of aluminium oxide. (1)

9.2 Which half-reaction (OXIDATION or REDUCTION) takes place at electrode **X**? (1)

9.3 What is the function of the cryolite? (1)

9.4 Write down the reduction half-reaction. (2)

9.5 Write down a balanced equation that shows why the carbon rod, **X**, must be replaced regularly. (3)
[8]

QUESTION 10 (Start on a new page.)

10.1 The reactions represented below take place during one of the industrial processes used in the fertiliser industry.

I: $4NH_3(g) + 5O_2(g) \overset{Pt}{\rightleftharpoons} 4NO(g) + 6H_2O(g)$ $\Delta H < 0$

II: $NO(g) + O_2(g) \rightleftharpoons \underline{\mathbf{X}}$

III: $NO_2 + H_2O(\ell) \rightleftharpoons HNO_3(aq) +$ _____

Write down:

10.1.1 The name of this industrial process (1)

10.1.2 The function of Pt in reaction **I** (1)

10.1.3 The NAME of product **X** (1)

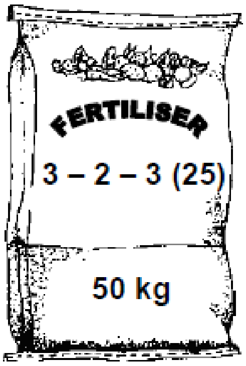
10.1.4 A balanced equation for reaction **III** (2)

10.1.5 TWO ways in which the yield of the NO(g) obtained in reaction **I** can be increased without changing the amount of reactants and products (2)

10.2 NPK fertilisers contain NH_4NO_3, $(NH_4)_3PO_4$ and $KC\ell$ in varying proportions.

10.2.1 What does *NPK* mean? (1)

10.2.2 Consider the fertiliser illustrated below.



Calculate the mass, in kg, of $KC\ell$ needed to produce this fertiliser. (6)
[14]

TOTAL: 150

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2017

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?

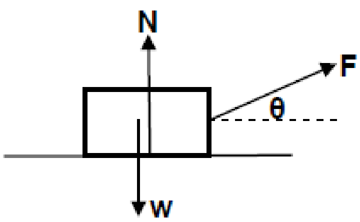
A The weight of an object on Earth is the same as that on the moon.

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?

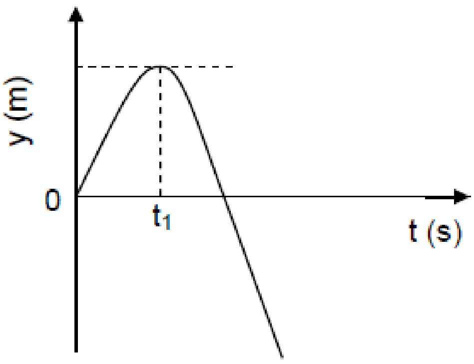
A $N = w + F\cos\theta$

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.

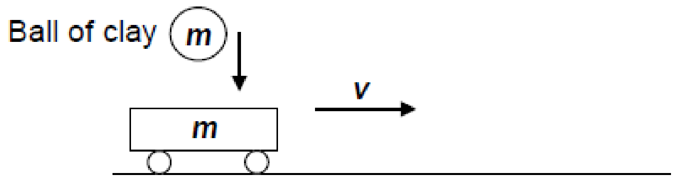


Which ONE of the combinations below regarding the magnitudes of the stone's velocity and acceleration, at time t_1, is CORRECT?

	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

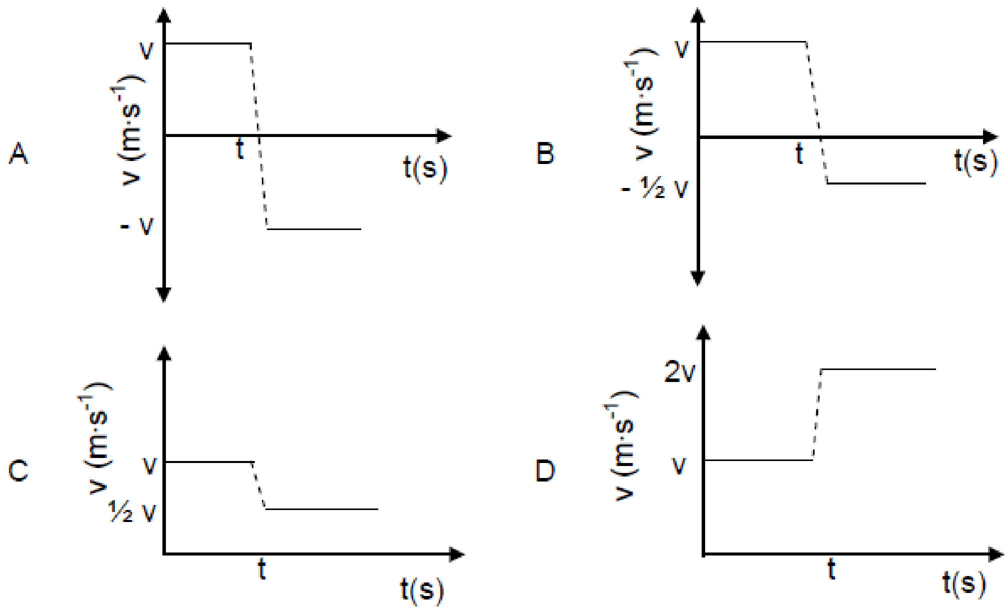
(2)

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 …

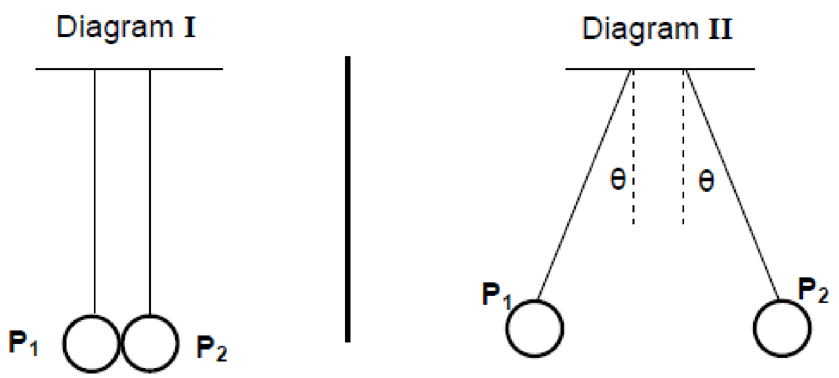
A moving towards Earth and the light is blue shifted.

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 $\mathcal{E}$ 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 …

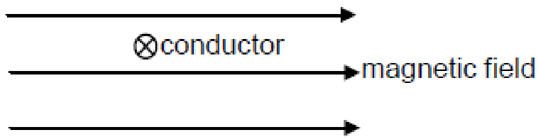
A ¼P

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**.

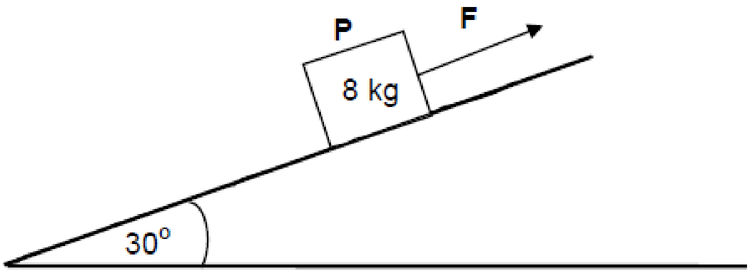
D the threshold frequency of metal **N** is lower than that of metal **M**. (2)

[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)

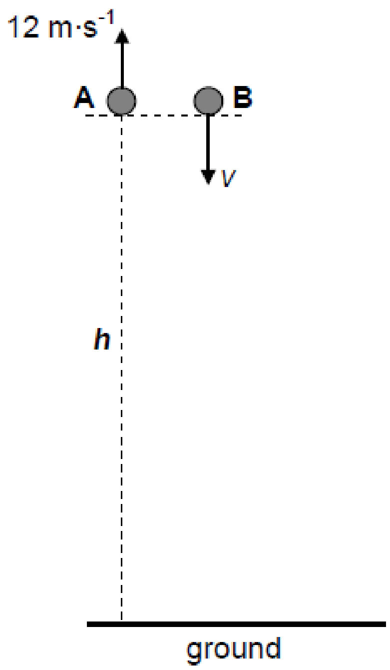
2.2.2 Calculate the mass of the planet if its radius is 700 km. (4)
[21]

QUESTION 3 (Start on a new page.)

Stone **A** is projected vertically upwards at a speed of 12 m·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:

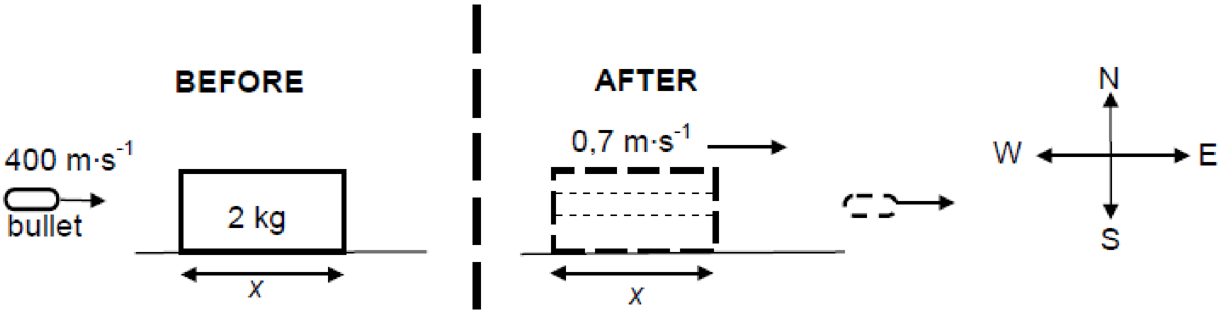
- The time taken for stone **A** to reach its maximum height
- The velocity with which stone **B** is thrown downwards (4)

[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)

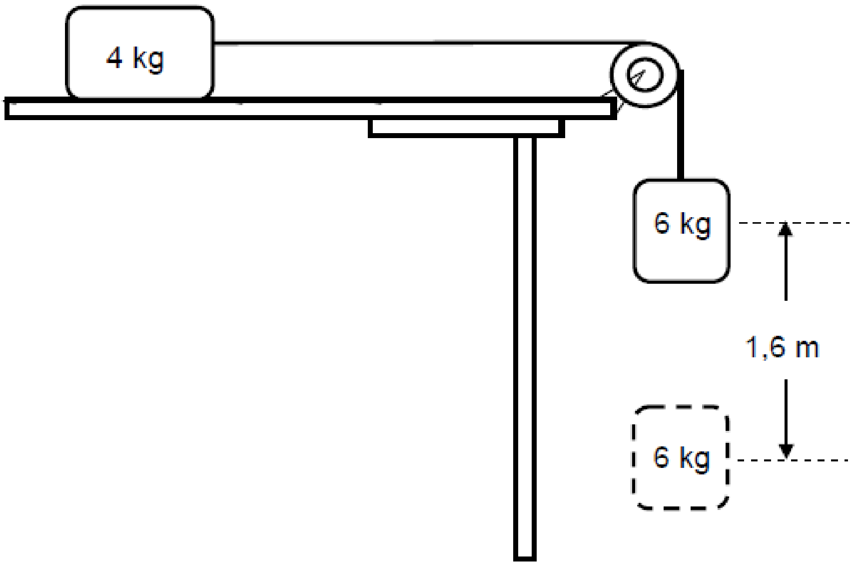
4.3 If the bullet takes 0,002 s to travel through the block, calculate the length, *x*, of the block. (5)

[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.

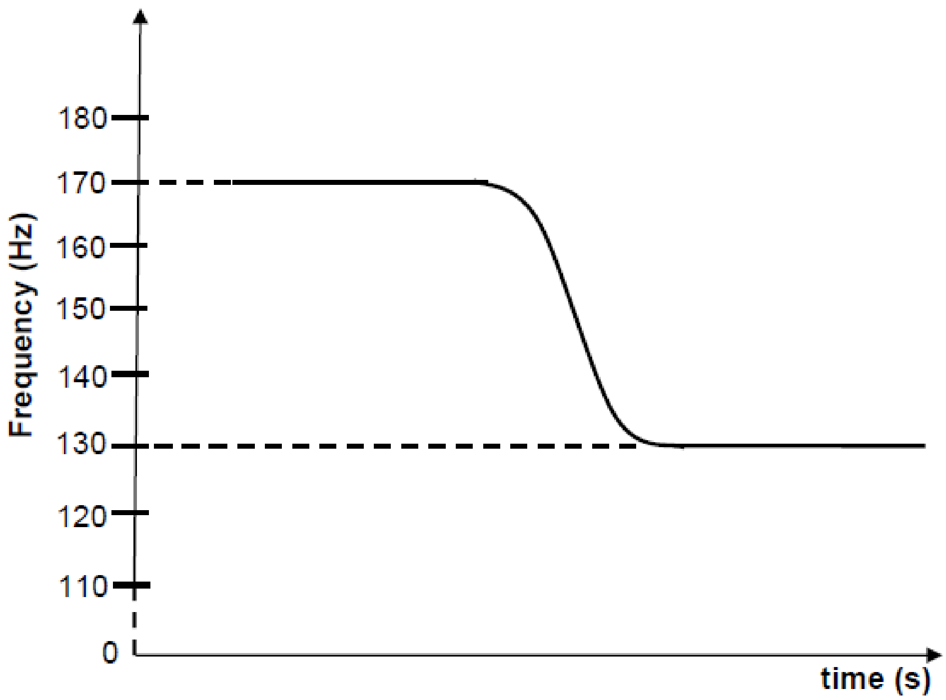
5.4 Use **energy principles** to calculate the speed of the 6 kg block when it falls through 1,6 m while still attached to the 4 kg block. (5)

[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)

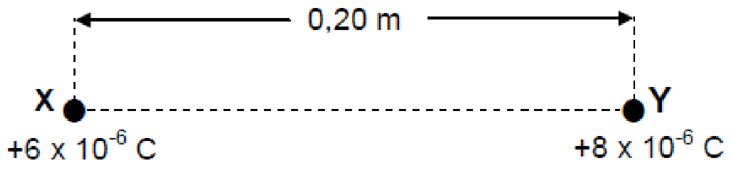
6.2.2 Moves away from the listener (1)

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.)

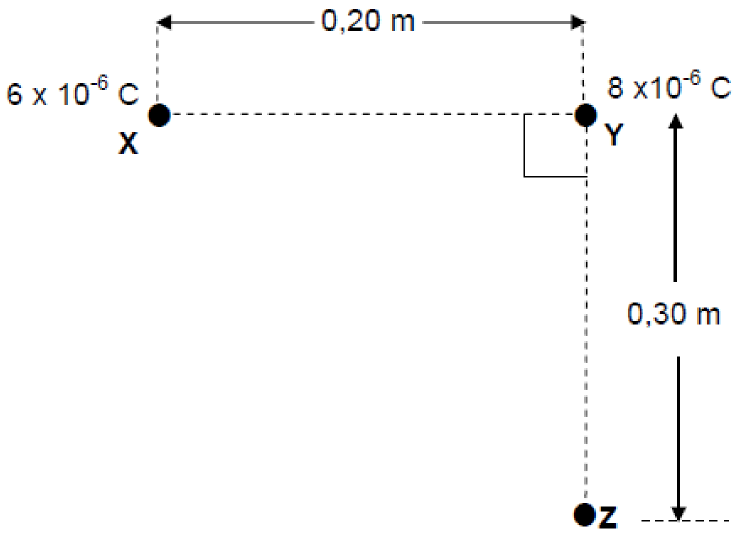
Two small spheres, **X** and **Y**, carrying charges of $+6 \times 10^{-6}$ C and $+8 \times 10^{-6}$ C respectively, are placed 0,20 m apart in air.



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.

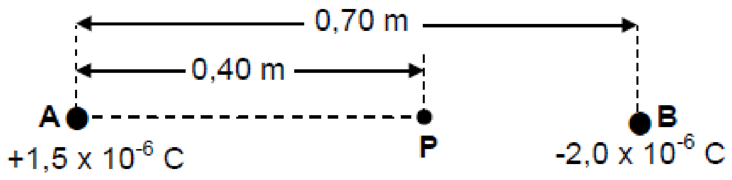


7.3 Draw a vector diagram showing the directions of the electrostatic forces and the net force experienced by charged sphere **Y** due to the presence of charged spheres **X** and **Z** respectively. (3)

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**.

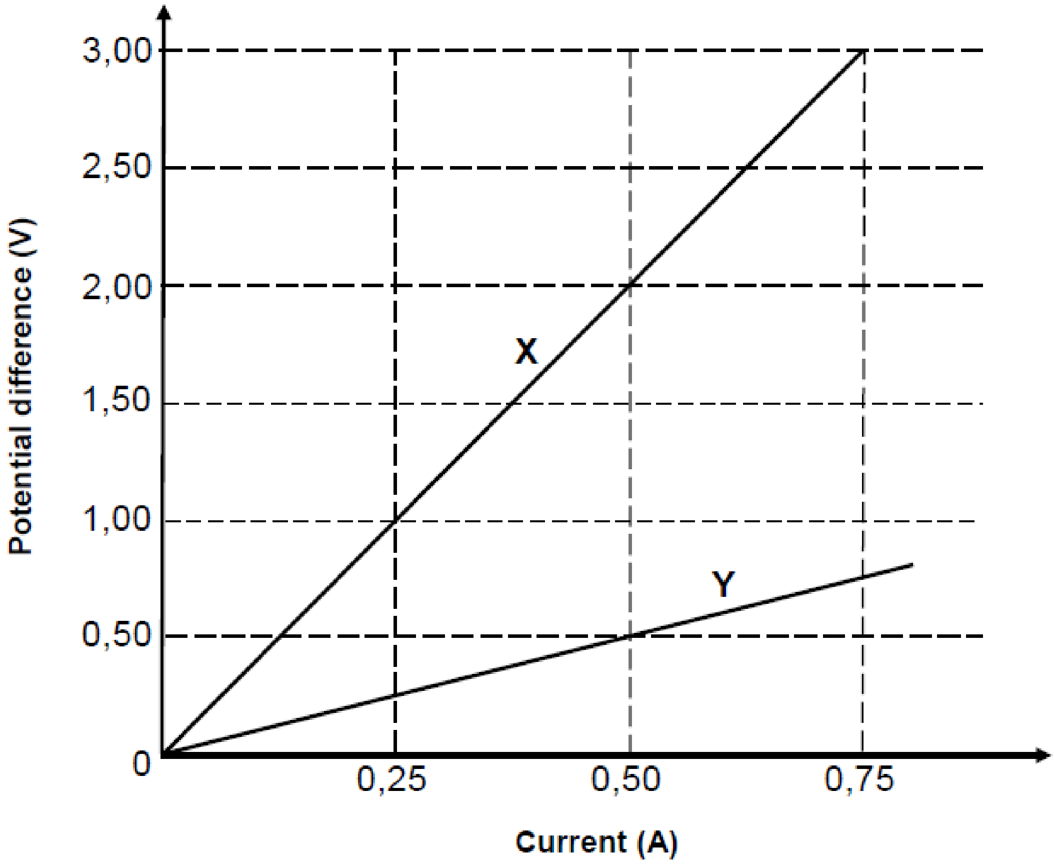
Calculate the magnitude of the electrostatic force experienced by this charge. (3)
[9]

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



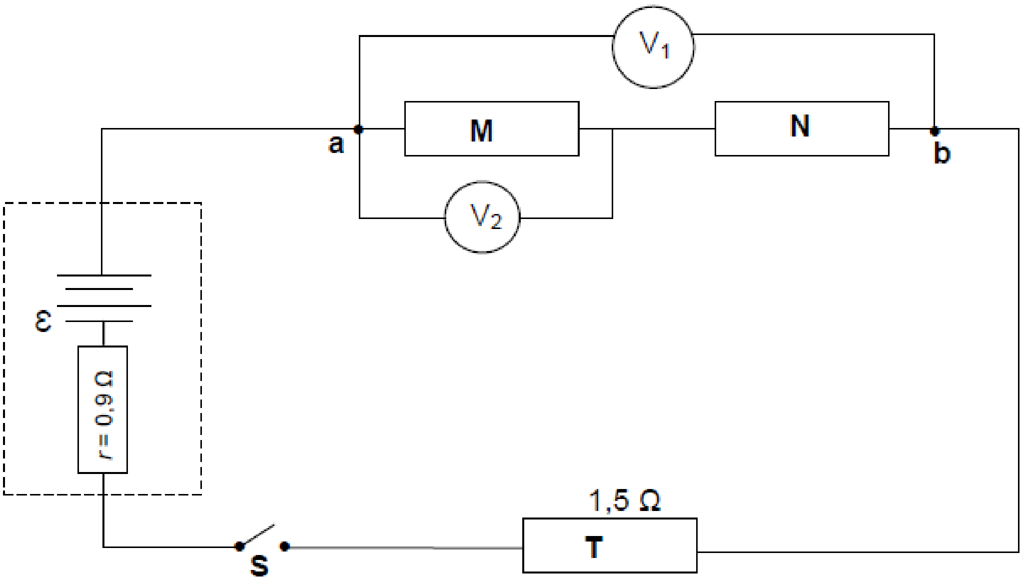
9.1.1 State Ohm's law in words. (2)

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 $\mathcal{E}$ 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 ($\mathcal{E}$) of the battery (4)

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

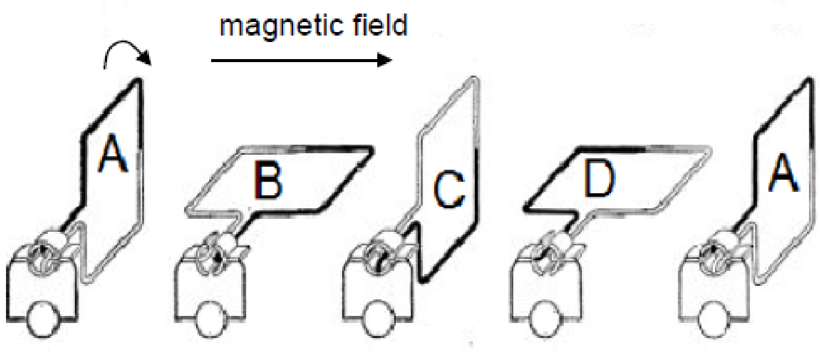
9.2.3 Write down the resistance of **N**. (No calculations required.) Give a reason for the answer. (2)

[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.

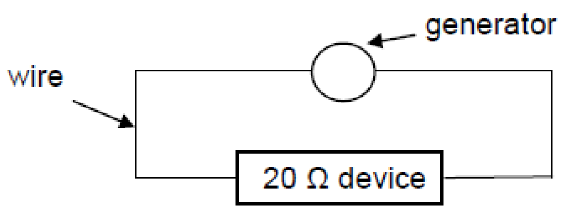
The direction of the magnetic field is shown in the diagram below.



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.

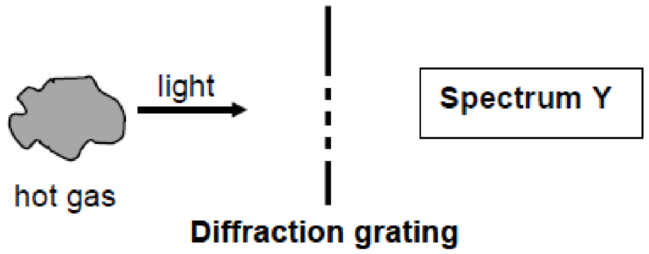


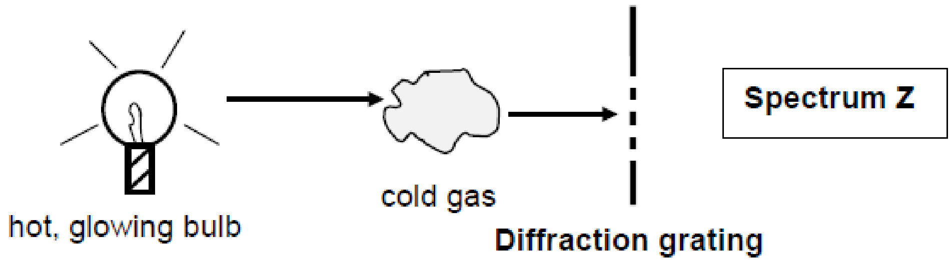
10.2.1 Write down the total resistance of the circuit. (1)

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.





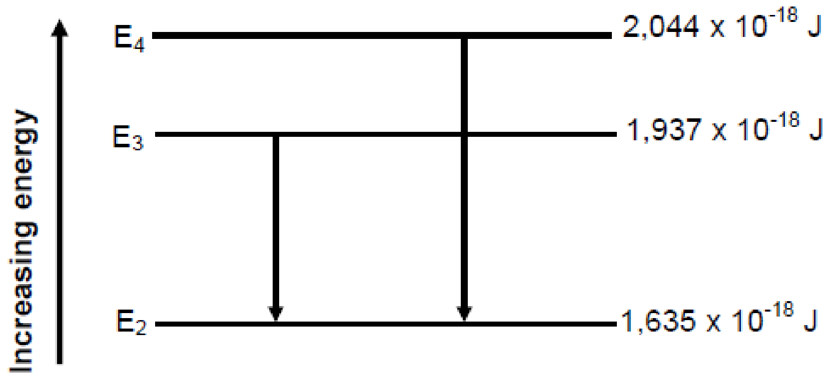
Name the type of spectrum of:

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

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2017

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 $C_7H_{14}O_2$:

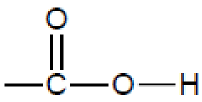
A Heptanal

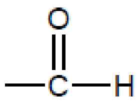
B Heptan-1-ol

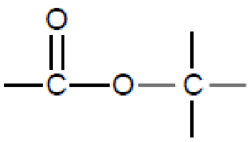
C Heptan-2-ol

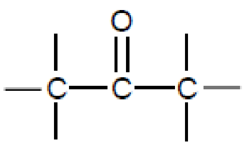
D Heptanoic acid (2)

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?

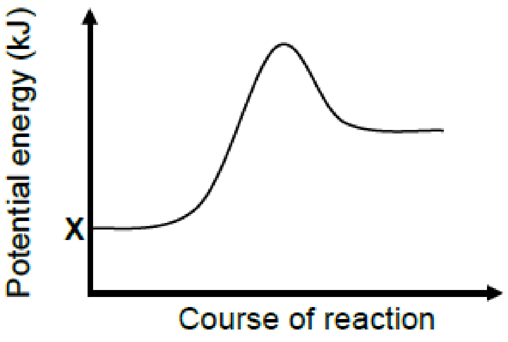
A $5CH_2 = CH_2 \rightarrow —(CH_2CH_2)_5—$

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

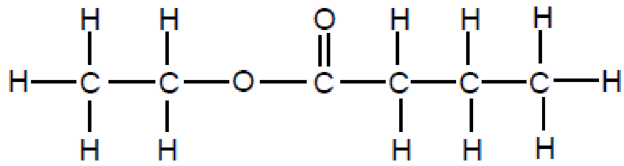
C Depletion of oxygen in water

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)

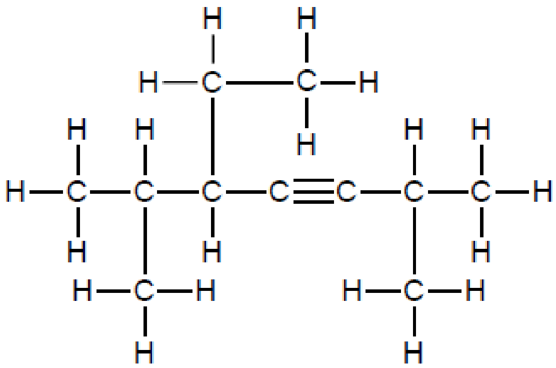
2.1.2 IUPAC name (2)

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]

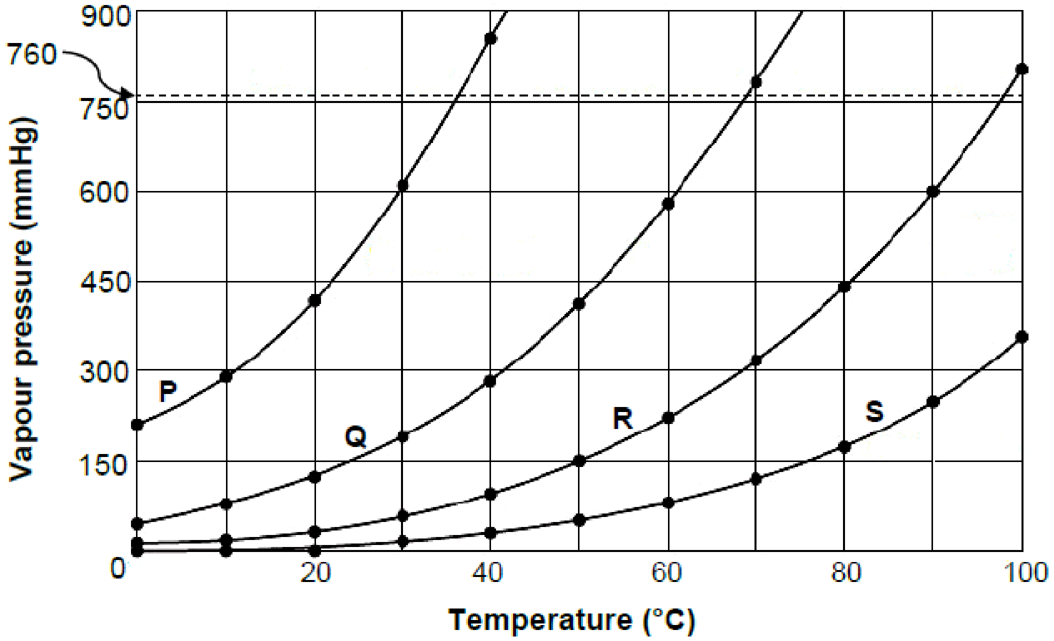
QUESTION 3 (Start on a new page.)

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.

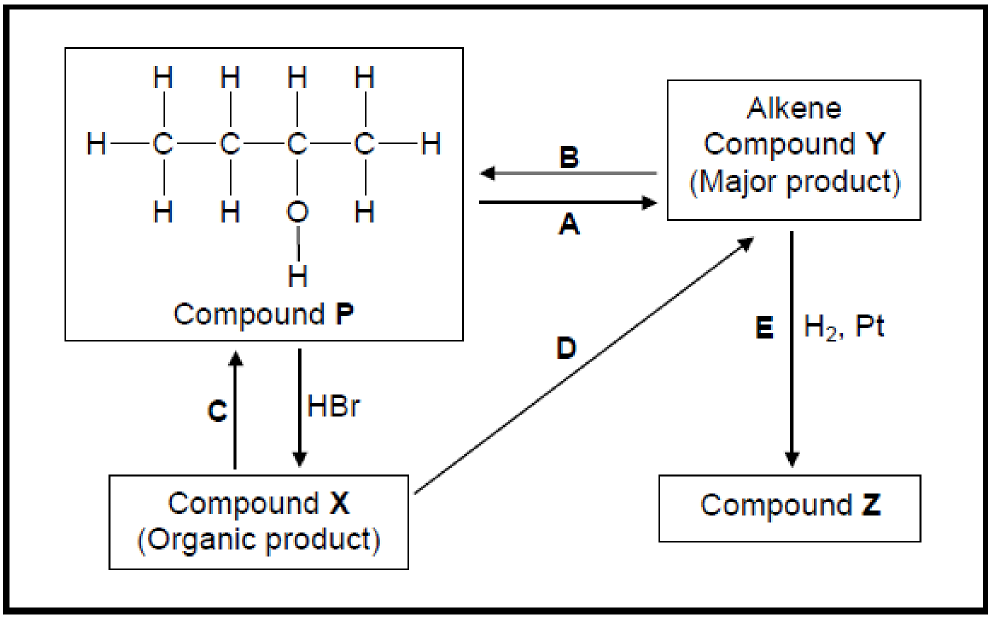
3.4.1 Draw the structural formula of a chain isomer of **P**. Write down the IUPAC name of this isomer. (3)

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:

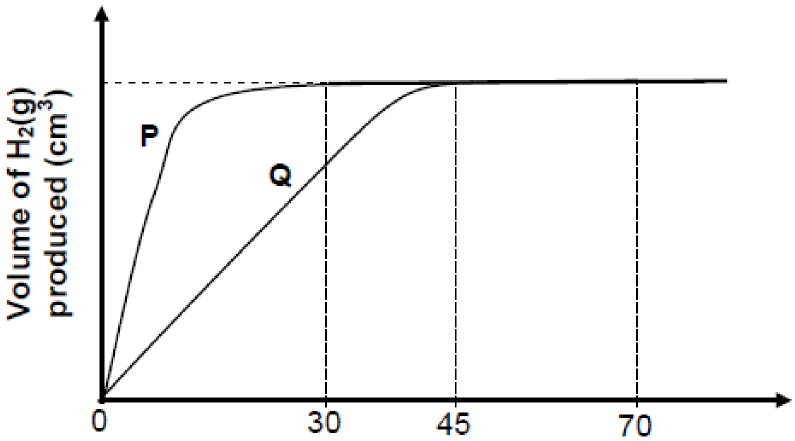
$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

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:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

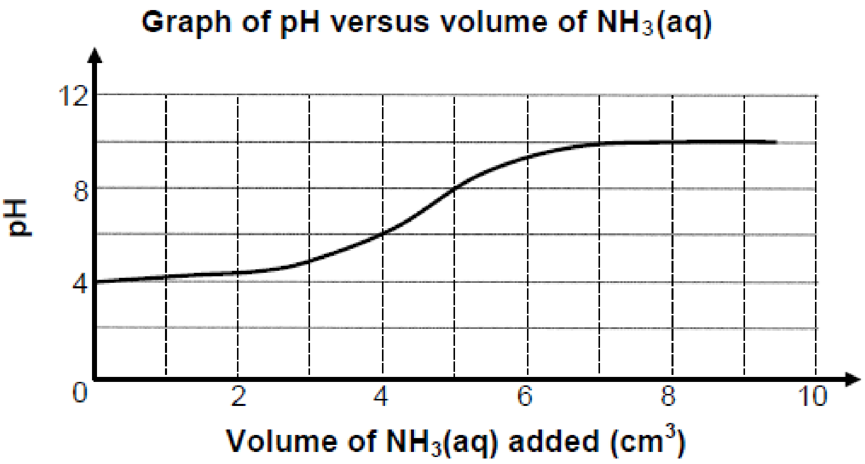
7.1.1 Is ammonia a WEAK or a STRONG base? Give a reason for the answer. (2)

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.

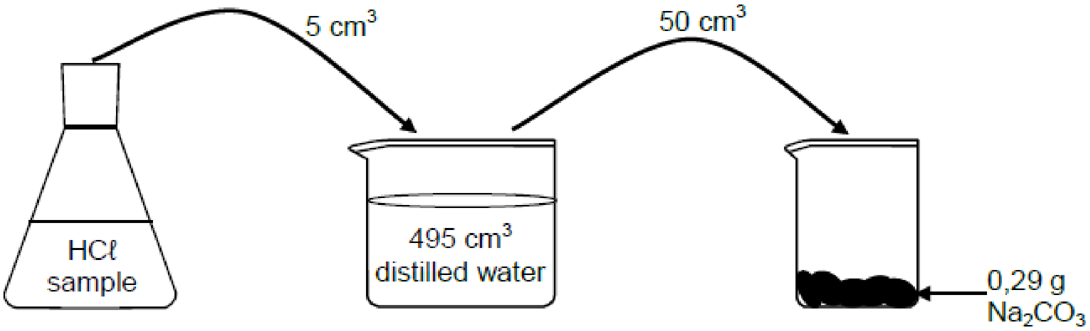


7.2.1 Is the soil sample ACIDIC or BASIC? Refer to the graph above and give a reason for the answer. (2)

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).



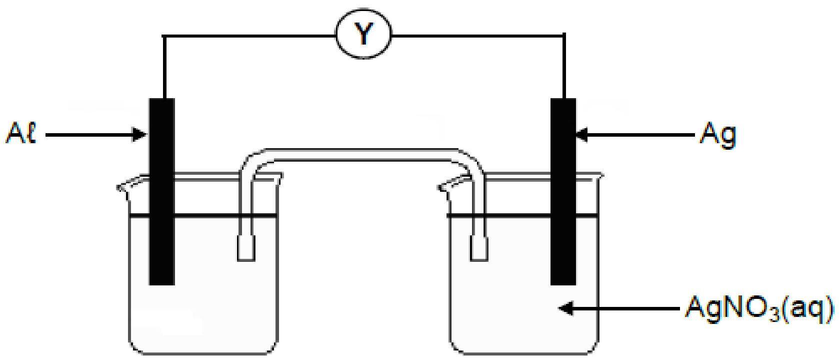
The balanced equation for the reaction is:

$$Na_2CO_3(s) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

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 | Zn^{2+}(aq)	$Cℓ_2$ | $Cℓ^-$(aq)	Cu | 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)

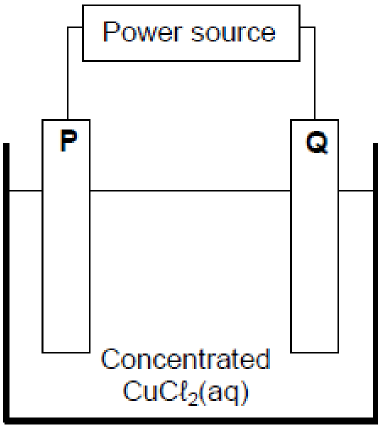
8.2.2 State the standard conditions under which the half-cells should operate to ensure a fair comparison. (2)

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.

Process X

I: $A + 5O_2(g) \rightarrow 4NO + 6H_2O(g)$

II: $2NO(g) + O_2(g) \rightarrow 2\mathbf{B}$

III: $\mathbf{B} + H_2O(g) \rightarrow HNO_3(g) + NO(g)$

Process Y

IV: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Process X → Ammonium nitrate ← Process Y

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

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1m_2}{d^2}$ or/*of* $F = G\frac{m_1m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ or/*of* $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or/*of* $K_{max} = \frac{1}{2}mv^2_{max}$	

PAPER TWO

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1,013 \times 10^{5}$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22,4\ dm^{3}\cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6,02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$c=\frac{n}{V}$ or/*of* $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*	Electronegativity / *Elektronegatiwiteit*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
29	1,9	Cu	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)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															
				58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
				90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Half-reactions/*Halfreaksies*	$E^\ominus$ (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2(g)}$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	− 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	− 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	− 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	− 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	− 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	− 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	− 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	− 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	− 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	− 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	− 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	− 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	− 1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	− 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	− 2,36
$Na^+ + e^- \rightleftharpoons Na$	− 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	− 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	− 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	− 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	− 2,93
$Li^+ + e^- \rightleftharpoons Li$	− 3,05

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

NSC

TABLE 4B: STANDARD REDUCTION POTENTIALS

TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Half-reactions/*Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

SOLUTIONS

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2014

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	A ✓✓	(2)
1.3	D ✓✓	(2)
1.4	C ✓✓	(2)
1.5	B ✓✓	(2)
1.6	C ✓✓ (Accept/ *Aanvaar* R)	(2)
1.7	A ✓✓	(2)
1.8	D ✓✓	(2)
1.9	A ✓✓	(2)
1.10	C ✓✓	(2) **[20]**

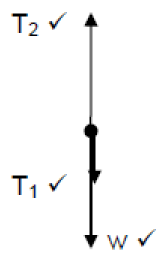
QUESTION 2/*VRAAG 2*

2.1 When a resultant (net) force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force✓ and inversely proportional to the mass of the object.✓

Wanneer 'n resulterende (netto) krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The net force acting on an object is equal to the rate of change of momentum ✓✓ of the object (in the direction of the force). (2 or 0)
Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering in momentum van die voorwerp (in die rigting van die krag).(2 of 0) (2)

2.2



(3)

2.3

OPTION 1/*OPSIE 1*

$F_{net} = ma$✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 – (5)(9,8) – T_1$✓$= 5a$ ✓

$201 – T_1 = 5a$

$T_1 = 201 - 5a$........(1)

For 20 kg block/*Vir 20 kg-blok*

$T_1 + (-mg) = ma$.......(2)

$T_1 + [-20(9,8)]$ ✓ $= 20a$

$5 = 25a$

$a = 0,2\ m\cdot s^{-2}$ upwards/*opwaarts*

$\therefore T_1 = 201 - 5(0,2)$ ✓

$= 200\ N$ ✓

OR/*OF* $T_1 = 20(9,8) + 20(0,2)$ ✓

$= 200\ N$ ✓

(6)

OPTION 2 /*OPSIE 2*

$F_{net} = ma$✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 - (5)(9,8) - T_1$✓$= 5a$ ✓

$201 - T_1 = 5a$

$T_1 = 201 - 5a$........(1)

For 20 kg block/*Vir 20 kg-blok* ,

$T_1 + (-mg) = ma$.......(2)

$T_1 + [-20(9,8)]$ ✓ $= 20a$

(1) x 4 : $4T_1 = 804 – 20a$

$\therefore T_1 - 196 = 804 – 4T_1$ ✓

$\therefore 5T_1 = 1\ 000$

$\therefore T_1 = 200\ N$ ✓

(6)

OPTION 3/*OPSIE 3*
$F_{net} = ma$ ✓
For 5 kg block/*Vir 5 kg-blok*
$T_2 + (-mg) + (-T_1) = ma$
$250 - (5)(9,8) - T_1$ ✓ $= 5a$ ✓
$201 - T_1 = 5a$
$T_1 = 201 - 5a$........(1)
$\therefore a = \dfrac{201 - T_1}{5}$
For 20 kg block/*Vir 20 kg-blok* ,
$T_1 + (-mg) = ma$.......(2)
$T_1 + [-(20)(9,8)]$ ✓ $= 20a$
$\therefore T_1 - 196 = 20(\dfrac{201 - T_1}{5})$ ✓
$\therefore T_1 = 200$ N ✓

(6)

2.4 **Q** ✓ (1)

[12]

QUESTION 3/*VRAAG 3*

3.1 An object moving / Motion under the influence of gravity / weight / gravitational force only (and there are no other forces such as friction).✓✓ (2 or/*of* 0)
('n Voorwerp wat / Beweging slegs onder die invloed van swaartekrag / gewig / gravitasiekrag (en daar is geen ander kragte soos wrywing nie). (2)

3.2

OPTION 1/*OPSIE 1* Upwards positive/*Opwaarts positief:*	Downwards positive/*Afwaarts positief:*
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
0 ✓ $= 15\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓	0 ✓ $= -15\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 3,06$ s	$\Delta t = 3,06$ s
It takes/*Dit neem* 3,06 s ✓	It takes/*Dit neem* 3,06 s ✓

(4)

OPTION 2/*OPSIE 2* Upwards positive/*Opwaarts positief:*	Downwards positive/*Afwaarts positief:*
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
0 ✓ $= 15 + (-9,8)\Delta t$ ✓	0 ✓ $= -15 + (9,8)\Delta t$ ✓
$\Delta t = 1,53$ s	$\Delta t = 1,53$ s
It takes (2)(1,53) = 3,06 s ✓	It takes/*Dit neem* 3,06 s ✓

(4)

OPTION 3 / *OPSIE 3* Upwards positive/*Opwaarts positief:*	Downwards positive/*Afwaarts positief:*
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
-15 ✓ $= 15 + (-9,8)\Delta t$ ✓	15 ✓ $= -15 + (9,8)\Delta t$ ✓
$\Delta t = 3,06$ s ✓	$\Delta t = 3,06$ s ✓

(4)

OPTION 4/*OPSIE 4*

Upwards positive/*Opwaarts positief:*

$F_{net}\ \Delta t = \Delta p$ ✓
$mg\ \Delta t = m\ (v_f - v_i)$
$\Delta t = \dfrac{(0 - 15)✓}{-9,8\ ✓}$
$\Delta t = 1,53$ s
It takes/*Dit neem* (2)(1,53s) = 3,06 s✓

Downwards positive /*Afwaarts positief:*

$F_{net}\ \Delta t = \Delta p$ ✓
$mg\ \Delta t = m\ (v_f - v_i)$
$\Delta t = \dfrac{0 - (-15)✓}{9,8\ ✓}$
$\Delta t = 1,53$ s
It takes/*Dit neem* (2)(1,53s) = 3,06 s✓ (4)

OPTION 5/*OPSIE 5*

Upwards positive/*Opwaarts positief:*

$F_{net}\ \Delta t = \Delta p$ ✓
$mg\ \Delta t = m\ (v_f - v_i)$
$\Delta t = \dfrac{-15 - (15)✓}{-9,8\ ✓}$
= 3,06 s✓

Downwards positive/*Afwaarts positief:*

$F_{net}\ \Delta t = \Delta p$ ✓
$mg\ \Delta t = m\ (v_f - v_i)$
$\Delta t = \dfrac{15 - (-15)✓}{9,8\ ✓}$
$\Delta t = 3,06$ s✓ (4)

OPTION 5/*OPSIE 6*

Upwards positive/*Opwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
For ball A/*Vir bal A*
$0 = (15)^2 + 2\ (-9,8)\Delta y$ ✓
$\Delta y_A = 11,48$ m
$\Delta y = \left(\dfrac{v_f + v_i}{2}\right)\Delta t$
$11,48 = \left(\dfrac{15 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,53$ s

It takes/*Dit neem* (2)(1,53s) = 3,06 s✓

Downwards positive/*Afwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
For ball A/*Vir bal A*
$0 = (-15)^2 + 2\ (9,8)\Delta y$ ✓
$\Delta y_A = -11,48$ m
$\Delta y = \left(\dfrac{v_f + v_i}{2}\right)\Delta t$
$-11,48 = \left(\dfrac{-15 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,53$ s

It takes/*Dit neem* (2)(1,53s) = 3,06 s✓

3.3

OPTION 1/*OPSIE 1*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
For ball A/*Vir bal A*	For ball A/*Vir bal A*
$0 = (15)^2$✓ $+ 2(-9,8)\Delta y$✓	$0 = (-15)^2$✓ $+ 2(9,8)\Delta y$✓
$\Delta y_A = 11,48$ m	$\Delta y_A = -11,48$ m
When A is at highest point *Wanneer A op hoogste punt is*	When A is at highest point *Wanneer A op hoogste punt is*
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 0 + \frac{1}{2}(-9,8)(1,53)^2$✓✓ $\Delta y_B = -11,47$ m $\Delta y_B = 11,47$ m downward/*afwaarts*	$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 0 + \frac{1}{2}(9,8)(1,53)^2$✓✓ $\Delta y_B = 11,47$ m $\Delta y_B = 11,47$ m downward/*afwaarts*
Distance/*Afstand* = $y_A + y_B$ $= 11,47 + 11,48$ ✓ $= 22,95$ m✓	Distance/*Afstand* = $y_A + y_B$ $= 11,48 + 11,47$ ✓ $= 22,95$ m✓

OPTION 2/*OPSIE 2*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
At maximum height $v_f = 0$: *By maksimum hoogte $v_f = 0$:*	At maximum height $v_f = 0$: *By maksimum hoogte $v_f = 0$:*
Ball/*Bal* A $\Delta y_A = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= 15(1,53)$ ✓ $+ \frac{1}{2}(-9,8)(1,53)^2$✓ $= 11,48$ m	Ball/*Bal* A $\Delta y_A = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= (-15)(1,53)$ ✓ $+ \frac{1}{2}(9,8)(1,53)^2$✓ $= -11,48$ m
When A is at highest/point *Wanneer A op hoogste punt is*	When A is at highest point *Wanneer A by hoogste punt is*
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 0 + \frac{1}{2}(-9,8)(1,53)^2$✓✓ $\Delta y_B = -11,47$ m $\Delta y_B = 11,47$ m downward/*afwaarts*	$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 0 + \frac{1}{2}(-9,8)(1,53)^2$✓✓ $\Delta y_B = -11,47$ m $\Delta y_B = 11,47$ m downward/*afwaarts*
Distance/*Afstand* = $y_A + y_B$ $= 11,48 + 11,47$✓ $= 22,95$ m✓	Distance/*Afstand* = $(y_A + y_B)$ $= 11,48 + 11,47$ ✓ $= 22,95$ m✓

(7)

OPTION 3/*OPSIE 3*

Upwards positive/*Opwaarts positief:*

Ball A/*Bal A*

$\Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$\Delta y_A = 15(1{,}53)$ ✓ $+ \frac{1}{2}(-9{,}8)(1{,}53)^2$ ✓

$= 11{,}48$ m

For ball B/*Vir bal B*

$v_f = v_i + a\Delta t$

$v_f = 0 + (-9{,}8)(1{,}53)$

$v_f = 14{,}99$ m·s^{-1}

$v_f^2 = v_i^2 + 2a\Delta x$

$14{,}99^2$ ✓ $= 0 + 2(-9{,}8)\,\Delta y_B$ ✓

$\Delta y_B = -11{,}47$ (m)

$= 11{,}47$ m downward/*afwaarts*

Distance/*Afstand* $= (y_A + y_B)$

$= 11{,}48 + 11{,}47$ ✓

$= 22{,}95$ m ✓

Downwards positive/*Afwaarts positief:*

Ball A/*Bal A*

$y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$\Delta y_A = -15(1{,}53)$ ✓ $+ \frac{1}{2}(9{,}8)(1{,}53)^2$ ✓

$= -11{,}48$ (m)

$= 11{,}48$ m upward/*opwaarts*

For ball B/*Vir bal B*

$v_f = v_i + a\Delta t$

$v_f = 0 + (9{,}8)(1{,}53)$

$v_f = 14{,}99$ m·s^{-1}

$v_f^2 = v_i^2 + 2a\Delta x$

$14{,}99^2$ ✓ $= 0 + 2(9{,}8)\,\Delta y_B$ ✓

$\Delta y_B = 11{,}47$ (m)

Distance/*Afstand* $= (y_A + y_B)$

$= 11{,}48 + 11{,}47$ ✓

$= 22{,}95$ m ✓

(7)

OPTION 4/*OPSIE 4*

Upwards positive/*Opwaarts positief:*

Ball A/*Bal A*

$\Delta y_A = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(15+0)}{2}$ ✓ $(1{,}53)$ ✓

$= 11{,}48$ m

For ball B/*Vir bal B*

$v_f = v_i + a\Delta t$

$= 0 + (-9{,}8)(1{,}53)$

$= -15$ m·s^{-1}

$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0-15)\times 1{,}53}{2}$ ✓ ✓

$= -11{,}47$ m

$= 11{,}47$ m downward/*afwaarts*

Distance/*Afstand* $= (y_A + y_B)$

$= 11{,}48 + 11{,}47$ ✓

$= 22{,}95$ m ✓

Downwards positive/*Afwaarts positief:*

Ball A/*Bal A*

$\Delta y_A = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(-15+0)}{2}$ ✓ $(1{,}53)$ ✓

$= -11{,}48$ (m)

$= 11{,}48$ m upwards/*opwaarts*

$v_f = v_i\Delta t + a\Delta t$

$= 0 + (9{,}8)(1{,}53)$

$= 15$ m·s^{-1}

$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0+15)\times 1{,}53}{2}$ ✓ ✓

$= 11{,}47$m

Distance/*Afstand* $= y_A + y_B$

$= 11{,}48 + 11{,}47$ ✓

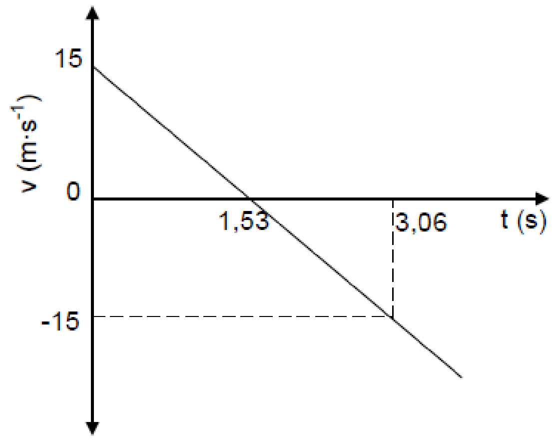
$= 22{,}95$ m ✓

(7)

OPTION 5/*OPSIE 5*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
Ball A/*Bal A* $W_{net} = \Delta K$✓	Ball A/*Bal A* $W_{net} = \Delta K$✓
OR/*OF* $\frac{1}{2} m(v_f^2 - v_i^2) = mg(h_f - h_i)\cos\theta$ $\frac{1}{2} m(0 - 15^2)$ ✓ $= m(9,8)h_f\cos 180^{\circ}$ ✓ $h = 11,48$ m	**OR/*OF*** $\frac{1}{2} m(v_f^2 - v_i^2) = mg(h_f - h_i)\cos\theta$ $\frac{1}{2} m(0 - 15^2)$ ✓ $= m(9,8)h_f\cos 180^{\circ}$ ✓ $h = 11,48$ m
OR/*OF* For Ball B when A is at highest point./ *Vir Bal B wanneer A by sy hoogste punt is.*	**OR/*OF*** For Ball B when A is at highest point./ *Vir Bal B wanneer A by sy hoogste punt is.*
$v_f = v_i + a\Delta t$ $= 0 + (-9,8)(1,53) = -15\ m \cdot s^{-1}$ ✓ $\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 - 15) \times 1,53}{2}$ ✓ $= -11,48$ m = 11,48 m downward/*afwaarts*	$v_f = v_i + a\Delta t$ $= 0 + (9,8)(1,53) = 15\ m \cdot s^{-1}$ ✓ $\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 + 15)(1,53)}{2}$ ✓ = 11,48 m downward/*afwaarts*
Distance/*Afstand* = $y_A + y_B$ = 11,48 + 11,48✓ = 22,96 m✓	Distance/*Afstand* = $y_A + y_B$ = 11,48 + 11,48✓ = 22,96 m✓ (7)

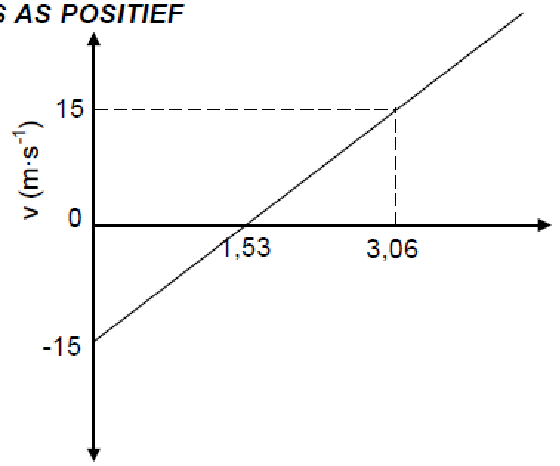
OPTION 7/*OPSIE 7*	
Upwards positive/*Opwaarts positief:* Ball A $\frac{1}{2} m v_i^2 + mgh_i = \frac{1}{2} m v_f^2 + mgh_f$✓ $\frac{1}{2} m(15^2)$ ✓ $+0 = \frac{1}{2} m(0) + m(9,8)h$ ✓ $h = 11,48$ m	**Downwards positive/*Afwaarts positief:*** Ball A $\frac{1}{2} m v_i^2 + mgh_i = \frac{1}{2} m v_f^2 + mgh_f$✓ $\frac{1}{2} m(15^2)$ ✓ $+0 = \frac{1}{2} m(0) + m(9,8)h$ ✓ $h = 11,48$ m
OR/*OF* For Ball B when A is at highest point. *Vir Bal B wanneer A by sy hoogste punt is.*	**OR/*OF*** For Ball B when A is at highest point. *Vir Bal B wanneer A by sy hoogste punt is.*
$v_f = v_i + a\Delta t$ $= 0 + (-9,8)(1,53)$ ✓ $= -15\ m \cdot s^{-1}$ $\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(0 - 15)(1,53)}{2}$ ✓ $= -11,48$ m = 11,48 m downward/*afwaarts*	$v_f = v_i + a\Delta t$ $= 0 + (9,8)(1,53)$ ✓ $= 15\ m \cdot s^{-1}$ $\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(0 + 15)(1,53)}{2}$ ✓ = 11,48 m downward/*afwaarts*
Distance/*Afstand* = $y_A + y_B$ = 11,48 + 11,48✓ = 22,96 m✓	Distance/*Afstand* = $y_A + y_B$ = 11,48 + 11,48✓ = 22,96 m✓ (7)

3.4



(4)
[17]

CONSIDER MOTION DOWNWARD AS POSITIVE/*BESKOU BEWEGING AFWAARTS AS POSITIEF*



Criteria/*Kriteria*	**Marks/*Punte***
Graph starts at correct Initial velocity shown./*Grafiek begin by korrekte beginsnelheid aangetoon.*	✓
Time for maximum height shown (1,53 s)./*Tyd vir maksimum hoogte aangetoon.(1,53 s)*	✓
Time for return shown (3,06 s) /*Tyd om terug te keer (3,06) aangetoon.*	✓
Shape/*Vorm*: Straight line extending beyond 3,06 s/ *Reguitlyn wat verby 3,06 s strek.*	✓

(4)
[17]

QUESTION 4/*VRAAG 4*

4.1 $p = mv$✓
$= 50(5)$✓
$= 250\ kg{\cdot}m{\cdot}s^{-1}$✓ (downward/*afwaarts*)

OR/*OF*
$p = mv$✓
$= 50(-5)$✓
$= -250\ kg{\cdot}m{\cdot}s^{-1}$
$= 250\ kg{\cdot}m{\cdot}s^{-1}$✓ (downward/*afwaarts*) (3)

4.2 The product of the (net) force and the time interval (during which the force acts)✓✓ (2 or 0)
Die produk van die (netto) krag en die tydinterval (waartydens die krag inwerk) (2 of 0). (2)

4.3

OPTION 1/*OPSIE 1* $\Delta p = F_{net}\Delta t$✓ $0 - 250$ ✓$= F_{net}(0,2)$ $F_{net} = -1\ 250\ N$ $= 1\ 250\ N$ ✓	$\Delta p = F_{net}\Delta t$✓ $250 - 0$ ✓$= F_{net}(0,2)$ $F_{net} = 1\ 250\ N$ ✓	$\Delta p = F_{net}\Delta t$✓ $50(0 - (-5))$✓$= F_{net}(0,2)$ $F_{net} = 1\ 250\ N$ ✓	(3)

OPTION 2/*OPSIE 2* $m(v_f - v_i) = F_{net}\Delta t$✓ $50\ (0 - 5)$ ✓$= F_{net}\ (0,2)$ $F_{net} = -1\ 250\ N$ $= 1\ 250\ N$ ✓	$m(v_f - v_i) = F_{net}\Delta t$✓ $50\ (5 - 0)$ ✓$= F_{net}\ (0,2)$ $F_{net} = 1\ 250\ N$ ✓	(3)

OPTION 3 /*OPSIE 3* $v_f = v_i + a\Delta t$ $0 = 5 + a(0,2)$ ✓ $a = -25\ m{\cdot}s^{-2}$ $F_{net} = ma$✓ $= 50\ (-25)$ $= -1\ 250\ N$ $= 1\ 250\ N$✓	$v_f = v_i + a\Delta t$ $5 = 0 + a(0,2)$ ✓ $a = 25\ m{\cdot}s^{-2}$ $F_{net} = ma$✓ $= 50\ (25)$ $= 1\ 250\ N$✓	(3)

4.4 Greater than/*Groter as* ✓ (1)

4.5 For the same momentum change, ✓
the stopping time (contact time) ✓ will be smaller (less) ✓
∴ the (upward) force exerted (on her) is greater.
Vir dieselfde verandering in momentum,
sal die stilhoutyd (kontaktyd) kleiner wees
∴ *die (opwaartse)krag wat (op haar) uitgeoefen word, sal groter wees.* (3)
[12]

QUESTION 5/*VRAAG 5*

5.1.1 In an isolated/closed system, ✓ the total mechanical energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly die totale meganiese energie behoue / bly konstant.

OR/*OF*
The total mechanical energy of a system is conserved/ remains constant ✓ in the absence of friction. ✓
Die totale meganiese energie van 'n sisteem bly behoue/bly konstant in die afwesigheid van wrywing.

OR/*OF*
The total mechanical energy of a system remains constant ✓ provided the net work done by external non conservative forces is zero. ✓
Die totale meganiese energie van 'n sisteem bly konstant, mits die arbeid verrig deur eksterne nie-konserwatiewe kragte, nul is.

OR/*OF*
In the absence of a non-conservative force, the total mechanical energy is conserved/remains constant
In die afwesigheid van 'n nie-konserwatiewe krag, bly die totale meganiese energie behoue / konstant

OR/*OF*
In an isolated/closed system, ✓ the sum of kinetic and gravitational potential energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly som van kinetiese en gravitasionele potensiële energie behoue / bly konstant.

5.1.2 No/*Nee* ✓ (1)

5.1.3

OPTION 1/*OPSIE 1*	
Along **AB**/*Langs* **AB** $E_{\text{mechanical at A}} = E_{\text{mechanical at B}}$ $(E_p + E_k)_A = (E_p + E_k)_B$ $(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ ✓ $(10)(9,8)(4) + 0 = 0 + ½ (10) v_f^2$ ✓ $v_f = 8,85 \text{ m·s}^{-1}$	Along **AB**/*Langs* **AB** $W_{net} = \Delta E_k$ ✓ $F_g \Delta h \cos\theta = ½ m(v_f^2 - v_i^2)$ $(10)(9,8)(4)\cos 0° = ½ (10)(v_f^2 - 0)$ ✓ $v_f = 8,85 \text{ m·s}^{-1}$

(6)

<table>
<tr><td colspan="2">Along AB/Langs AB

$W_{nc} = \Delta K + \Delta U$ ✓
$0 = ½ (10)(v_f^2 – 0) + 10(9,8)(4 – 0)$ ✓
$v_f = 8,85\ m{\cdot}s^{-1}$</td></tr>
<tr><td colspan="2">Substitute 8,85 m·s⁻¹ in one of the following options
Vervang 8,85 m·s⁻¹ in een van die volgende opsies</td></tr>
<tr><td>Along BC/Langs BC

$W_{net} = \Delta K$✓
$f\Delta x \cos\theta = \Delta K$
$\underline{f(8)\cos 180^o}$ ✓= $\underline{½ (10)(0 – 8,85^2)}$ ✓
$f = 48,95$ N✓</td><td>Along BC/Langs BC

$W_{nc} = \Delta K + \Delta U$ ✓
$f\ \Delta x\cos\theta = \Delta K + \Delta U$
$\underline{f(8)\cos 180}$ ✓= $\underline{½ (10)(0 - 8,85^2)}$ + 0✓
$f = 48,95$ N✓ (Accept/ Aanvaar 49 N)</td></tr>
</table>

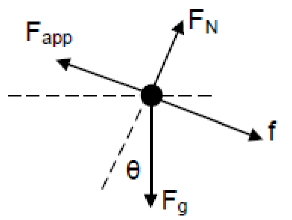
<u>OPTION 2/*OPSIE 2*</u>
Along **AC**/*Langs* **AC**

$W_{nc} = \Delta K + \Delta U$✓
$f\Delta x\cos\theta = \Delta K + \Delta U$
$(f)(8)$✓$(\cos180^o)$✓ $= (0 - 0)$ ✓ $+ 10 (9,8)(0 - 4)$ ✓
$f = 49$ N ✓ (6)

5.2.1 $f_k = \mu_k N$✓
$= \mu_k mg\cos\theta$
$= \underline{(0,19)(300)(9,8) \cos 25^o}$✓
$= 506,26$ N✓ (3)

5.2.2

<u>OPTION 1/*OPSIE 1*</u>



$\left.\begin{array}{l} F_{net} = 0 \\ \underline{F_{app} + (-F_g\sin\theta) + (-f) = 0} \end{array}\right\}$ ✓
$F_{app} - (300)(9,8)\sin 25^o$✓ - $506,26$✓ $= 0$
$F_{app} = 1\ 748,76$ N

$P_{ave} = Fv_{ave}$ ✓
$= 1748,76 \times 0,5$✓
$= 874,38$ W ✓ (6)

OPTION 2/*OPSIE 2*
$W_f + W_{app} + W_N + W_g = 0$ ✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\Delta x\cos\theta = 0$
$(506{,}26\Delta x\cos 180^{\circ})$ ✓ $+ (F_{app}\Delta x\cos 0) + 300(9{,}8)\Delta x\cos 115^{\circ}$ ✓ $= 0$

$F_{app} = 1748{,}76$ N
$P_{ave} = Fv_{ave}$ ✓
$= (1748{,}76)(0{,}5)$ ✓
$= 874{,}38$ W ✓ (6)

OPTION 3/*OPSIE 3*
$W_f + W_{app} + W_N + W_g = 0$ ✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\sin\theta\Delta x\cos\theta = 0$
$(506{,}26\Delta x\cos 0)$ ✓ $+ (F_{ap}\Delta x\cos 0) + 300(9{,}8)\sin 25^{\circ}\,\Delta x\cos 180)$ ✓ $= 0$
$F_{app} = 1\,748{,}76$ N

$P_{ave} = Fv_{ave}$ ✓
$= (1\,748{,}76)(0{,}5)$ ✓ (6)
$= 874{,}38$ W ✓ **[18]**

QUESTION 6/*VRAAG 6*

6.1.1 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 Towards/*Na* ✓

Observed/detected frequency is greater than the actual frequency. ✓
Waargenome frekwensie is groter as die werklike frekwensie. (2)

6.1.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

(1200) ✓ $= \frac{343}{343 - v_s}$ ✓ 1130 ✓

$v_s = 20{,}01\ m\cdot s^{-1}$ ✓
Accept/*Aanvaar:* $(19{,}42 - 20{,}01\ m\cdot s^{-1})$ (5)

6.2 The star is approaching the earth. ✓
Die ster nader die aarde.
OR/*OF*
The earth and the star are approaching (moving towards) each other. ✓
Die aarde en die ster nader mekaar.

The spectral lines in diagram 2 are shifted towards the blue end/blue shifted. ✓ (2)
Die spektrumlyne in diagram 2 het verskuif na die blou ent/blou verskuiwing **[11]**

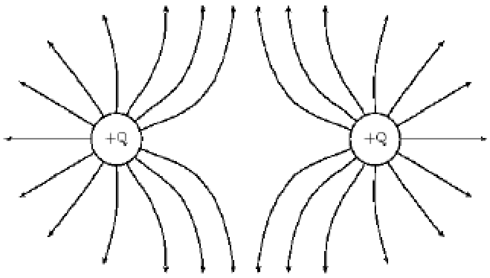
QUESTION 7/*VRAAG 7*

7.1 To ensure that charge does not leak to the ground/insulated. ✓
Om te verseker dat die lading nie na die grond toe lek nie/isoleer. (1)

Notes/*Aantekeninge*
Accept/*Aanvaar*
In order retain original charge✓/To insulate the charges./ *Om oorspronklike lading te behou/ Om lading te isoleer.*

7.2 Net charge/*Netto lading* = $\frac{Q_R + Q_S}{2} = \frac{+8 + (-4)}{2}$ ✓= 2 μC✓ (2)

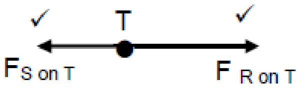
7.3



Criteria for sketch:/*Kriteria vir skets:*	Marks/ *Punte*
Correct direction of field lines *Korrekte rigting van veldlyne*	✓
Shape of the electric field *Vorm van elektrieseveld*	✓
No field line crossing each other / No field lines inside the spheres/ *Geen veldlyne wat maekaar kruis nie / Geen veldlyne binne sfeer nie*	✓

(3)

7.4



(2)

7.5

OPTION 1/*OPSIE 1*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{ST} = (9\times10^9)\frac{(1\times10^{-6})(2\times10^{-6})}{(0,2)^2}$ ✓ ✓ = 0,45 N / 4,5 x 10^{-1} N left/*links*

OR/*OF*

$F_{TS} = \frac{1}{4}F_{RT} = \frac{1}{4}(1,8) = 0,45$ N

$F_{RT} = 9\times10^9 \times \frac{(2\times10^{-6})(1\times10^{-6})}{(0,1)^2}$ ✓ = 1,8 N right/*regs*

OR/*OF*

$F_{RT} = 4F_{ST} = 4(0,45) = 1,8$ N right /*regs*

$F_{net} = F_{ST} + F_{RT} = \underline{1,8 + (-0,45)}$ ✓

= $\underline{1,35 \text{ N}}$ or towards sphere S / *na sfeer* or/*of* *right/regs S*✓ (6)

OPTION 2/*OPSIE 2*
$E_R = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 $N.C^{-1}$ right/*regs*
$E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ ✓= 4,5 x 10^5 $N.C^{-1}$ left/*links*
E_{net} = 1,8 x 10^6 - 4,5 x 10^5 ✓= 1,35 x 10^6 $N.C^{-1}$right/*regs*
F = EQ ✓= (1,35 x 10^6)(1 x 10^{-6}) ✓ = 1,35 N towards sphere S / na sfeer S right/*regs* ✓

(6)

7.6 Force experienced ✓per unit positive charge ✓placed at that point.
Krag ondervind per eenheid positiewe lading by daardie punt. (2)

7.7

OPTION 1/*OPSIE 1*
$E = \frac{F}{q}$ ✓ = $\frac{1,35}{1\times10^{-6}}$ ✓= 1,35 x 10^6 $N\cdot C^{-1}$✓

(3)

OPTION 2/*OPSIE 2*
$E_R = \frac{kQ}{r^2}$ ✓ = $\frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 $N\cdot C^{-1}$ right/*regs*
$E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ = 4,5 x 10^5 $N\cdot C^{-1}$ left/*links*
E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 $N\cdot C^{-1}$✓ (3)
OPTION 3/*OPSIE 3*
$E = \frac{F}{q}$ ✓ = $\frac{1,8}{1\times10^{-6}}$ ✓= 1,8 x 10^6 $N\cdot C^{-1}$
$E = \frac{F}{q} = \frac{0,45}{1\times10^{-6}}$ = 4,5 x 10^5 $N\cdot C^{-1}$
E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 $N\cdot C^{-1}$✓

(3)
[19]

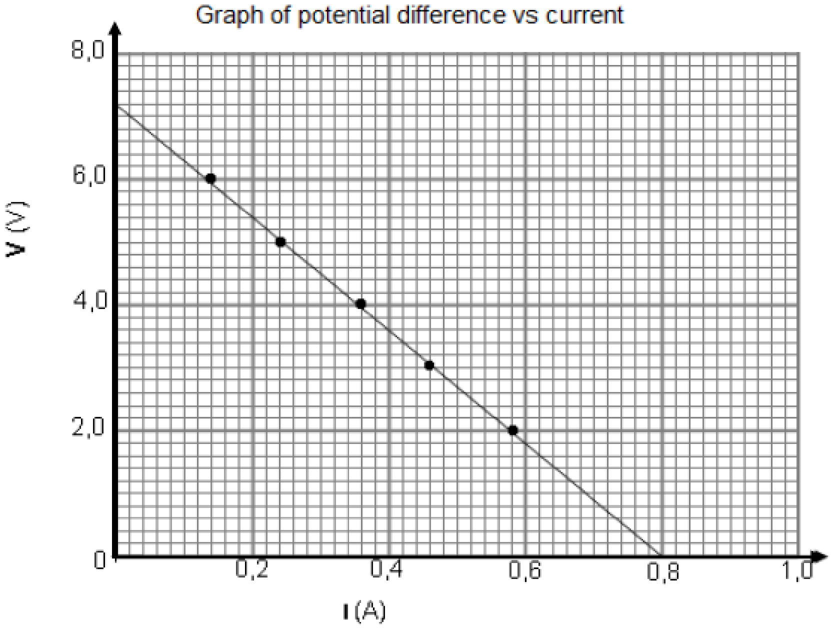
QUESTION 8/*VRAAG 8*

8.1.1 Keep the temperature (of battery) constant.
Hou die temperatuur (van battery) konstant (1)

8.1.2

Grafiek van potensiaalverskil teenoor stroom

Graph of potential difference vs current



Criteria for drawing line of best fit:/*Kriteria vir teken van lyn van beste pas:*	Marks/ *Punte*
ALL points correctly plotted (at least 4 points) *ALLE punte korrek gestip (ten minste 4 punte)*	✓✓
Correct line of best fit if all plotted points are used (at least 3 point) *Korrekte lyn van beste pas indien alle punte gebruik word (ten minste 3 punte)*	✓

(3)

8.1.3 7,2 V✓
(Accept any readings between 7,0 V and 7,4 V or the value of the y-intercept
/*Aanvaar enige lesing tussen 7,0 V en 7,4 V of die waarde van die y-afsnit* (1)

8.1.4

Slope/*Helling* $= \dfrac{\Delta V}{\Delta I}$

$= \dfrac{0 - 7{,}2\ ✓}{0{,}8 - 0\ ✓} = -9$

r = 9 Ω✓ (3)

8.2.1

OPTION 1/*OPSIE 1*

$P = VI$ ✓

$100 = 20(I)$ ✓

$I = 5\ A$ ✓ (3)

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$ ✓

$100 = \frac{(20)^2}{R}$

$R = 4\ \Omega$

$V = IR$

$20 = I(4)$ ✓

$I = 5\ A$ ✓ (3)

OPTION 3/*OPSIE 3*

$P = \frac{V^2}{R}$ ✓

$100 = \frac{(20)^2}{R}$

$R = 4\ \Omega$

$P = I^2R$

$100 = I^2(4)$ ✓

$I = 5\ A$ ✓

8.2.2

OPTION 1/*OPSIE 1*

$P = \frac{V^2}{R}$ ✓

$R = \frac{(20)^2}{150}$ ✓

$= 2,67\ \Omega$ ✓ (3)

OPTION 2/OPSIE 2

$P = VI$ ✓

$150 = (20)I$

$I = 7,5\ A$

$V = IR$

$20 = (7,5)R$ ✓

$R = 2,67\ \Omega$ ✓

OR/*OF*

$P = I^2R$

$150 = (7,5)^2R$ ✓

$R = 2,67\ \Omega$ ✓ (3)

OPTION 3/*OPSIE 3*

I_X : I_Y
5 : 7,5
1 : 1,5

R_X : R_Y
1,5 : 1✓
4 ✓: 2,67 Ω✓ (3)

8.2.3

OPTION 1/*OPSIE 1*

$P = VI$ **OR/*OF*** $P = I^2R$

$I_{150W} = \frac{150}{20}$ ✓ $= 7,5$ A **OR/*OF*** $I_{150W} = \sqrt{\frac{150}{2,67}}$ ✓ $= 7,5$ A

$I_{tot} = (5 + 7,5)$ ✓
$\varepsilon = I(R + r)$ ✓
$24 = 12,5(R + r)$
$24 = V_{ext} + V_{ir}$
$24 = 20 + 12,5(r)$ ✓
$r = 0,32\ \Omega$ ✓ (5)

OPTION 2/*OPSIE 2*

$V = Ir$✓
$I_{tot} = (5 + 7,5)$ ✓
$(24 - 20)$ ✓$= 12,5\ r$✓
$\therefore r = \frac{4}{12,5}$
$r = 0,32\ \Omega$✓ (5)

OPTION 3/*OPSIE 3*

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{//}} = \frac{1}{4} + \frac{1}{2,67}$ ✓ OR/*OF* $R_{//} = \frac{(4)(2,67)}{4 + 2,67}$

$\therefore R_{||} = 1,6\ \Omega$

$I_{tot} = \frac{20}{1,6} = 12,5$ A✓

$\varepsilon = I(R + r)$ ✓

$24 = 12,5(R + r)$
$24 = V_{ext} + V_{ir}$
$24 = 20 + 12,5(r)$ ✓
$r = 0,32\ \Omega$ ✓ (5)

OPTION 4/*OPSIE 4*
$P = VI$✓
$250 = (20)I$✓
$I = 12,5\ A$

$V = Ir$✓
$4 = (12,5)r$✓
$r = 0,32\ \Omega$ ✓ (5)

8.2.4 Device Z is a voltmeter ✓.
Toestel Z is 'n voltmeter (1)

8.2.5 Device **Z** should be a voltmeter (or a device with very high resistance) because it has a very high resistance✓ and will draw very little current. ✓
The current through **X** and **Y** will remain the same hence the device can operate as rated.
*Toestel **Z** moet 'n voltmeter wees (of 'n toestel met 'n baie hoë weerstand) omdat dit 'n baie hoë weerstand het en baie min sal stroom trek*
*Die stroom deur **X** en **Y** sal dieselfde bly, gevolglik kan die toestel werk soos ontwerp.* (2)
[22]

QUESTION 9/*VRAAG 9*

9.1 Electromagnetic induction / *Elektromagnetiese induksie*✓ (1)

9.2 Rotate the coil faster/Increase the number of coils/ Increase the strength of the magnetic field.
Roteer die spoel vinniger/Verhoog die aantal spoele / Verhoog die sterkte van die magneetveld. (1)

9.3 Slip rings/*Sleepringe*✓ (1)

9.4.1 It is the value of the voltage in a DC circuit✓ that will have the same heating effect as an AC circuit. ✓
Dit is die waarde van die potensiaalverskil in 'n GS-stroombaan✓ wat dieselfde verhittingseffek het as 'n WS-stroombaan✓ (2)

9.4.2
$$V_{rms} = \frac{V_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{339,45}{\sqrt{2}} \checkmark$$
$$V_{rms} = 240,03\ V \checkmark$$
(3)
[8]

QUESTION 10/*VRAAG 10*

10.1 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. (2)

10.2 **OPTION 1/*OPSIE 1***

$$\left.\begin{array}{l} E = W_o + E_{k(max)} \\ E = W_o + \frac{1}{2}mv^2_{max} \\ h\frac{c}{\lambda} = hf_0 + \frac{1}{2}mv^2_{max} \end{array}\right\} \checkmark \text{Any one / } \textit{Enige een}$$

$$\frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{\lambda} \checkmark = (6{,}63 \times 10^{-34})(5{,}548 \times 10^{14}) \checkmark + \frac{1}{2}(9{,}11 \times 10^{-31})(5{,}33 \times 10^5)^2 \checkmark$$

$\lambda = 4 \times 10^{-7}$ m✓ (5)

OPTION 2/*OPSIE 2*

$$\left.\begin{array}{l} E = W_o + E_{k(max)} \\ E = W_o + \frac{1}{2}mv^2_{max} \\ hf = hf_0 + \frac{1}{2}mv^2_{max} \end{array}\right\} \checkmark \text{Any one / } \textit{Enige een}$$

$$(6{,}63 \times 10^{-34})f = (6{,}63 \times 10^{-34})(5{,}548 \times 10^{14}) \checkmark + \frac{1}{2}(9{,}11 \times 10^{-31})(5{,}33 \times 10^5)^2 \checkmark$$

$f = 7{,}5 \times 10^{14}$ Hz

$c = f\lambda$
$3 \times 10^8 = (7{,}5 \times 10^{14})\lambda$✓
$\lambda = 4 \times 10^{-7}$ m ✓ (5)

10.3 Smaller (less) than ✓
Kleiner (minder) as (1)

10.4 The wavelength/frequency/energy of the incident light (photon/hf) is constant✓.
Die golflengte/frekwensie/energie van die invallende lig (foton/hf) is konstant

Since the speed is larger, the kinetic energy is larger ✓ the work function/W_0/threshold frequency smaller. ✓

Aangesien die spoed vergroot, is die kinetiese energie groter, is die arbeidsfunksie / W_0 / drumpel frekwensie kleiner (3)
[11]

GRAND TOTAL/*GROOTTOTAAL*: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2014

MEMORANDUM

QUESTION 1 / *VRAAG 1*

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 B ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 D ✓✓ (2)

1.10 C ✓✓ (2)
[20]

QUESTION 2 / *VRAAG 2*

2.1
2.1.1 B ✓ (1)

2.1.2 E ✓ (1)

2.1.3 F ✓ (1)

2.2
2.2.1 2-bromo-3-chloro-4-methylpentane
2-bromo-3-chloro-4-metielpentaan / 2-broom-3-chloor-4-metielpentaan

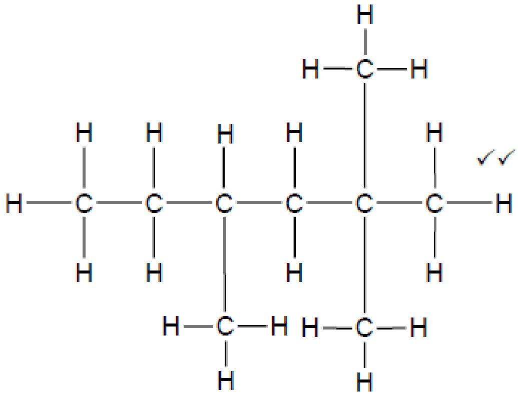
Marking criteria / *Nasienriglyne:*
- Correct stem i.e. pentane. / *Korrekte stam d.i. pentaan.* ✓
- All substituents correctly identified. / *Alle substituente korrek geïdentifiseer.* ✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used. ✓
Substituente korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik.

(3)

2.2.2 Ethene / *Eteen* ✓ (1)

2.3

2.3.1



<u>Marking criteria / *Nasienriglyne:*</u>

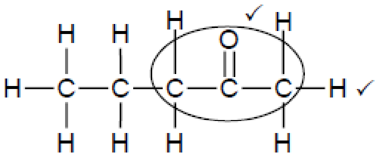
- Six saturated C atoms in longest chain i.e. hexane. ✓
  Ses versadigde C-atome in langste ketting d.i. heksaan.
- Three methyl substituents on second C and fourth C. ✓
  Drie metielsubstituente op tweede C en vierde C.

<u>Notes / *Aantekeninge:*</u>

- If correct structure, but H atoms omitted / *Indien korrekte struktuur, maar H-atome weggelaat:* Max / *Maks.* $\frac{1}{2}$
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max./*Maks.* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule:* $\frac{0}{2}$

(2)

2.3.2



<u>Marking criteria / *Nasienriglyne:*</u>

- Whole structure correct / *Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct / *Slegs funksionele groep korrek:* $\frac{1}{2}$

<u>Notes / *Aantekeninge:*</u>

- If two or more functional groups/Indien *twee of meer funksionele groepe:* $\frac{0}{2}$
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max / *Maks* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule:* $\frac{0}{2}$

(2)

2.4

2.4.1 (Compounds with) the same molecular formula ✓ but different functional goups / different homologous series. ✓
(Verbindings met) dieselfde molekulêre formule, maar verskillende funksionele groepe / verskillende homoloë reekse. (2)

2.4.2 <u>B & F</u> ✓ (1)

[14]

QUESTION 3 / *VRAAG 3*

3.1 **ANY ONE / *ENIGE EEN*:**

- Alkanes have <u>ONLY single bonds</u>. ✓
  Alkane het <u>SLEGS enkelbindings</u>.
- Alkanes have <u>single bonds between C atoms.</u>
  Alkane het <u>enkelbindings tussen C-atome.</u>
- Alkanes have no double OR triple bonds OR multiple bonds.
- *Alkane het geen dubbel- OF trippelbindings OF meervoudige bindings nie.*
- Alkanes contain the <u>maximum number of H atoms bonded to C atoms</u>.
  Alkane bevat die <u>maksimum getal H-atome gebind aan C-atome</u>. (1)

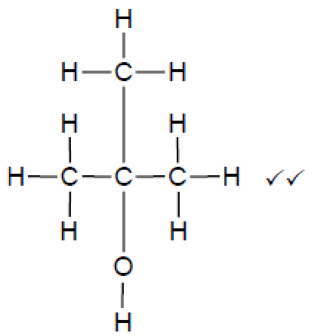
3.2

3.2.1 **ANY ONE / *ENIGE EEN:***

– C – O – H ✓ (C with bonds above and below)	– C – OH (C with bonds above and below)	– OH	– O – H
R – OH	R – O – H		

(1)

3.2.2



<u>Marking criteria / *Nasienriglyne:*</u>

- - OH group on second C atom of longest chain. ✓
  - OH-groep op tweede C-atoom van langste ketting.
- Tertiary group consisting of four C atoms with methyl group on 2nd C atom. ✓
  Tersiêre groep bestaande uit vier C-atome met metielgroep op 2de C-atoom.
- If two or more functional groups / *Indien twee of meer funksionele groepe:* $\frac{0}{2}$

<u>Notes / *Aantekeninge:*</u>

- Accept / *Aanvaar* **–** OH
- If correct structure and number of bonds, but H atoms omitted / *Indien korrekte struktuur en getal bindings, maar H-atome weggelaat:* Max / *Maks.* $\frac{1}{2}$
- Condensed or semi-structural formula / *Gekondenseerde of semistruktuurformule:* Max / *Maks.* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule:* $\frac{0}{2}$

(2)

3.3
3.3.1

Criteria for investigative question / *Riglyne vir ondersoekende vraag:*	
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Ask a question about the relationship between the independent and dependent variables. *Vra 'n vraag oor die verwantskap tussen die onafhanklike en afhanklike veranderlikes.*	✓

Examples / *Voorbeelde*:

- How does an increase in chain length / molecular size / molecular structure / molecular mass / surface area influence boiling point?
  Hoe beïnvloed 'n toename in kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / reaksieoppervlak die kookpunt?
- What is the relationship between chain length / molecular size / molecular structure / molecular mass / surface area and boiling point?
  Wat is die verwantskap tussen kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte en kookpunt? (2)

3.3.2
- **Structure / *Struktuur*:**
  The chain length / molecular size / molecular structure / molecular mass / surface area increases. ✓
  Die *kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte neem toe.*
- **Intermolecular forces / *Intermolekulêre kragte*:**
  Increase in strength of intermolecular forces / induced dipole / London / dispersion / Van der Waals forces. ✓
  Toename in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte / Van der Waalskragte.
- **Energy / *Energie*:**
  More energy needed to overcome / break intermolecular forces. ✓
  Meer *energie benodig om intermolekulêre kragte te oorkom / breek.*

OR / *OF*

- **Structure / *Struktuur*:**
  From propane to methane the chain length / molecular size / molecular structure / molecular mass / surface area decreases. ✓
  Van propaan na metaan neem die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte af.
- **Intermolecular forces / *Intermolekulêre kragte:***
  Decrease in strength of intermolecular forces / induced dipole forces / London forces / dispersion forces. ✓
  Afname in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte.
- **Energy / *Energie*:**
  Less energy needed to overcome / break intermolecular forces. ✓
  Minder energie benodig om intermolekulêre kragte te oorkom / breek. (3)

3.4
- Between propane molecules are London forces / dispersion forces / induced dipole forces. ✓
  Tussen propaanmolekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.
- Between propan-1-ol molecules are London forces / dispersion forces / induced dipole forces and hydrogen bonds. ✓
  Tussen propan-1-ol molekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en waterstofbindings.
- Hydrogen bonds / Forces between alcohol molecules are stronger or need more energy than London forces / dispersion forces / induced dipole forces. ✓
  Waterstofbindings / Kragte tussen alkoholmolekule is sterker of benodig meer energie om oorkom te word as Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.

OR/*OF*

Between propane molecules are weak London forces / dispersion forces / induced dipole forces ✓ and between propan-1-ol molecules are strong hydrogen bonds. ✓✓
Tussen propaanmolekule is swak Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en tussen propan-1-olmolekule is sterk waterstofbindings. (3)
[12]

QUESTION 4 / *VRAAG 4*

4.1

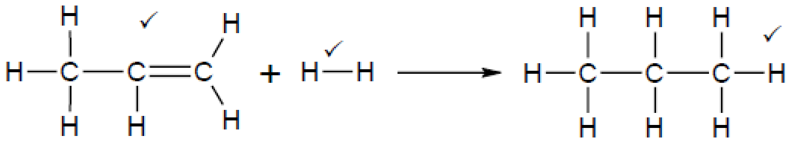
4.1.1 Substitution / chlorination / halogenation ✓
Substitusie / chlorering / halogenering / halogenasie (1)

4.1.2 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

4.2

4.2.1 Hydrogenation / *Hidrogenasie / Hidrogenering* ✓ (1)

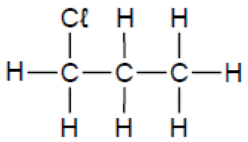
4.2.2



Notes / *Aantekeninge*:
- Ignore/*Ignoreer* ⇌
- Accept H_2 if condensed. / *Aanvaar H_2 as gekondenseerd.*
- Any additional reactants and/or products
  Enige addisionele reaktanse en / of produkte: Max./*Maks.* $\frac{2}{3}$
- Accept coefficients that are multiples.
  Aanvaar koëffisiënte wat veelvoude is.
- Molecular / condensed formulae
  Molekulêre-/ gekondenseerde formule: Max./*Maks.* $\frac{2}{3}$

(3)

4.3



Marking criteria / *Nasienriglyne:*

- Whole structure correct:/ *Hele struktuur korrek:* $\frac{2}{2}$
- Only ONE Cℓ atom as functional group. / *Slegs EEN Cℓ-atoom as funksionele groep.* $\frac{1}{2}$

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:* $\frac{0}{2}$

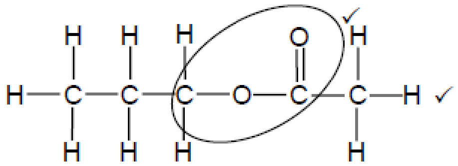
(2)

4.4

4.4.1 Esterification / Condensation ✓
Verestering / Esterifikasie / Kondensasie (1)

4.4.2 (Concentrated) H_2SO_4 / (Concentrated) sulphuric acid ✓
(Gekonsentreerde) H_2SO_4 / (Gekonsentreerde) swawelsuur of swaelsuur (1)

4.4.3



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:*

- If two or more functional groups/Indien *twee of meer funksionele groepe:* $\frac{0}{2}$
- 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)

4.4.4 Propyl ✓ ethanoate ✓
Propieletanoaat (2)

4.5 Sulphuric acid / H_2SO_4 / Phosphoric acid / H_3PO_4 ✓
Swawelsuur / Swaelsuur / H_2SO_4 / Fosforsuur / H_3PO_4 (1)

[15]

QUESTION 5 / *VRAAG 5*

5.1 **ONLY ANY ONE OF/ *SLEGS ENIGE EEN VAN*:**

- Change in concentration of products / reactants ✓ per (unit) time. ✓
  Verandering in konsentrasie van produkte / reaktanse per (eenheids)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 (eenheids)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 (eenheids)tyd. (2)

5.2

5.2.1 Temperature / *Temperatuur* ✓ (1)

5.2.2 Rate of reaction / Volume of gas (formed) per (unit) time ✓
Reaksietempo / Volume gas (gevorm) per (eenheids)tyd (1)

5.3
- Larger mass / amount / surface area. ✓
  Groter massa / hoeveelheid / reaksieoppervlak.
- More effective collisions per (unit) time. / Frequency of effective collisions increase./ More particles collide with sufficient kinetic energy & correct orientation per (unit) time. ✓✓
  Meer effektiewe botsings per (eenheids)tyd. / Frekwensie van effektiewe botsings verhoog./ Meer deeltjies bots met genoeg kinetiese energie & korrekte oriëntasie per tyd(seenheid).

IF / *INDIEN*: • Larger mass / amount / surface area. ✓ *Groter massa / hoeveelheid / reaksieoppervlak.* • More particles collide. / More collisions. ✓ *Meer deeltjies bots. / Meer botsings.* *Max./Maks.* $\frac{2}{3}$
Notes / *Aantekeninge*: **IF/INDIEN:** No reference to mass / amount / surface area in answer: Geen verwysing na *massa / hoeveelheid / reaksieoppervlak in antwoord:* $\frac{0}{3}$

(3)

5.4 **Marking criteria / *Nasienriglyne:***

Compare Exp.1 with Exp. 2: *Vergelyk Eksp. 1 met Eksp. 2:*	The reaction in exp. 1 is faster in exp. 1 than in exp. 2 due to the higher acid concentration. *Die reaksie in eksp. 1 is vinniger as dié in eksp. 2 as gevolg van die hoër suurkonsentrasie.*	✓
	Therefore the gradient of the graph representing exp. 1 is greater / steeper than that of exp. 2. / Graph of Exp. 1 reaches constant volume in shorter time than exp. 2. *Dus is die gradiënt van die grafiek wat eksp. 1 voorstel, groter/steiler as dié vir eksp. 2. / Grafiek van exp. 1 bereik konstante volume in korter tyd as dié vir eksp. 2.*	✓
Compare Exp. 1 with Exp 3 & 4: *Vergelyk Eksp. 1 met Eksp. 3 & 4:*	The reaction in exp. 3 is faster than that in exp. 1 due to the higher temperature. *Die reaksie in eks. 3 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur.*	✓
	The reaction in exp. 4 is faster than that in exp. 1 due to the higher temperature / larger surface area. *Die reaksie in eks. 4 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur / groter reaksieoppervlak.* **OR/*OF*** *Graph A represents exp. 4 due to the greater mass of $CaCO_3$ - greater yield of CO_2 at a faster rate.* *Grafiek A stel eksp. 4 voor as gevolg van die groter massa $CaCO_3$ - groter opbrengs CO_2 teen vinniger tempo.*	✓
	Therefore the gradient of the graphs of exp. 3 & 4 are greater/steeper than that of exp. 1. / Graphs of Exp. 3 & 4 reaches constant volume in shorter time than exp. 1. *Dus is die gradiënte van die grafieke vir eksp. 3 & 4 is groter/steiler as dié in eksp. 1./ Grafieke van exp. 3 & 4 bereik konstante volume in korter tyd as dié vir eksp. 1.*	✓
Final answer *Finale antwoord*	C	✓

(6)

Notes/*Aantekeninge*

- Compare exp. 1 with exp. 2 / *Vergelyk eksp. 1 met eksp. 2*:
  - Factor & rate / *Faktor & tempo.*
  - Gradient / volume CO_2 per time / gradient / *volume CO_2 per tyd.*
- Compare exp. 1 with exp. 3 / *Vergelyk eksp. 1 met eksp. 3*:
  - Factor & rate / *Faktor & tempo.*
- Compare exp. 1 with exp. 4/ *Vergelyk eksp. 1 met eksp. 4*:
  - Factor & rate / *Faktor & tempo.*
- Compare gradient / volume CO_2 per time of exp 1 with that of exp. 3 & 4 *Vergelyk gradient/volume CO_2 per tyd van eksp 1 met die van eksp. 3 & 4*
- Final answer / *finale antwoord*: C

5.5

Marking criteria / *Nasienriglyne:*

- Divide volume by / *Deel volume deur*: 25,7 ✓
- Use ratio / Gebruik *verhouding*: $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute / *Vervang* 100 in $n = \frac{m}{M}$. ✓
- Subtraction / *Aftrekking.* ✓
- Final answer / *Finale antwoord:* 7,00 g to/*tot* 7,5 g ✓

OPTION 1 / *OPSIE 1*

$n(CO_2) = \frac{V}{V_m}$

$= \frac{4,5}{25,7}$ ✓

$= 0,18 \text{ mol} \quad (0,175 \text{ mol})$

$n(CaCO_3) = n(CO_2) = 0,18$ mol ✓

$n(CaCO_3) = \frac{m}{M}$

$0,18 = \frac{m}{100}$ ✓

$\therefore$ m = 18 g (17,5 g)

$m(CaCO_3)$ not reacted/*nie gereageer nie):*

25 – 18 ✓ = 7,00 g ✓ (7,49 g)

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7.00 g – 7,5 g)

OPTION 2 / *OPSIE 2*

Calculate mass of CO_2:
Bereken massa CO_2:

$n(CO_2) = \frac{V}{V_m}$

$= \frac{4,5}{25,7}$ ✓

$= 0,18 \text{ mol} \quad (0,175 \text{ mol})$

$n(CO_2) = \frac{m}{M}$

$0,18 = \frac{m}{44}$

$\therefore m(CO_2)$ = 7,92 g (7,7043 g)

Ratio/ verhouding ✓

$m(CaCO_3 \text{ needed / } benodig) = \frac{7,92}{44} \times 100$ ✓

$= 18 \text{ g} \quad (17,5 \text{ g})$

$m(CaCO_3$ not reacted/*nie gereageer nie):*

25 – 18,00 ✓ = 7,00 g ✓ (7,49 g)

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7.00 g – 7,5 g)

(5)

OPTION 3 / *OPSIE 3*

25,7 dm^3 : 1 mol
4,5 dm^3 : 0,18 mol ✓

100 g ✓: 1 mol
x : 0,18 mol ✓
x = 18 g

$m(CaCO_3$ not reacted/*nie gereageer nie):*

25 – 18 ✓ = 7,00 g ✓

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

OPTION 4 / *OPSIE 4*

100 g $CaCO_3 \rightarrow 25,7 \text{ dm}^3 \text{ } CO_2$ ✓✓
x g $\rightarrow 4,5 \text{ dm}^3 \text{ } CO_2$ ✓
$\therefore$ x = 17,51 g

Mass not reacted/*Massa nie gereageer nie*
= 25 – 17,51 ✓
= 7,49 g ✓

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

(5)

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. ✓✓

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

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation / *Puntetoekenning:*

- 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.
- Substitution of K_C value / *Vervanging van K_C-waarde.* ✓
- Equilibrium concentration of both NO_2 & N_2O_4 multiplied by 0,08 dm^3. ✓
  Ewewigskonsentrasie van beide NO_2 & N_2O_4 vermenigvuldig met 0,08 dm^3
- Change in n(N_2O_4) = equilibrium n(N_2O_4) – initial n(N_2O_4) ✓
  Verandering in n(N_2O_4) = *ewewig* n(N_2O_4) – *aanvanklike* n(N_2O_4)
- **USING** ratio ***/ GEBRUIK*** *verhouding:* $NO_2 : N_2O_4 = 2 : 1$ ✓
- Initial n(NO_2)= equilibrium n(NO_2) + change n(NO_2). ✓
  Aanvanklike n(NO_2)= ewewig n(NO_2) + verandering n(NO_2).
- Final answer / *Finale antwoord*: 1,11 (mol) ✓
  Accept range/*Aanvaar gebied:* 1,11 – 1,12 (mol)

OPTION 1 / *OPSIE 1*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{[N_2O_4]}{(0,2)^2}$ ✓

$\therefore [N_2O_4] = 171 \times (0,2)^2$
$= 6,84\ mol\cdot dm^{-3}$

No K_C expression, correct substitution / *Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_C expression / *Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

(8)

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	1,11 ✓	0	
Change (mol) *Verandering (mol)* ✓	1,094	0,55 ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	0,55	
Equilibrium concentration ($mol\cdot dm^{-3}$) *Ewewigskonsentrasie ($mol\cdot dm^{-3}$)*	0,2	6,84	x 0,08 ✓

OPTION 2 / *OPSIE 2*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{[N_2O_4]}{(0,2)^2}$ ✓

$\therefore [N_2O_4] = 171 \times (0,2)^2$
$= 6,84\ mol\cdot dm^{-3}$

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.* $\frac{5}{8}$

Equilibrium moles / *Ewewigsmol:*

$$\left.\begin{aligned} n(N_2O_4) &= (6,84)(0,080) \\ &= 0,55\ mol \\ n(NO_2) &= (0,2)(0,080) \\ &= 0,016\ mol \end{aligned}\right\} \checkmark \times 0,08\ dm^3$$

$n(N_2O_4$ formed/*gevorm*$) = \underline{0,55 - 0}$ = 0,55 mol ✓

Ratio / *Verhouding*:
$n(NO_2$ reacted / *gereageer*$) = 2n(N_2O_4$ formed/*gevorm*$) = 2(0,55) = 1,094$ mol
✓
Initial / *Aanvanklike* $n(NO_2) = 0,016 + 1,094$ ✓ $= 1,11$ (mol) ✓ (8)

OPTION 3 / *OPSIE 3*

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2x + 0,016	0	
Change (mol) *Verandering (mol)* ✓	2x	x ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	x	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x}{0,08}$	x 0,08 & ÷0,08 ✓

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{\frac{x}{0,08}}{(0,2)^2} \checkmark$$

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $^5/_8$

$\therefore$ x = 0,5472

$\therefore$ n(initial/*aanvanklik*) = 2(0,5472) + 0,016

= 1,11 mol ✓

(8)

OPTION 4 / *OPSIE 4*

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x	0	
Change (mol) *Verandering (mol)* ✓	x – 0,016	$\frac{x-0,016}{2}$ ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	$\frac{x-0,016}{2}$	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x-0,016}{0,16}$	x 0,08 & ÷0,08 ✓

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{\frac{x-0,016}{0,16}}{(0,2)^2} \checkmark$$

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $^5/_8$

$\therefore$ x = 1,11 mol ✓

(8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Mark allocation / *Puntetoekenning:*

- 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.
- Substitution of K_C value. / *Vervanging van K_C-waarde.* ✓
- Change in $[N_2O_4]$ = equilibrium $[N_2O_4]$ – initial $[N_2O_4]$. ✓
  Verandering in $[N_2O_4]$ = ewewig $[N_2O_4]$ – aanvanklike $[N_2O_4]$.
- **USING** ratio/***GEBRUIK*** *verhouding: $NO_2 : N_2O_4 = 2 : 1$* ✓
- Initial $[NO_2]$ = equilibrium $[NO_2]$ + change in $[NO_2]$. ✓
  Aanvanklike $[NO_2]$ = ewewigs $[NO_2]$ + verandering in $[NO_2]$.
- Equilibrium concentration of $[NO_2]$ multiplied by 0,08 dm^3. ✓
  Ewewigskonsentrasie van $[NO_2]$ vermenigvuldig met 0,08 dm^3.
- Final answer/*Finale antwoord*: 1,11 (mol) ✓
  Accept range/*Aanvaar gebied:* 1,11 – 1,12 (mol)

OPTION 5 / *OPSIE 5*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

$171 ✓ = \frac{[N_2O_4]}{(0,2)^2}$ ✓

$\therefore [N_2O_4] = 171 \times (0,2)^2$
$= 6,84 \text{ mol·dm}^{-3}$

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.* $\frac{5}{8}$

	NO_2	N_2O_4	
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	13,88	0	
Change (mol·dm^{-3}) ✓ *Verandering (mol·dm^{-3})*	13,68	6,84 ✓	ratio ✓ *verhouding*
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,2	6,84	

$n(NO_2) = cV = (13,88)(0,08)$ ✓ $= 1,11$ mol ✓ (8)

<u>OPTION 6 / *OPSIE 6*</u>

	NO_2	N_2O_4	
Initial concentration ($mol \cdot dm^{-3}$) *Aanvangskonsentrasie ($mol \cdot dm^{-3}$)*	x	0	
Change ($mol \cdot dm^{-3}$) ✓ *Verandering* ($mol \cdot dm^{-3}$)	x – 0,2	$\frac{x - 0,2}{2}$ ✓	ratio ✓ *verhouding*
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x - 0,2}{2}$	

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{\frac{x-0,2}{2}}{(0,2)^2} \checkmark$$

$\therefore$ x = 13,88 $mol \cdot dm^{-3}$

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.* $\frac{5}{8}$

$n(NO_2)$ = cV = (13,88)<u>(0,08)</u> ✓ = 1,11 mol ✓ (8)

6.3

6.3.1 Concentration (of the gases) increases. / Molecules become more condensed or move closer to each other. ✓
Konsentrasie (van die gasse) verhoog. / Molekule word meer saamgepers of beweeg nader aan mekaar. (1)

6.3.2
- Increase in pressure favours the reaction that leads to smaller number of moles / volume of gas. ✓
Toename in druk bevoordeel die reaksie wat tot die kleiner getal mol / volume gas lei.
- Forward reaction is favoured. / *Voorwaartse reaksie word bevoordeel.* ✓
- Number of moles/amount of N_2O_4 / colourless gas increases.✓
Aantal mol/hoeveelheid 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)

6.4

6.4.1 Darker / *Donkerder* ✓ (1)

6.4.2 Decreases / *Verlaag* ✓ (1)

[16]

QUESTION 7/ *VRAAG 7*

PENALISE ONCE FOR THE INCORRECT CONVERSION OF UNITS.
PENALISEER EENMALIG VIR VERKEERDE OMSKAKELING VAN EENHEDE.

7.1
7.1.1 Ionises / dissociates completely (in water) ✓
Ioniseer / dissosieer volledig (in water). (1)

7.1.2 NO_3^- / Nitrate ion / *Nitraatioon* ✓ (1)

7.1.3 $pH = -\log[H_3O^+]$ / $-\log[H^+]$ ✓
$= -\log(0,3)$ ✓
$= 0,52$ ✓

Notes/*Aantekeninge:*
- If no/incorrect formula/*Indien geen/foutiewe formule*: Max./*Maks:* $\frac{2}{3}$
- If no substitution step: 2 marks for correct answer./*Indien geen substitusie stap: 2 punte vir korrekte antwoord.*

(3)

7.2
7.2.1
$c = \frac{n}{V}$ ✓

$2 = \frac{n}{0,1}$ ✓

$\therefore n(HC\ell) = 0,2$ mol ✓ (3)

7.2.2 Burette / *Buret* ✓ (1)

7.2.3 B ✓
Titration of strong acid and strong base. ✓✓
Titrasie van sterk suur en sterk basis.

OR/*OF*
The endpoint will be approximately at pH = 7 which is in the range of the indicator.
Die eindpunt sal ongeveer by pH = 7 wees wat in die gebied van die indikator is. (3)

7.2.4 The number of moles of acid in the flask remains constant. ✓
Die getal mol van die suur in die fles bly konstant. (1)

7.2.5

$c = \frac{n}{V}$ ✓

$0,2 = \frac{n}{0,021}$ ✓

$n = 4,2 \times 10^{-3}$ mol ✓

n($HC\ell$ in excess/*in oormaat*):

n($HC\ell$) = n(NaOH)

$= 4,2 \times 10^{-3}$ mol (3)

7.2.6 **POSITIVE MARKING FROM QUESTION 7.2.1 AND 7.2.5.**
POSITIEWE NASIEN VAN VRAAG 7.2.1 EN 7.2.5.

Marking criteria / *Nasienriglyne:*

- n($HC\ell$ reacted) = initial (from Q7.2.1) – excess (from Q7.2.5).✓
  n($HC\ell$ reageer) = begin (van Q7.2.1) – oormaat (van Q7.2.5).
- Use mol ratio of acid: base = 2 : 1. ✓
  Gebruik molverhouding suur : basis = 2 : 1.
- Substitute / *Vervang* 40 into / in $n = \frac{m}{M}$ ✓
- $\frac{m(\text{MgO reacted / } \textit{reageer})}{4,5} \times 100$. ✓
- Final answer / *Finale antwoord:* 87,11 % ✓

OPTION 1 / *OPSIE 1*

n($HC\ell$ reacted/*gereageer*):

0,2 – $4,2 \times 10^{-3}$ ✓ = 0,196 mol

n(MgO reacted/*gereageer*):

½n($HC\ell$) = ½(0,196)

$= 9,8 \times 10^{-2}$ mol ✓

n(MgO reacted/*gereageer*) = $\frac{m}{M}$

$\therefore 0,098 = \frac{m}{40}$ ✓

$\therefore$ m = 3,92 g

% purity/ *suiwerheid* = $\frac{3,92}{4,5} \times 100$ ✓

= 87,11% ✓

(Accept range: 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %*)

OPTION 2 / *OPSIE 2*

n($HC\ell$ reacted/*gereageer*):

0,2 – $4,2 \times 10^{-3}$ ✓ = 0,196 mol

n($HC\ell$ reacted/*gereageer*) = $\frac{m}{M}$

$0,196 = \frac{m}{36,5}$

$\therefore$ m($HC\ell$ reacted/*gereageer*) = 7,154 g

40 g MgO ✓ .... 73 g $HC\ell$ ✓

x g MgO .... 7,154 g

$\therefore$ x = 3,92 g

% purity/*suiwerheid* = $\frac{3,92}{4,5} \times 100$ ✓

= 87,11% ✓

(Accept range: 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %*)

(5)

[21]

QUESTION 8 / *VRAAG 8*

8.1
- 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
- Temperature/*Temperatuur*: 25 °C / 298 K ✓ (2)

8.2
- Platinum is inert / does not react with the H^+ ions OR acid. ✓
  Platinum is onaktief / reageer nie met die H^+-ione OF suur nie.
- Platinum is a conductor (of electricity). ✓
  Platinum is 'n geleier (van elektrisiteit). (2)

8.3

8.3.1 Salt bridge / *Soutbrug* ✓ (1)

8.3.2 -0,31 V ✓ (1)

8.3.3 $2H^+ + 2e^- \rightarrow H_2$ ✓✓

Marking guidelines / *Nasienriglyne:*

• $2H^+ + 2e^- \rightleftharpoons H_2$	$\frac{1}{2}$	$H_2 \rightleftharpoons 2H^+ + 2e^-$	$\frac{0}{2}$
$H_2 \leftarrow 2H^+ + 2e^-$	$\frac{2}{2}$	$H_2 \rightarrow 2H^+ + 2e^-$	$\frac{0}{2}$

(2)

8.4

8.4.1 **POSITIVE MARKING FROM QUESTION 8.3.2.**
POSITIEWE NASIEN VAN VRAAG 8.3.2.

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓

$2,05$ ✓ $= -0,31$ ✓ $- E^\theta_{M/M^{2+}}$

$E^\theta_{M/M^{2+}} = -2,36$ (V) ✓

M is magnesium/ Mg. ✓

Option 2/ *Opsie 2*

✓ $\begin{cases} M \rightarrow M^{2+} + 2e^- & E° = 2,36 \text{ (V)} \\ X^{2+} + 2e^- \rightarrow X & \underline{E° = -0,31 \text{ (V)}} ✓ \\ & E° = 2,05 \text{ V} ✓ \end{cases}$

Thus/*Dus*: $E^\theta_{reduction} = -2,36$ (V) ✓

M is magnesium/ Mg. ✓

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. $E^\theta_{cell} = E^\theta_{OA} - E^\theta_{RA}$ followed by correct substitutions: $\frac{4}{5}$
Enige ander formule wat onkonvensionele afkortings gebruik bv. $E^\theta_{sel} = E^\theta_{OM} - E^\theta_{RM}$ gevolg deur korrekte vervangings: $\frac{4}{5}$

Notes / *Aantekeninge*
Give mark for Mg / magnesium ONLY if concluded from -2,36 V.
Ken punt vir Mg / magnesium slegs toe indien afgelei uit -2,36 V (5)

8.4.2 Exothermic / *Eksotermies* ✓ (1)

8.5 The cell reaction reaches equilibrium. ✓
Die selreaksie bereik ewewig.

Notes / *Aantekeninge:*
Accept: One or more of reactants are used up. / The cell reaction has run to completion.
Aanvaar: *Een of meer van reaktanse word opgebruik. / Die selreaksie het volledig verloop.*

(1)
[15]

QUESTION 9 / *VRAAG 9*

9.1 Electrolytic / *Elektrolities* ✓ (1)

9.2 Q ✓ & T ✓

$Cu^{2+} + 2e \rightarrow Cu$ ✓✓

Notes / *Aantekeninge:*
IF more than TWO electrodes, mark first two.
Indien *meer as TWEE elektrodes, sien eerste twee na.*

Marking guidelines / *Nasienriglyne*			
$Cu^{2+} + 2e \rightleftharpoons Cu$	$(\frac{1}{2})$	$Cu \rightarrow Cu^{2+} + 2e^-$	$(\frac{0}{2})$
$Cu \leftarrow Cu^{2+} + 2e$	$(\frac{2}{2})$	$Cu \rightleftharpoons Cu^{2+} + 2e^-$	$(\frac{0}{2})$

(4)

9.3

9.3.1 $C\ell_2$ / chlorine (gas) / *chloor(gas)* ✓ (1)

9.3.2 Cu^{2+} (ions) / copper(II) ions / $CuC\ell_2$ / copper(II) chloride ✓
Cu^{2+} (ione) / *koper(II)-ione* / $CuC\ell_2$ / *koper(II)chloried* (1)

9.4 Cu is a stronger reducing agent ✓ than $C\ell^-$ (ions) ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
Cu is 'n sterker reduseermiddel as $C\ell^-$(-ione) en Cu sal geoksideer word (na Cu^{2+}).

OR/*OF*
$C\ell^-$ (ions) is a weaker reducing agent ✓ than Cu ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
$C\ell^-$(-ione) is 'n swakker reduseermiddel as Cu en Cu sal geoksideer word (na Cu^{2+}).

(3)
[10]

QUESTION 10 / *VRAAG 10*

10.1

10.1.1 Nitrogen / N_2 / *Stikstof* ✓
Hydrogen / H_2 / *Waterstof* ✓ (2)

10.1.2 $NH_3 + HNO_3$ ✓ $\rightarrow NH_4NO_3$ ✓ Bal. ✓

Notes / *Aantekeninge:*

- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing: ✓ *Balansering*
- Ignore double arrows. / *Ignoreer dubbelpyle.*
- Marking rule 6.3.10. / *Nasienreël 6.3.10.* (3)

10.2

Marking criteria / *Nasienriglyne:*

- Use ratio / *gebruik verhouding:* $\frac{3}{9}$ ✓
- x 20 kg ✓
- x 36 / 36 % ✓
- Final answer / *Finale antwoord:* 2,4 kg ✓

OPTION 1 / *OPSIE 1:*	**OPTION 2 / *OPSIE 2:***	**OPTION 3 / *OPSIE 3:***
$\% \text{ N} = \frac{3}{9}$ ✓ (x 36) ✓ = 12 % $\therefore \text{m(N)} : \frac{12}{100}(\times 20 \text{ kg})$ ✓ = 2,4 kg ✓	m(nutrients/*voedingstowwe*): $\frac{36}{100}$ ✓ (x 20) ✓ = 7,2 kg $\therefore \text{m(N)} = \frac{3}{9}$ ✓ x 7,2 = 2,4 kg ✓	m(N): $\frac{3}{9}$✓ $\times (\times 20)$✓ $(\times \frac{36}{100})$✓ = 2,4 kg ✓

(4)
[9]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

FEBRUARY/MARCH 2015
FEBRUARIE/MAART 2015

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	C✓✓	(2)
1.3	D ✓✓	(2)
1.4	B✓✓	(2)
1.5	D✓✓	(2)
1.6	A✓✓	(2)
1.7	A✓✓	(2)
1.8	C✓✓	(2)
1.9	A✓✓	(2)
1.10	B✓✓	(2)
		[20]

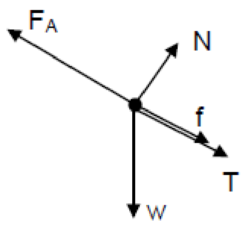
QUESTION 2/*VRAAG 2*

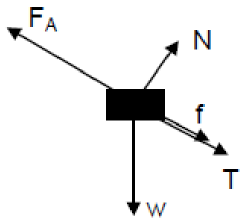
2.1 When one body exerts a force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.
Wanneer een liggaam 'n krag op 'n tweede liggaam uitoefen, oefen die tweede liggaam 'n krag van gelyke grootte in die teenoorgestelde rigting op die eerste liggaam.

OR/*OF*:
When body A exerts a force on body B, body B will exert a force of equal magnitude but opposite in direction on body A.
Indien liggaam A 'n krag uitoefen op liggaam B, sal B 'n krag van gelyke grootte maar teenoorgesteld in rigting op liggaam A uitoefen.

ACCEPT/*AANVAAR* (for 1 mark only/*vir slegs 1 punt*)
Action and reaction are equal and opposite.
Aksie en reaksie is gelyk en teenoorgesteld (2)

2.2



Accept/Aanvaar Force diagram *Kragtediagram*	**Notes/*Aantekeninge***
	Do not penalise for length of arrows *Moenie vir die lengte van die pyltjies penaliseer nie* If w is not shown but $F_{//}$ and $F_{\square}$ are shown give 1 mark for both. *Indien w nie aangetoon is nie maar $F_{//}$ en $F_{\perp}$ is getoon, ken 1 punt toe vir beide.*

Accept the following symbols/*Aanvaar die volgende simbole.*	
N	F_N; Normal;/*Normaal* ✓
F_A	40 N✓
f	F_f,f_k ✓
w	F_G Weight/*Gewig*; Gravitational force/*Gravitasiekrag*✓
T	Tension/*Spanning*; F_T ; ✓

(5)

2.3.1 **OPTION 1/*OPSIE 1***

For the 1 kg block/*Vir die 1 kg blok*;

$f_k = \mu_k N$

$= \mu_k\ mg\cos\theta$ ✓

$= 0{,}29\ (1 \times 9{,}8 \cos 30^o)$ ✓

$= 2{,}46$ N ✓

OPTION 2/*OPSIE 2*

BY PROPORTION:/*DEUR EWEREDIGHEID*

The smaller mass = ¼ of the larger mass ✓

Die kleiner massa = ¼ die groter massa

∴frictional force/*wrywingskrag* = ¼ (10) ✓

= 2,5 N ✓ (3)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.2**

POSITIEWE NASIEN VANAF VRAAG 2.2

OPTION 1/*OPSIE 1*

$F_{net} = ma$ ✓

For 1 kg block/*Vir 1 kg blok*

$F_A - \{(T+f_k) + mg\sin\theta\} = ma$

$40 - \{T + 2{,}46 + 1(9{,}8)(\sin 30^o)\}$ ✓ $= (1 \times)\ a$ ✓

$40 - T - 7{,}36 = a$

$32{,}64 - T = a$........(1)

For 4 kg block/*Vir 4 kg blok*

$T - (mg\sin\theta + f_k) = 4a$

$T - (4 \times 9{,}8 \sin 30^o + 10) = 4a$ ✓

$T - 29{,}6 = 4a$.........(2)

From (1) and (2)/*Vanaf (1) en (2)*

$a = 0{,}61\ m{\cdot}s^{-2}$

$T = 29{,}6 + (4(0{,}61)$ ✓

$T = 32{,}04$ N ✓

OPTION 2/*OPSIE 2*

Consider the blocks as a single system.

Beskou die blokke as 'n enkele sisteem.

$F_A - [\ (f_{tot}) - \{(4+1)\ g\sin 30^o\}] = (4+1)a$

$40 - (10 - 2{,}46) - (5(9{,}8)\sin 30^o)$ ✓ $= 5a$ ✓

$\therefore a = 0{,}61\ m{\cdot}s^{-2}$

For 1 kg block/*Vir 1 kg blok*

$F_{net} = ma$ ✓

$F_A - \{(T+f_k) + mg\sin\theta\} = ma$

$40 - \{T + 2{,}46 + 1(9{,}8)(\sin 30^o)\} = (1 \times)\ a$ ✓

$40 - T - 7{,}36 = a$

$32{,}64 - T = 0{,}61$ ✓

$T = 32{,}04$ N ✓

Notes/*Aantekeninge*

Learners need not show how (1) and (2) were combined

Leerders hoef nie aan te toon hoe (1) en (2) gekombineer is nie.

The first correct substitution for equation (1) should carry 2 marks.

The second substitution must carry 1 mark.

Die eerste korrekte vervanging vir vergelyking (1) moet 2 punte tel.

Die tweede vervanging tel 1 punt.

OR/*OF*

For 4 kg block/*Vir 4 kg blok*
Fnet - ma
$\underline{T - (mg\ sin\theta + f_k) = 4a}$
$\underline{T - (4 \times 9{,}8\ sin30^{\circ} + 10) = 4a}$✓
T- 29,6 = 4a
T = 29,6 + (4)(0,61) ✓
 = 32,04 N✓ (6)
[16]

QUESTION 3/*VRAAG 3*

3.1 Free fall/*Vrye val*

ACCEPT/*AANVAAR*
Vertically accelerated motion/projectile motion.
Vertikale versnelde beweging /projektielbeweging (1)

3.2.1

Downward motion as positive ***Afwaartse beweging as positief*** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ 30✓ = $\underline{v_i (1{,}5) + \frac{1}{2} (9{,}8)(1{,}5)^2}$ ✓ v_i = 12,65 m·s^{-1}✓ **Upward motion as positive** ***Opwaartse beweging as positief*** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ -30✓ = $\underline{v_i (1{,}5) + \frac{1}{2} (-9{,}8)(1{,}5)^2}$ ✓ v_i = 12,65 m·s^{-1}✓	**<u>Notes / *Aantekeninge*</u>** Accept/*Aanvaar* g or/*of* a $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ $s = ut + \frac{1}{2} at^2$

(4)

3.2.2

<u>OPTION 1/*OPSIE 1*</u> **Positive marking from QUESTION 3.2.1** ***Positiewe nasien vanaf VRAAG 3.2.1*** **Downward motion as positive** ***Afwaartse beweging as positief*** $v_f^2 = v_i^2 + 2a\Delta y$✓ $12{,}65^2$ ✓= $\underline{0 + 2(9{,}8)\ \Delta y}$✓ Δy = 8,16 m✓ Height/*Hoogte* **XC = XB + BC** (30 + 8,16) = 38,16 m Height is/*Hoogte is* 38,16 m✓	**<u>Notes / *Aantekeninge*</u>** For/*Vir* **XB** Accept/*Aanvaar* g or/*of* a $v^2 = u^2 + 2as$ The height must be written down in order to score the final mark. *Die hoogte moet neergeskryf word om die finale punt te kry.*

Upward motion as positive ***Opwaartse beweging as positief*** $v_f^2 = v_i^2 + 2a\Delta y$✓ $(-12,65)^2$ ✓= $\underline{0 + 2(-9,8)\ \Delta y}$✓ Δy = - 8,16 m✓ Height/*Hoogte* **XC = XB + BC** (-30) +(- 8,16) = -38,16 m Height is /*Hoogte is* 38,16 m) ✓

(5)

OPTION /*OPSIE 2*	**Notes / *Aantekeninge***
Positive marking from QUESTION 3.2.1 ***Positiewe nasien vanaf VRAAG 3.2.1*** **Downward motion as positive** ***Afwaartse beweging as positief*** $v_B = v_X + a\Delta t$✓ $\underline{12,65 = 0 + 9,8\Delta t}$✓ Δt = 1,29 s $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ = $\underline{0 + \frac{1}{2} (9,8(1,29)^2}$✓ Δy = 8,15 m Height/*Hoogte* **XC = XB + BC** (30 + 8,15) = 38,15 m✓ **Upward motion as positive** ***Opwaartse beweging as positief*** $v_B = v_X + a\Delta t$✓ $\underline{-12,65 = 0 + (-)9,8\Delta t}$✓ Δt = 1,29 s $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ = $\underline{0 + \frac{1}{2} (-9,8(1,29)^2}$✓ Δy = -8,15 m Height/*Hoogte* **XC = XB + BC** (-30) + (-8,15) = 38,15 m✓	**Start with time for XB** ***Begin met tyd vir XB*** Accept/*Aanvaar* g or/*of* a v=u+at $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2} at^2$

(5)

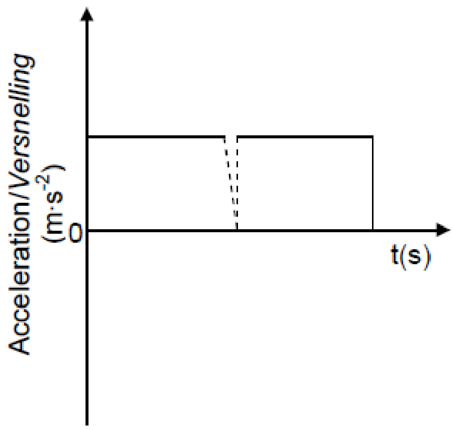
OPTION 3/*OPSIE 3*	**Notes / *Aantekeninge***
Positive marking from QUESTION 3.2.1 ***Positiewe nasien vanaf VRAAG 3.2.1*** **Downward motion as positive** ***Afwaartse beweging as positief*** $v_C = v_B + a\Delta t$✓ $= \underline{12,65 + 9,8\ (1,5)}$ ✓ $= 27,35\ m{\cdot}s^{-1}$ $v_C^2 = v_X^2 + 2a\Delta y$✓ $\underline{(27,35)^2} = \underline{0 + 2(9,8)\ \Delta y}$✓ $\therefore \Delta y = 38,16\ m$ Height is /*Hoogte is* 38,16 m✓ **Upward motion as positive** ***Opwaartse beweging as positief*** $v_C = v_B + a\Delta t$✓ $= -\underline{12,65 + (-9,8)\ (1,5)}$ ✓ $= -27,35\ m{\cdot}s^{-1}$ $v_C^2 = v_X^2 + 2a\Delta y$✓ $\underline{(-27,35)^2} = \underline{0 + 2(-9,8)\ \Delta y}$✓ $\therefore \Delta y = -38,16\ m$ Height/*Hoogte* = 38,16m✓	start with velocity at C Accept/*Aanvaar* g or/*of* a $v = u + at$ $v^2 = u^2 + 2as$ The height must be written down in order to score the final mark. *Die hoogte moet neergeskryf word om die finale punt te kry.*

(5)

OPTION 4/*OPSIE 4*	**Notes / *Aantekeninge***
Positive marking from QUESTION 3.2.1 ***Positiewe nasien vanaf VRAAG 3.2.1*** $\Delta U + \Delta K = 0$✓ $(mgh + 0)$ ✓ $= 0 + (½\ m(12,65)^2)$✓ $h = 8,16\ m$✓ $XC = h + 30$ $= (30 + 8,16)$ $= 38,16\ m$✓	Accept/*Aanvaar* $mgh_i + ½\ mv_i^2 = mgh_f + ½\ mv_f^2$ Take point B as the zero position and XH = h *Neem punt B is nul posisie en XH = h*

(5)

3.3 **OPTION 1/*OPSIE 1***

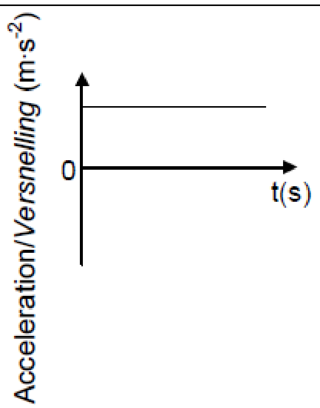


Notes / *Aantekeninge*

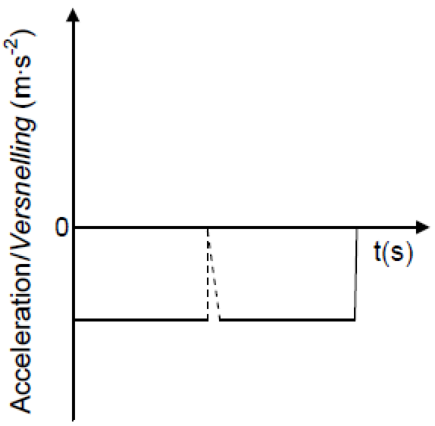
Criteria/*Kriteria*	**Mark/*Punt***
For **each** line correctly drawn as shown *Vir **elke** lyn korrek geteken soos getoon*	✓✓
Both axes correctly labelled *Beide asse korrek benoem*	✓

Accept/*Aanvaar*

Only 2 marks for this answer/Slegs 2 punte vir hierdie antwoord



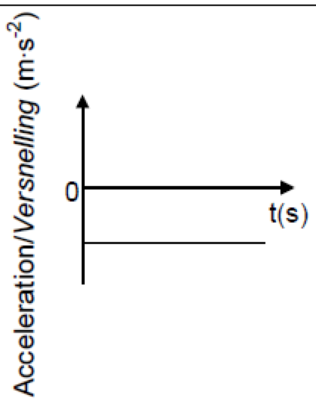
OPTION 2/*OPSIE 2*



Notes / *Aantekeninge*

Criteria/*Kriteria*	**Mark/*Punt***
For **each** line correctly drawn as shown *Vir **elke** lyn korrek geteken soos getoon*	✓✓
Both axes correctly labelled *Beide asse korrek benoem*	✓

Only 2 marks for this answer/Slegs 2 punte vir hierdie antwoord



(3)
[13]

QUESTION 4/*VRAAG 4*

4.1

$W_{net} = \Delta K$ ✓ $W_{net} = \frac{1}{2}(M + m)(v_f^{\,2} - v_i^{\,2})$ $W_{fr} = f\Delta x\cos\theta$ ✓ $= \frac{1}{2}(M + m)(v_f^{\,2} - v_i^{\,2})$ $10 \times 2\cos180$ ✓ $= \frac{1}{2}(7{,}02)(0 - v_i^2)$ ✓ $v_{bb} = 2{,}39\ m{\cdot}s^{-1}$ ✓ $(2{,}387)\ m{\cdot}s^{-1}$	**Notes / *Aantekeninge*** 1 mark for either of the formulae indicated *1 punt vir enige van die formule aangedui* **Accept/*Aanvaar*** $W_{nc} = \Delta K + \Delta U$ with $\Delta U = 0$	(5)

4.2

The total linear momentum of an (isolated) closed system remains constant. *Die totale lineêre momentum in 'n geslote (geïsoleerde) sisteem bly konstant* **ACCEPT/*AANVAAR*** In an isolated system the total momentum before collision equals the total momentum after collision. *In 'n (geïsoleerde) geslote sisteem is die totale momentum voor botsing gelyk aan die totale momentum na botsing.*	**Notes/*Aantekeninge*** 2 or/*of* 0	(2)

4.3.

Positive marking from QUESTION 4.1 **Positiewe nasien vanaf VRAAG 4.1** $\Sigma p_i = \Sigma p_f$ ✓ $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$ $0{,}02v_i + (7)(0) = (7{,}02)(2{,}39)$ $0{,}02v_i$ ✓ $= 7{,}02\ (2{,}39)$ ✓ $v_i = 838{,}89\ m{\cdot}s^{-1}$ ✓	**Notes / *Aantekeninge*** Accept/*Aanvaar* $(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ $837{,}84\ m{\cdot}s^{-1}$ (for learners working with $2{,}387\ m{\cdot}s^{-1}$/*vir leerders wat met* $2{,}387\ m{\cdot}s^{-1}$ *werk*)	(4) **[11]**

QUESTION 5/*VRAAG 5*

5.1 $\Delta U + \Delta K = 0$✓
$(5)(9,8)(5) + 0$✓ $+ (0 + ½ (5v_f^2)$✓ $= 0$
$v_f = \sqrt{2 \times 9,8 \times 5}$
$= 9,90\ m{\cdot}s^{-1}$✓ $(9,899\ m{\cdot}s^{-1})$ (4)

Notes / *Aantekeninge*
Accept/*Aanvaar*
$Mgh_i + ½ Mv_i^2 = Mgh_f + ½ Mv_f^2$

5.2 No friction/zero resultant force ✓so there is no loss in energy.✓/Only conservative forces present./Mechanical energy is conserved
Geen wrywing/nul resulterende krag dus is daar geen verlies in energie nie/ Slegs konserwatiewe kragte is teenwoordig./Meganiese energie bly behoue (2)

5.3 A force for which the work done is path dependent.✓✓
'n Krag waarvoor arbeid verrig afhanklik van die pad gevolg is (2)

Notes / *Aantekeninge*
Accept/*Aanvaar*
A force which does not conserve mechanical energy./*'n Krag wat nie meganiese energie behoue laat bly nie.*

5.4

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta U + \Delta K$ ✓
$F\ \Delta x \cos\theta = \Delta U + \Delta K$
$(18\ \Delta x \cos 180$✓$) = (5)(9,8)(3 - 0)$✓ $+ ½ (5)(0 - 9,90^2)$✓
$\Delta x = 5,4458m$✓
$\theta = \sin^{-1} \dfrac{3}{5,4458}$ ✓
$\theta = 33,43^o$✓

OPTION 2/*OPSIE 2*

$W_{net} = W_f + W_G$✓
$W_{net} = f\ \Delta x \cos\theta + mg\sin\theta\Delta x\cos\theta$
$= [(18)\ \Delta x \cos 180^o) + 5\ (9,8)\dfrac{3}{\Delta x}(\Delta x)\cos 180^o]$✓
$= -18\Delta x - 147$
$W_{net} = \Delta K$✓
$\Delta K = ½ (5)(0 - 9,90^2)$✓
$= -245,025$
$-18\Delta x - 147 = -245,025$
$\Delta x = 5,4458\ m$✓
$\theta = \sin^{-1} \dfrac{3}{5,4458}$ ✓
$\theta = 39,43^o$✓ (7)

[15]

QUESTION 6/*VRAAG 6*

6.1.1 $v = f\lambda$ ✓

$\lambda = \frac{340}{520}$

$= 0,65$ m ✓ (2)

6.1.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L = \frac{340 ✓}{(340 - 15) ✓}(520)$ ✓

$f_L = 544$ Hz

$v = f\lambda$

$\lambda = \frac{340}{544}$ ✓

$= 0,63$m ✓ (6)

Notes / *Aantekeninge*

Accept/*Aanvaar*

$f_L = \frac{v}{v - v_s} f_s$

6.2 The wavelength in QUESTION 6.1.2 is shorter because the waves are compressed as they approach the observer. ✓ ✓

Die golflengte in VRAAG 6.1.2 is korter omdat die golwe saamgedruk word soos hulle die waarnemer nader. (2)

6.3 The red shift occurs when the spectrum of a distant star moving away from the earth is shifted toward the red end of the spectrum. ✓ ✓

Rooi verskuiwings vind plaas wanneer die spektrum van 'n vêr afgeleë ster wat vanaf die aarde wegbeweeg na die rooi ent van die spektrum skuif. (2)

[12]

QUESTION 7/*VRAAG 7*

7.1 The net electrostatic force on a charged particle due to the presence of another charged particle is directly proportional to the product of the charges✓and inversely proportional to the square of the distance between them (their centres) ✓

Die netto elektrostatiese krag op 'n gelaaide deeltjies as gevolg van die teenwoordigheid van 'n ander gelaaide deeltjie is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle (hul middelpunte)

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.

OR/*OF*

Any two charged particles will exert an electrostatic force on each other where the force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charged particles. (their centres)

Enige twee gelaaide deeltjies sal 'n elektrostatiese krag op mekaar uitoefen waar die krag direk eweredig is aan die produk van die ladings en omgekeerd eweredig is aan die kwadraat van die afstand tussen hulle (tussen hul middelpunte) (2)

7.2

7.2.1 $F = \frac{KQ_1Q_2}{r^2}$ ✓

$1{,}44 \times 10^{-1} = \frac{(9 \times 10^9)Q^2}{(0{,}5)^2}$ ✓

Q = 2 x10^{-6} C✓ (4)

7.2.2 **Positive marking from QUESTION 7.2.1**

Positiewe nasien vanaf VRAAG 7.2.1

Q = ne✓

2 x10^{-6} = n(1,6x10^{-19}) ✓

n = 1,25 x10^{13} electrons/*elektrone*✓ (3)

7.3

7.3.1 Left /*Links* (west/*wes*) ✓ (1)

7.3.2 Take right as positive/*Neem regs as positief*

$E_{net} = E_A + E_B$ ✓

$$(3\times10^4) = -\frac{(9\times10^9)(2\times10^{-6})}{(1,5)^2}\checkmark + \frac{(9\times10^9)Q_{final}}{(1)^2}\checkmark$$

$Q_{final} = 4,22 \times 10^{-6}$ C ✓

Q = ne

$4,22 \times 10^{-6} = n(1,6\times10^{-19})$ ✓

$n_f = 2,64 \times 10^{13}$ electrons/*elektrone* ✓

electrons removed/*elektrone verwyder*

$= (2,64 \times 10^{13} + 1,25 \times 10^{13})$ ✓

$= 3,89 \times 10^{13}$ electrons/*elektrone* ✓

Notes / *Aantekeninge*

No. electrons should be removed $= n_f - n_i$
allocate the 1 mark for the subtraction
Aantal elektrone wat verwyder moet word $= n_f - n_i$
Ken 1 punt toe vir aftrekking

(8)
[18]

QUESTION 8/*VRAAG 8*

8.1.1 Ensure that the wires have:/*Maak seker dat die drade*
The same length/*dieselfde lengte het.* ✓
The same thickness/cross-sectional area/*dieselfde dikte/deursnit-area/ oppervlakte het* ✓ (2)

8.1.2 Wire **A** (Resistor A)/*Draad A* ✓

$R = \frac{\Delta V}{\Delta I}$ ✓

$R_A = \frac{4,4}{0,4}$ ✓ $= 11\ \Omega$ ✓

Accept any correct coordinates chosen from the graph
Aanvaar enige korrekte koördinate van die grafiek gekies.

$R_B = \frac{2,2}{0,4}$ ✓ $= 5,5\ \Omega$ ✓

$E = I^2 R\Delta t$ ✓

For the same time and current, the heating in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde tyd en stroom, sal die verwarming in A hoër wees omdat sy weerstand groter is as die van B.

ACCEPT/*AANVAAR*: $P = I^2R$
For the same current, the heat produced per unit time in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde stroom, sal die hitte vrygestel per eenheidstyd in A hoër wees omdat sy weerstand groter is as die van B. (8)

8.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$I_{5,5\Omega} : I_{11\Omega}$ 2 : 1 $I_{5,5\Omega} = (0,2)(2)$ ✓✓ $= 0,4$ A✓	V = IR $V_{11\ \Omega} = 0,2 \times 11$ $= 2,2$ V✓ $V_{5,5} = V_{11} = 2,2$ V✓ $I_{5,5} = \frac{2,2}{5,5}$ $= 0,4$ A✓

(3)

8.2.2

OPTION 1/OPSIE 1	**Notes / *Aantekeninge***
V = IR $I_{tot} = (0,4 + 0,2)$ ✓ $= 0,6$ A $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ ✓ $\frac{1}{R_p} = \frac{1}{11} + \frac{1}{5,5}$ ✓ $R_P = 3,67\ \Omega$ $R_T = R_P + R_A$ $= 3,67 + 11$✓ $= 14,67\Omega$ $\varepsilon = I(R + r)$ ✓ $9 = \underline{0,6(14,67 + r)}$ ✓ $r = 0,33\ \Omega$ ✓	Accept/*Aanvaar* $R_P = \frac{R_1R_2}{R_1 + R_2}$ ✓ $= \frac{11 \times 5,5}{11 + 5,5}$ ✓ $= 3,67\ \Omega$

(7)

OPTION 2/*OPSIE 2*
$I_{tot} = (0,4 + 0,2)$ ✓ $= 0,6$ A $V_{ext} = V_{11\ \Omega} + V_{//}$ ✓ $= [I_{tot}(R_{11}) + 2,2]$ $= 0,6\ (11)$ ✓ $+ 2,2$ $= 8,8$V✓ $\varepsilon = V_{ext} + I_{tot}(r)$ ✓ $9 = 8,8 + 0,6r$✓ $r = 0,33\ \Omega$✓

(7)

8.2.3 Decrease/*Afneem* ✓
The total resistance increases ✓/ *Die totale weerstand neem toe* (2)
[22]

QUESTION 9/*VRAAG 9*

9.1.1

<u>OPTION 1/*OPSIE 1*</u> $P_{av} = \frac{V^2_{rms}}{R}$ ✓ $100✓ = \frac{\left(\frac{340}{\sqrt{2}}\right)^2}{R}$ ✓ ✓ R = 578 Ω✓	**<u>Notes / *Aantekeninge*</u>** Assume correct formula for V_{rms} and give a mark if the substitution is correct1 mark *Aanvaar die korrekte formule vir V_{wgk} en ken 'n punt toe indien die vervanging korrek is.*
<u>OPTION 2/*OPSIE 2*</u> $V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{340}{\sqrt{2}}$ ✓= 240,04 $P_{ave} = \frac{V^2_{rms}}{R}$ ✓ $100✓ = \frac{240{,}04^2}{R}$ ✓ R = 578 Ω ✓	

(5)

9.1.2

<u>OPTION 1/*OPSIE 1*</u> $P_{av} = I_{rms}V_{rms}$ ✓ $100 = I_{rms}\frac{340}{\sqrt{2}}$ ✓ $I_{rms} = \frac{100}{\frac{340}{\sqrt{2}}}$ = 0,417 A ✓	**<u>OPTION 2/*OPSIE 2*</u>** $V_{rms} = I_{rms} R$✓ $\frac{340}{\sqrt{2}} = I_{rms}(578)$ ✓ I_{rms} = 0,417 A✓

(3)

9.2 Can be stepped up or down/ can be transmitted with less power loss.
Kan verhoog of verlaag word/ kan versend word met minder energie verlies. (1)

[9]

QUESTION 10/*VRAAG 10*

10.1 The minimum energy needed to emit an electron ✓ from (the surface of) a metal. ✓
Die minimum energie benodig om 'n elektron uit die (oppervlak van) 'n metaal vry te stel. (2)

10.2
$$E = W_0 + \frac{1}{2}mv_{max}^2$$
$$h\frac{c}{\lambda} = W_0 + \frac{1}{2}mv_{max}^2$$
Any ONE OF/*ENIGE EEN van*✓

$$\frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{(\lambda)} = (3{,}36 \times 10^{-19}) + 2{,}32 \times 10^{-19}$$ ✓ ✓

λ = 3,50 x 10^{-7} m✓ (4)

10.3 **POSITIVE MARKING FROM QUESTION 10.2**
POSITIEWE NASIEN VANAF VRAAG 10.2

$$E = W_0 + \frac{1}{2}mv_{max}^2$$
OR/*OF*
$$h\frac{c}{\lambda} = W_0 + \frac{1}{2}mv_{max}^2$$
✓ ✓
$$\frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{(3{,}50 \times 10^{-7})} = (3{,}65 \times 10^{-19}) + E_k$$

E = 2,03 x 10^{-19} J✓ (4)

10.4.1 Increasing the intensity does not change the energy/ frequency/wavelength of the incident photons✓/The energy of a photon remains unchanged (for the same frequency).
Verhoging van die intensiteit, verander nie die energie/frekwensie/golflengte van die invallende fotone nie/Die energie van die foton bly onveranderd (vir dieselfde frekwensie). (1)

10.4.2 Increases./*Neem toe*✓ (1)

10.4.3 More photons (packets of energy) strike the surface of the metal per unit time✓ hence more (photo) electrons ejected per unit time ✓(leading to increased current).
Meer fotone (energie pakkies) tref die oppervlakte van die metaal per eenheidstyd, gevolglik word meer (foto)elektrone per eenheidstyd vrygestel (wat lei tot 'n verhoogde stroom). (2)
[14]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2015

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1	B✓✓	(2)
1.2	D✓✓	(2)
1.3	C✓✓	(2)
1.4	D✓✓	(2)
1.5	A✓✓	(2)
1.6	A✓✓	(2)
1.7	A✓✓	(2)
1.8	D✓✓	(2)
1.9	C✓✓	(2)
1.10	B✓✓	(2) **[20]**

QUESTION 2/*VRAAG 2*

2.1.1 When body A exerts a force on body B, body B exerts a force of equal magnitude in the opposite direction on body A. ✓✓
Wanneer liggaam A 'n krag uitoefen op liggaam B, oefen liggaam B 'n krag van gelyke grootte in die teenoorgestelde rigting op liggaam A uit.
OR/*OF*
If body A exerts a force on body B, then body B exerts an equal ✓ and opposite✓ force on body A
Indien liggaam A 'n krag uitoefen op liggaam B, dan sal liggaam B 'n gelyke maar teenoorgestelde krag op liggaam A uitoefen (2)

2.1.2

For 2,5 kg block/*Vir 2,5 kg blok* $T = mg$✓ $\therefore T = (2,5)(9,8)$✓ $= 24,5$ N✓	**OR/*OF*** $\left.\begin{array}{l}F_{net} = ma\\ T - mg = (2,5)(0)\end{array}\right\}$✓ $T - (2,5)(9,8)$✓ $= 0$ $T = 24,5$ N ✓	**OR/*OF*** $\left.\begin{array}{l}F_{net} = ma\\ mg - T = (2,5)(0)\end{array}\right\}$✓ $(2,5)(9,8) - T$✓ $= 0$ $T = 24,5$ N ✓

(3)

2.1.3

POSITIVE MARKING FROM 2.1.2 ***POSITIEWE NASIEN VANAF 2.1.2*** For mass M/*Vir mass M* $f_s = \mu_s N$✓ $\therefore N = \frac{24,5}{0,2}$✓✓ $= 122,5$ N $N = Mg = 122,5$ N $\underline{M(9,8) = 122,5\text{ N}}$✓ $M = 12,5$ kg✓	**OR/*OF*** $\mu_s N$✓ $= \mu_s Mg$ $24,5$✓ $= (0,2)$✓$\underline{M(9,8)}$ ✓ $M = 12,5$ kg✓

(5)

2.1.4

For the 5 kg block/*Vir die 5 kg blok*: $f_k = \mu_k N$ $f_k = (0,15)(5)(9,8)$ ✓ $= 7,35$ N $\left.\begin{array}{l}F_{net} = ma\\ T - f_k = ma\end{array}\right\}$✓ $\underline{T - 7,35 = 5a}$✓ For the 2,5 kg block/*Vir die 2,5 kg blok* $w - T = ma$ $\underline{(2,5)(9,8) - T = 2,5\,a}$ ✓ $17,15 = 7,5\,a$ $a = 2,29\ \text{m·s}^{-2}$✓

(5)

2.2

$$F = G\frac{m_1 m_2}{r^2} \checkmark$$

$$F = \frac{(6{,}67 \times 10^{-11})(6{,}5 \times 10^{20})(90)}{(550 \times 10^{3})^{2}} \checkmark \checkmark$$

$= 12{,}90$ N✓ (12,899 N)

(4)

OR/***OF***

$$g = \frac{Gm}{r^2} \checkmark$$

$$g = \frac{(6{,}67 \times 10^{-11})(6{,}5 \times 10^{20})}{(550 \times 10^{3})^{2}} \checkmark$$

$= 0{,}143...\text{m}\cdot\text{s}^{-2}$

w = mg

= (90)(0,143..)✓

= 12,89 N✓(*downwards/afwaarts*)

(4)

[19]

QUESTION 3/*VRAAG 3*

3.1.

OPTION 1/*OPSIE 1*		
Upwards positive/*Opwaarts positief:* $v_f = v_i + a\Delta t$✓ -16✓ = $\underline{16 - 9{,}8(\Delta t)}$ ✓ Δt = 3,27s✓	**Downwards positive/*Afwaarts positief:*** $v_f = v_i + a\Delta t$✓ 16✓ = -$\underline{16 + 9{,}8(\Delta t)}$ ✓ Δt = 3,27s✓	(4)

OPTION 2/*OPSIE 2*		
Upwards positive/*Opwaarts positief:* $v_f = v_i + a\Delta t$✓ To the top/*By bopunt*: 0✓ = $\underline{16 - 9{,}8(\Delta t)}$ ✓ Δt = 1,63s Total time/*Totale tyd* = 1,63 x 2 = 3,26(7) s✓	**Downwards positive/*Afwaarts positief:*** $v_f = v_i + a\Delta t$✓ To the top/*By bopunt*: 0✓ = -$\underline{16 + 9{,}8(\Delta t)}$ ✓ Δt = 1,63s Total time/*Totale tyd* = 1,63 x 2 = 3,26(7) s✓	(4)

3.1

OPTION 3/*OPSIE 3*		
Upwards positive/*Opwaarts positief:* $\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ 0✓ = $\underline{16\Delta t + ½ (-9{,}8) \Delta t^2}$✓ $\Delta t(16 - 4{,}9\Delta t) = 0$ Δt = 0 or/*of* 3,27 s Time taken/*Tyd geneem* = 3,27 s (accept/*aanvaar* 3,26 s) ✓	**Downwards positive/*Afwaarts positief:*** $\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ 0✓ = -$\underline{16\Delta t + ½ (9{,}8) \Delta t^2}$✓ $\Delta t(-16 + 4{,}9\Delta t) = 0$ Δt = 0 or/*of* 3,27 s Time taken/*Tyd geneem* = 3,27 s (accept/*aanvaar* 3,26 s) ✓	(4)

OPTION 4/*OPSIE 4*		
Upwards positive/*Opwaarts positief:* $v_f^2 = v_i^2 + 2a\Delta y$ At highest point/*By hoogste punt* $\underline{0 = 16^2 + 2(-9{,}8)\Delta y}$✓ Δy = 13,06 m $\Delta y = v_i\Delta t + ½a\Delta t^2$✓ $\underline{13{,}06 = 16\Delta t - 4{,}9\Delta t^2}$✓ Δt =1,62 or 1,65 Total time/*Totale tyd* = (1,62/1,65)x2 = 3,24 s✓or/*of* 3,3 s	**Downwards positive/*Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ At highest point/*By hoogste punt* $\underline{0 = (-16)^2 + 2(9{,}8)\Delta y}$✓ Δy = 13,06 m $\Delta y = v_i\Delta t + ½a\Delta t^2$✓ $\underline{13{,}06 = -16\Delta t + 4{,}9\Delta t^2}$✓ Δt =1,62 or 1,65 Total time/*Totale tyd* = (1,62/1,65) x 2 = 3,24 s✓or/*of* 3,3 s	(4)

OPTION 5/*OPSIE 5* Upwards positive/*Opwaarts positief:*	Downwards positive/*Afwaarts positief:*	
$v_f^2 = v_i^2 + 2a\Delta y$ At highest point/*By hoogste punt* $\underline{0 = 16^2 + 2(-9,8)\Delta y}$ ✓ $\Delta y = 13,06$ m $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $13,06 = \left(\frac{0+16}{2}\right)\Delta t$ ✓ $\Delta t = 1,63$ s Total time/*totale tyd* = 3,26 s ✓	$v_f^2 = v_i^2 + 2a\Delta y$ At highest point/*By hoogste punt* $\underline{0 = (-16)^2 + 2(9,8)\Delta y}$ ✓ $\Delta y = -13,06$ m $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $-13,06 = \left(\frac{0-16}{2}\right)\Delta t$ ✓ $\Delta t = 1,63$ s Total time/*totale tyd* = 3,26 s ✓	(4)

3.1

OPTION 6 /*OPSIE 6* Upwards positive/*Opwaarts positief:*	Downwards positive/*Afwaarts positief:*	
$F_{net}\,\Delta t = \Delta p$ ✓ $mg\,\Delta t = m\,(v_f - v_i)$ $-9,8\Delta t$ ✓ = $\underline{(0 - 16)}$ ✓ $\Delta t = 1,63$ s Total time/*Totale tyd* = (1,63)(2) = 3,26 s ✓	$F_{net}\,\Delta t = \Delta p$ ✓ $mg\,\Delta t = m\,(v_f - v_i)$ $9,8\Delta t$ ✓ = $\underline{\{0 - (-16)\}}$ ✓ $\Delta t = 1,63$ s Total time/*Totale tyd* = (1,63)(2) = 3,26 s ✓	(4)

OPTION 7 /*OPSIE 7* Upwards positive/*Opwaarts positief:*	Downwards positive/*Afwaarts positief:*	
$F_{net}\,\Delta t = \Delta p$ ✓ $mg\,\Delta t = m\,(v_f - v_i)$ $-9,8\Delta t$ ✓ = $\underline{[-16 - (+16)]}$ ✓ $\Delta t = 3,26$ s Total time/*Totale tyd* = 3,26 s ✓	$F_{net}\,\Delta t = \Delta p$ ✓ $mg\,\Delta t = m\,(v_f - v_i)$ $9,8\Delta t$ ✓ = $\underline{[16 - (-16)]}$ ✓ $\Delta t = 3,26$ s Total time/*Totale tyd* = 3,26 s ✓	(4)

3.3

OPTION 1 / *OPSIE 1*

Upwards positive/*Opwaarts positief:*

Take y_A as height of ball A from the ground. (no penalising)/Neem y_A as hoogte van bal A vanaf die grond. (geen penalisering)

$\Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$y_A - 0 = 16\Delta t + \frac{1}{2}(-9,8)\Delta t^2$

$= 16\Delta t - 4,9\Delta t^2$ ✓

Take y_B as height of ball B from the ground./Neem y_B as hoogte van bal B vanaf die grond.

$\Delta y_B = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$y_B - 30 = (v_i\Delta t + \frac{1}{2} a\Delta t^2)$

$y_B = 30 - [-9(\Delta t - 1) + \frac{1}{2}(-9,8)(\Delta t - 1)^2$ ✓

$= 34,1 + 0,8\Delta t - 4,9\Delta t^2$ ✓

$y_A = y_B$

$\therefore 16\Delta t - 4,9\Delta t^2 = 34,1 + 0,8\Delta t - 4,9\Delta t^2$

$15,2\Delta t = 34,1$

$\Delta t = 2,24$ s ✓

$y_A = 16(2,24) - 4,9(2,24)^2$

$= 11,25$ m ✓ (6)

Downwards positive/*Afwaarts positief:*

Take y_A as height of ball A from the ground.(no penalising)/Neem y_A as hoogte van bal A vanaf die grond. (geen penalisering)

$\Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$y_A - 0 = -16\Delta t + \frac{1}{2}(9,8)\Delta t^2$

$= -16\Delta t + 4,9\Delta t^2$ ✓

Take y_B as height of ball B from the ground/Neem as hoogte van bal B vanaf die grond..

$\Delta y_B = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$y_B - 30 = -(v_i\Delta t + \frac{1}{2} a\Delta t^2)$

$y_B = 30 - [9(\Delta t - 1) + \frac{1}{2}(9,8)(\Delta t - 1)^2$ ✓

$= 34,1 + 0,8\Delta t - 4,9\Delta t^2$ ✓

$y_A = y_B$

$16\Delta t - 4,9\Delta t^2 = 34,1 + 0,8\Delta t - 4,9\Delta t^2$

$15,2\Delta t = 34,1$

$\Delta t = 2,24$ s ✓

$\Delta y_A = (-16(2,24) + 4,9(2,24)^2)$

$= 11,25$ m ✓ (6)

3.3

OPTION 2/*OPSIE 2*

Upwards positive/*Opwaarts positief:*

$\Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$= 16\Delta t + \frac{1}{2}(-9,8)\Delta t^2$

$= 16\Delta t - 4,9\Delta t^2$ ✓

Distance travelled by ball A = $y_A = 16\Delta t - 4,9\Delta t^2$

$\Delta y_B = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= -9(\Delta t - 1) + \frac{1}{2}(-9,8)(\Delta t - 1)^2$ ✓

$= 0,8\Delta t - 4,9\Delta t^2 + 4,1$ ✓

Distance travelled by ball B = $y_B = 0,8\Delta t - 4,9\Delta t^2 + 4,1$

$y_A + (-y_B) = 30$

$16\Delta t - 4,9\Delta t^2 - (0,8\Delta t - 4,9\Delta t^2 + 4,1) = 30$

$15,2\Delta t = 34,1$

$\Delta t = 2,24$ s ✓

$\therefore \Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$y_A = 16 (2,24) - 4,9(2,24)^2$

$= 11,25$ m ✓ (6)

3.3

Downwards positive/*Afwaarts positief:*

$y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$= -16\Delta t + \frac{1}{2}(9,8)\Delta t^2$

$= -16\Delta t + 4,9\Delta t^2$ ✓

$y_B = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= 9(\Delta t - 1) + \frac{1}{2}(9,8)(\Delta t - 1)^2$ ✓

$= -0,8\Delta t + 4,9\Delta t^2 - 4,1$ ✓

$(-y_A) + y_B = 30$

$-(-16\Delta t + 4,9\Delta t^2) - 0,8\Delta t + 4,9\Delta t^2 - 4,1 = 30$

$15,2\Delta t = 34,1$

$\Delta t = 2,24$ s ✓

$\therefore \Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$\Delta y_A = -16 (2,24) + 4,9(2,24)^2$

$= -11,25$ m

$\therefore$Height of ball A/*Hoogte van bal A* = 11,25 m ✓ (6)

OPTION 3/*OPSIE 3*

Upwards positive/*Opwaarts positief:*

$v_f = v_i + a\Delta t$

After 1 s, speed of ball A/*Spoed van bal A na 1 s*

$v_f = 16 + (-9{,}8)(1)$

$= 6{,}2\ m\cdot s^{-1}$

Distance travelled by ball A in 1 s/*Afstand deur bal A afgelê in 1 s*

$\Delta y_A = v_i\Delta t + ½\ a\Delta t^2$ ✓

$= (16)(1) + ½(-9{,}8)1^2$

$= 11{,}1\ m$

For ball A, after 1 s/*Vir bal A na 1 s*

$\Delta y_A = 6{,}2\Delta t - 4{,}9\Delta t^2$ ✓

For ball/*Vir bal* **B,**

$\Delta y_B = v_i\Delta t + ½\ a\Delta t^2$

$= -9\Delta t + ½(-9{,}8)\Delta t^2$ ✓

$y_A + (-y_B) = (30 - 11{,}1) = 18{,}9$

$6{,}2\Delta t - 4{,}9\Delta t^2 - [-9\Delta t + ½(-9{,}8)\Delta t^2] = 18{,}9$

$15{,}2\Delta t = 18{,}9$

$\Delta t = 1{,}24\ s$ ✓

The balls meet after/*Die balle ontmoet na* (1,24 +1) = 2,24 s✓

$\Delta y_A = [6{,}2\ (1{,}24) - 4{,}9\ (1{,}24)^2]$

$= 0{,}154\ m$

Meeting point/*Ontmoetingspunt* = (11,1 + 0,154) = 11,25 m✓

OR/*OF*

$\Delta y = (-9)(1{,}24) + ½\ (-9{,}8)(1{,}24)^2$ ✓

$= -18{,}69\ m$

Meeting point/*Ontmoetingspunt* = (30 -18,69) = 11,31 m✓ (6)

Downwards positive/*Afwaarts positief:*

$v_f = v_i + a\Delta t$

After 1 s, speed of ball A/*Spoed van bal A na 1 s*

$v_f = -16 + (9{,}8)(1)$

$= -6{,}2\ ms^{-1}$

Distance travelled by ball A in 1 s/*Afstand deur bal A afgelê in 1 s*

$\Delta y_A = v_i\Delta t + ½\ a\Delta t^2$ ✓

$= (-16)(1) + ½(9{,}8)(1)^2$

$= -11{,}1\ m$

For ball A, after 1 s/*Vir bal A na 1 s*

$\Delta y_A = -6{,}2\Delta t + 4{,}9\Delta t^2$ ✓

For ball/*Vir bal* **B**

$\Delta y_B = v_i\Delta t + ½\ a\Delta t^2$

$= 9\Delta t + ½(9{,}8)\Delta t^2$ ✓

$-\Delta y_A + \Delta y_B = 18{,}9$

$6{,}2\Delta t - 4{,}9\Delta t^2 + [9\Delta t + ½(9{,}8)\Delta t^2] = 18{,}9$

$15{,}2\Delta t = 18{,}9$

$\Delta t = 1{,}24\ s$ ✓

The balls meet after/*Die balle ontmoet na* (1,24 +1) = 2,24 s✓

$\Delta y_A = -6{,}2\ (1{,}24) + 4{,}9\ (1{,}24)^2$

$= -0{,}154\ m$

Meeting point/*Ontmoetingspunt* = (-11,1 - 0,154) = 11,25 m✓

OR/*OF*

$\Delta y = (9)(1{,}24) + ½\ (9{,}8)(1{,}24)^2$ ✓

$= 18{,}69\ m$

Meeting point/*Ontmoetingspunt* = (30 -18,69) = 11,31 m✓ (6)

[13]

QUESTION 4/*VRAAG 4*

4.1

OPTION 1/*OPSIE 1* Take motion to the right as positive/*Neem beweging na regs as positief.* $\Sigma p_i = \Sigma p_f$ $(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$ ✓ Any one/*Enige een* $(m_1+m_2)v_i = m_1v_{f1} + m_2v_{f2}$ $\underline{(3 + 0{,}02)(0)}$ ✓ = $\underline{(3)(-1{,}4) + (0{,}02)\ v_{f2}}$ ✓ v_{f2} = 210 m·s^{-1} ✓ **OR/OF** Take motion to the left as positive/*Neem beweging na links as positief.* $\Sigma p_i = \Sigma\ p_f$ $(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$ ✓ Any one/*Enige een* $(m_1+m_2)v_i = m_1v_{f1} + m_2v_{f2}$ $\underline{(3 + 0{,}02)(0)}$ ✓ = $\underline{(3)(1{,}4) + (0{,}02)\ v_{f2}}$ ✓ v_{f2} = -210 m·s^{-1} Speed/*Spoed* = 210 m·s^{-1} ✓	(4)
OPTION 2/*OPSIE 2* Take motion to the right as positive/*Neem beweging na regs as positief.* $\Delta p_{bullet} = -\Delta p_{block}$ ✓ $m(v_f – v_i) = - m(v_f – v_i)$ $\underline{(0{,}02)(v_f – 0)}$ ✓ = $\underline{-(3)(-1{,}4 – 0)}$ ✓ $\therefore v_i$ = 210 m·s^{-1} ✓ **OR/OF** Take motion to the left as positive/*Neem beweging na links as positief* $\Delta p_{bullet} = -\Delta p_{block}$ ✓ $m(v_f – v_i) = - m(v_f – v_i)$ $\underline{(0{,}02)(v_f – 0)}$ ✓ = $\underline{-(3)(1{,}4 – 0)}$ ✓ $\therefore v_i$ = -210 m·s^{-1} Speed/*Spoed* = 210 m·s^{-1} ✓	(4)

4.2

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$v_f^2 = v_i^2 + 2a\Delta x$ ✓ $0 = 210^2 + 2a(0,4)$ ✓ $a = -55\ 125\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (0,02)(-55\ 125)$ ✓ $= -1\ 102,5\ N$ Magnitude of force = 1 102,5 N ✓ *Grootte van krag = 1 102,5 N*	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $0,4 = \left(\frac{210 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 0,004\ s\ (0,00381 s)$ $F_{net}\Delta t = \Delta p = m\Delta v$ ✓ $F_{net} = \frac{(0,02)(0 - 210)}{(0,004)}$ ✓ $= -1\ 050\ N$ Magnitude of force = 1 050 N ✓ *Grootte van krag = 1 050 N* (Accept/*Aanvaar*: 1102,5 N)

(5)

OPTION 3/*OPSIE 3*

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0 = 210^2 + 2a(0,4)$ ✓
$a = -55\ 125\ m{\cdot}s^{-2}$

$v_f = v_i + a\Delta t$
$0 = 210 - (55\ 125)\Delta t$
$\Delta t = 0,004\ s\ (0,00381\ s)$

$F_{net}\Delta t = \Delta p = m\Delta v$ ✓
$F_{net} = \frac{(0,02)(0 - 210)}{(0,004)}$ ✓
$= -1\ 050\ N$
Magnitude of force = 1 050 N ✓ (Accept/*Aanvaar*: 1 102,5 N)
Grootte van krag = 1 050 N

(5)

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \Delta K = \frac{1}{2} m(v_i^2 - v_f^2)$ } ✓ Any one/*Enige een*

$F_{net}(0,4)$ ✓ $\cos 180°$ ✓ $= \frac{1}{2}(0,02)(0^2 - 210^2)$ ✓
$F_{net} = 1\ 102,5\ N$ ✓

OR/OF

$W_{nc} = \Delta E_p + \Delta E_k$
$F_{net}\Delta x\cos\theta = 0 + \frac{1}{2} m(v_i^2 - v_f^2)$ } ✓ Any one/*Enige een*
$F_{net}(0,4)$ ✓ $\cos 180°$ ✓ $= \frac{1}{2}(0,02)(0^2 - 210^2)$ ✓
$F_{net} = 1\ 102,5\ N$ ✓

(5)

4.3 The same as/equal ✓
Dieselfde as/gelyk (1)
[10]

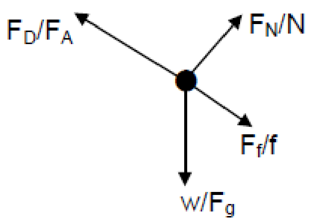
QUESTION 5/*VRAAG 5*

5.1

<u>OPTION 1/*OPSIE 1*</u>	**<u>OPTION 2/*OPSIE 2*</u>**
$v_{ave} = \frac{800}{75}$ ✓ $= 10{,}67 \text{ m·s}^{-1}$ $P_{ave} = Fv_{ave}$ ✓ $P_{ave} = (240)(10{,}67)$ $= 2\ 560{,}8$ W (2,56 kW) ✓	$v_{ave} = \frac{800}{75}$ ✓ $= 10{,}67 \text{ m·s}^{-1}$ ∴ Distance covered in 1s = 10,67m· ∴ W(Work done in 1 s) = $F\Delta x\cos\theta$ ✓ $= (240)(10{,}67)(1)$ $= 2\ 560{,}8 \text{ J s}^{-1}$ ∴ $P_{ave} = 2\ 560{,}8$ W (2,56 kW) ✓
<u>OPTION 3/*OPSIE 3*</u>	**<u>OPTION 4/*OPSIE 4*</u>**
$P = \frac{W}{\Delta t}$ ✓ $= \frac{F\Delta x\cos\theta}{\Delta t}$ $= \frac{(240)(800)\cos 0°}{75}$ ✓ $= 2\ 560$ W ✓	$P = \frac{W}{\Delta t}$ ✓ $= \frac{F\Delta x\cos\theta}{\Delta t}$ $= \frac{(240)(10{,}67)\cos 0°}{1}$ ✓ $= 2\ 560$ W ✓

(3)

5.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force/2 940 N *F_g / F_w / gewig / mg / gravitasiekrag*
f	$F_{friction}$ / F_f / friction /294 N /f_k *$F_{wrywing}$ / F_w / wrywing/294 N /f_k*
N	F_N / F_{normal} / normal force F_N / $F_{normaal}$ / *normaalkrag*
F_D	$F_{Applied/toegepas}$/350 N/Average driving force $F_{driving/dryfkrag}$/350/*Gemiddelde aandrywingskrag*

(4)

5.3 The <u>net/total work done on an object is equal</u> ✓ to the <u>change in the object's kinetic energy</u> ✓
Die <u>netto/totale arbeid verrig op 'n voorwerp is gelyk</u> aan die <u>verandering in die voorwerp se kinetiese energie</u>.
OR/*OF*
The <u>work done on an object by a resultant/net force is equal</u> ✓ to the <u>change in the object's kinetic energy</u>. ✓
Die <u>arbeid verrig op 'n voorwerp deur 'n resulterende krag is gelyk</u> aan die <u>verandering in die voorwerp se kinetiese energie</u>. (2)

5.4

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta U + \Delta K$ ✓

$W_f + W_D = \Delta U + \Delta K$

$f\Delta x\cos\theta + W_D = mg(h_f - h_i) + ½(m)(v_f^2 - v_i^2)$

$(f\Delta x\cos\theta + F_D\Delta x\cos\theta = mg(h_f - h_i) + ½m(v_f^2 - v_i^2)$

$(294)(450)(\cos 180^\circ)$ ✓ $+ (350)(450)\cos 0^\circ$ ✓ $= (300)(9,8)(5 - 0)$ ✓ $+ ½(300)(v_f^2 - 0)$ ✓

$v_f = 8,37 \text{ m·s}^{-1}$ ✓ (6)

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$ ✓

$W_{net} = W_D + W_g + W_f + W_N$

$= (F_D\Delta x\cos\theta) + (mg\sin\alpha)\Delta x\cos\theta) + (f\Delta x\cos\theta) + 0$

$W_{net} = [350(450)](\cos 0)$ ✓ $+ (300)(9,8)\ \frac{5}{450}(450)(\cos 180)$ ✓ $+$

$294(450)(\cos 180^\circ)$ ✓

$= 157\ 500 - 14\ 700 - 132\ 300$

$= 10\ 500$ J

$W_{net} = \Delta K$

$10\ 500 = ½(300)(v_f^2 - 0)$ ✓

$v_f = 8,37 \text{ m·s}^{-1}$ ✓

OR/*OF*

$\alpha = \sin^{-1}\frac{5}{450}$

$= 0,64^\circ$ (6)

OPTION 3/*OPSIE 3*

$W_{net} = W_D + W_g + W_f + W_N$

$= (F_D\Delta x\cos\theta) + mg\Delta x\cos\theta) + f\Delta x\cos\theta + 0$

$W_{net} = (350)(450)(\cos 0^\circ)$ ✓ $+ (300)(9,8)(450)\cos(90 + 0,64)$ ✓ $+ 294(450)(\cos 180^\circ)$ ✓

$= 157\ 500 - 14\ 777,74 - 13\ 2300$

$= 10\ 430,51$ J

$W_{net} = \Delta K$ ✓

$10\ 430,51 = ½(300)(v_f^2 - 0)$ ✓

$v_f = 8,34 \text{ m·s}^{-1}$ ✓

OR/*OF*

$\alpha = \sin^{-1}\frac{5}{450}$

$= 0,64^\circ$ (6)

OPTION 4/*OPSIE 4*

$F_{net} = F_D + (-mg\sin\alpha) + (-f)$

$= 350$ ✓ $+ [-(300)(9,8)\sin 0,64^\circ]$ ✓ $+ (-294)$ ✓

$= 23,16$ N

OR/*OF*

$F_{net} = 350$ ✓ $- (300)(9,8)\sin 0,64^\circ$ ✓ $- 294$ ✓

$= 350 - 32,84 - 294$

$= 23,16$ N

$W_{net} = F_{net}\Delta x\cos\theta$

$= (23,16)(450)\cos 0^\circ$

$= 10\ 422$ J

$W_{net} = \Delta K$ ✓

$10\ 422 = ½(300)(v_f^2 - 0)$ ✓

$v_f = 8,34 \text{ m·s}^{-1}$ ✓ (6)

[15]

QUESTION 6/*VRAAG 6*

6.1.1 Frequency (of sound detected by the listener (observer))✓
Frekwensie van klank deur luisteraar (waarnemer) waargeneem (1)

6.1.2 The apparent change in frequency or pitch of 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) van die klank deur 'n luisteraar waargeneem omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting het. (2)

6.1.3 Away/*Weg van*✓
Detected frequency of source decreases✓
Waargenome frekwensie van bron neem af (2)

6.1.4

<u>OPTION 1/OPSIE 1</u>

EXPERIMENT/*EKSPERIMENT* 2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$874 \overset{✓}{=} \frac{v}{v + 10}(900)$ ✓ ✓

v = 336,15 m·s^{-1}✓ (Accept/*Aanvaar* : 336,15 m·s^{-1} – 323,33 m·s^{-1}) (5)

EXPERIMENT/*EKSPERIMENT* 3

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$850 \overset{✓}{=} \frac{v}{v + 20}(900)$ ✓ ✓

v = 340 m·s^{-1}✓ (Accept/*Aanvaar* : 313,33 m·s^{-1} – 340 m·s^{-1}) (5)

EXPERIMENT 4/*EKSPERIMENT* 4

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$\overset{✓}{827} = \frac{v}{v + 30}(900)$ ✓ ✓

v = 339,86 m·s^{-1}✓ (Accept/*Aanvaar* : 339,86 m·s^{-1} – 345 m·s^{-1}) (5)

OPTION 2/OPSIE 2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

Experiment/Eksperiment 2 and/en 3

$\frac{874(v+10)}{v}$ ✓ $= \frac{850(v+20)}{v}$ ✓

874v + 8740 = 850v + 1700 ✓ both frequencies / beide frekwensies

$\therefore v = 344{,}17\ m \cdot s^{-1}$ ✓

Experiment/Eksperiment 2 and/en 4

$\frac{874(v+10)}{v}$ ✓ $= \frac{827(v+30)}{v}$ ✓

874v + 8740 = 827v + 24810 ✓ both frequencies / beide frekwensies

$\therefore v = 341{,}91\ m \cdot s^{-1}$ ✓

Experiment/Eksperiment 3 and/en 4

$\frac{850(v+20)}{v}$ ✓ $= \frac{827(v+30)}{v}$ ✓

850v + 1700 = 827v + 24810 ✓ both frequencies / beide frekwensies

$\therefore v = 339{,}57\ m \cdot s^{-1}$ ✓ (5)

6.2 Away from the Earth/*Weg vanaf die aarde*✓ (1)

[11]

QUESTION 7/*VRAAG 7*

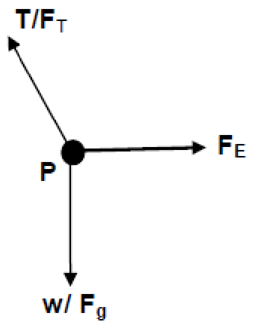
7.1

$$n = \frac{Q}{e} \checkmark$$

$$n = \frac{0,5 \times 10^{-6}}{1,6 \times 10^{-19}} \checkmark$$

$n = 3,13 \times 10^{12}$ ✓electrons/*elektrone* (3)

7.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T	F_T / tension F_T / *spanning*
F_E	Electrostatic force/F_C/ Coulombic force/F_Q /$F_{RP/PR}$ *Elektrostiesekrag / Coulombkrag / F_Q /$F_{RP/PR}$*

(3)

7.3 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes of the) charges and inversely proportional to the square of the distance (r) between them. ✓✓

Die grootte van die elektrostatiese krag wat deur een puntlading (Q_1) op 'n ander puntlading (Q_2)uitgeoefen word, is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aam die kwadraat van die afstand (r) tussen hulle. (2)

7.4

OPTION 1/*OPSIE 1*

$F_E = k\dfrac{Q_1Q_2}{r^2}$ ✓

$T\sin\theta/(T\cos\theta) = F_E$

$\therefore T\sin 7^\circ/(T\cos 83^\circ)$ ✓ $= \dfrac{(9\times10^9)(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2}$ ✓ ✓

$\therefore T = 0,83$ N ✓ (Accept/*Aanvaar* 0,82 N) (5)

OPTION 2/*OPSIE 2*

$F_E = \dfrac{kQ_1Q_2}{r^2}$ ✓

$F_E = \dfrac{(9\times10^9)(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2}$ ✓ ✓

$= 0,101$ N

$\tan 7^\circ = \dfrac{T_x}{T_Y} = \dfrac{0,101}{T_Y}$ ✓

$T_Y = 0,823$ N

$T = \sqrt{T_X^2 + T_Y^2} = \sqrt{(0,101)^2 + (0,823)^2} = 0,83\text{N}$ ✓ (5)

OPTION 3/*OPSIE 3*

$F = \dfrac{kQ_1Q_2}{r^2}$ ✓ $= \dfrac{(9\times10^9)(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2}$ ✓ ✓ $= 0,101$ N

$\dfrac{F_E}{\sin 7^\circ} = \dfrac{T}{\sin 90^\circ}$

$\dfrac{0,101}{\sin 7^\circ} = \dfrac{T}{\sin 90^\circ}$ ✓

$T = 0,83$ N ✓ (5)

[13]

QUESTION 8/*VRAAG 8*

8.1 $E_X = E_2 + E_{(-8)}$ ✓

$= \frac{kQ_2}{r^2} + \frac{kQ_{-8}}{r^2}$ ✓correct equation /*korrekte vergelyking*

$= \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ ✓ $+ \frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ ✓

$= 2,88 \times 10^6 + 3,2 \times 10^6$

$= 6,08 \times 10^6\ N{\cdot}C^{-1}$ ✓ to the east/*na oos* ✓

OR/*OF*

$E = k\frac{Q}{r^2}$ ✓

$E_2 = \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ ✓

$= 2,88\times 10^6\ NC^{-1}$ to the east/*na oos*

$E_{-8} = \frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ ✓

$= 3,2 \times 10^6\ N{\cdot}C^{-1}$ to the east/*na oos*

$E_X = E_2 + E_{(-8)}$

$= (2,88 \times 10^6 + 3,2 \times 10^6)$ ✓

$= \underline{6,08 \times 10^6}\ \underline{N{\cdot}C^{-1}}$ ✓ to the east/*na oos*✓ (6)

8.2 **OPTION 1/*OPSIE 1***

$F_E = QE$✓

$= (-2 \times 10^{-9})(6,08 \times 10^6)$✓

$= -12,16 \times 10^{-3}\ N$

$= 1,22 \times 10^{-2}\ N$✓ to the west/*na wes*✓ (4)

OPTION 2/*OPSIE 2*

$F_{(-2)Q1} = qE_{(2)}$ ✓

$= (2 \times 10^{-9})(2,88\times 10^6)$

$= 5,76 \times 10^{-3}\ N$ to the west/*na wes*

$F_{(-2)Q2} = qE_{(8)}$

$= (2 \times 10^{-9})(3,2 \times 10^6)$

$= 6,4 \times 10^{-3}\ N$ to the west/*na wes*

$F_{net} = \underline{5,76 \times 10^{-3}} + \underline{6,4 \times 10^{-3}}$ ✓

$= 1,22 \times 10^{-2}\ N$ ✓to the west/*na wes*✓ (4)

<u>OPTION 3/*OPSIE 3*</u> $F = k\frac{Q_1Q_2}{r^2}$ ✓ $F_{(-2)2} = \frac{(9\times10^9)(2\times10^{-9})(2\times10^{-5})}{(0{,}25)^2}$ $= 5{,}76 \times 10^{-3}$ N to the west/*na wes* $F_{(-2)(-8)} = \frac{(9\times10^9)(2\times10^{-9})(8\times10^{-6})}{(0{,}15)^2}$ $= 6{,}4 \times 10^{-3}$ N to the west/*na wes* $F_{net} = (5{,}76 \times 10^{-3} + 6{,}4 \times 10^{-3})$ ✓ $= 1{,}22 \times 10^{-2}$ N ✓to the west/*na wes* ✓

(4)

8.3 $2{,}44 \times 10^{-2}$ N✓ (1)

[11]

QUESTION 9/*VRAAG 9*

9.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. (provided temperature and all other physical conditions are constant) ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly)
OR/*OF*

The current in a conductor is directly proportional to the potential difference across the conductor, provided temperature and all other physical conditions are constant ✓✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur mits temperatuur en alle fisiese toestande konstant bly (2)

9.2

<u>OPTION 1/*OPSIE 1*</u>	**<u>OPTION 2/*OPSIE 2*</u>**
V = IR✓ $V_8 = (0{,}5)(8)$✓ = 4 V $V_8 = V_{16}$ $\therefore V_{16} = 4$ V $I_{16} = \frac{V}{R} = \frac{4}{16} = 0{,}25$ A $I_{tot//} = A_1 = (0{,}5 + 0{,}25)$ ✓ = 0,75 A✓	V = IR✓ $V_8 = (0{,}5)(8)$ ✓ = 4 V $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ $= \frac{1}{8} + \frac{1}{16}$ ✓ R = 5,33 Ω $I_{tot//} = \frac{4}{5{,}33}$ $A_1 = 0{,}75$ A✓

(4)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$I_1R_1 = I_2R_2$✓ $(0,5)(8) = I_{16}(16)$ ✓ $I_{16} = \frac{(8)(0,5)}{16} = 0,25$ A $I_{tot//} = A_1 = (0,5 + 0,25)$ ✓ $= 0,75$ A✓	$2R_{8\Omega} = R_{16\Omega}$✓ $\therefore I_{R16} = ½ I_{R8}$ ✓ $\therefore I_{R16} = ½ (0,5) = 0,25$ A $A_1 = (0,5 + 0,25)$ ✓ $= 0,75$ A✓

(4)

9.3

OPTION 1/*OPSIE 1*

$V = IR$

$V_{20\Omega} = (0,75)(20)$ ✓ $= 15$ V

$V_{//tot} = (15 + 4)$ ✓ $= 19$ V

$V_R = 19$ V

$P = VI$✓

$12 = (19)I$ ✓

$I_R = A_2 = 0,63$ A✓ (5)

OPTION 2/*OPSIE 2*

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{8} + \frac{1}{16}$ ✓

$R_{//} = 5,33\ \Omega$

OR/*OF*

$R = \frac{R_1R_2}{R_1 + R_2} = \frac{8 \times 16}{8 + 16}$ ✓ $= 5,33\ \Omega$

$R_{//} + R_{20} = (5,33 + 20)$ ✓ $= 25,33\Omega$

$V_{//tot} = I(R_{//} + R_{20})$

$= (0,75)(25,33)$

$= 19$ V

$P = VI$

12✓ $= I(19)$ ✓

$I_R = A_2 = 0,63$ A✓ (5)

OPTION 3/*OPSIE 3*

$V = IR$

$V_{20\Omega} = (0,75)(20)$ ✓ $= 15$ V

$V_{//tot} = (15 + 4)$ ✓ $= 19$ V

$V_R = 19$ V

$P = \frac{V^2}{R}$

$12 = \frac{(19)^2}{R}$

$R = 30,08\ \Omega$

$P = I^2R$✓

$12 = I^2(30,08)$✓

$I = 0,63$ A✓ (5)

9.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$(\varepsilon) = I(R + r)$ ✓ $= V_{terminal} + V_{int}$ $= 19 + (0,75 + 0,63)(1)$ ✓ $= 20,38$ V✓	$V_{int} = Ir$ $= (0,75 + 0,63)(1)$✓ $= 1,38$ V $\varepsilon = V_{terminal} + V_{int}$ ✓ $= 19 + 1,38$ $= 20,38$ V ✓

(3)

OPTION 3/OPSIE 3

$R = \frac{V}{I} = \frac{19}{0,63} = 30,16\ \Omega$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{30,16} + \frac{1}{25,33}\quad \therefore R_p = 13,77\ \Omega$

$I_{tot} = 0,63 + 0,75 = 1,38$ A

$\varepsilon = I(R + r)$ ✓
$= (1,38)(13,77 + 1)$✓
$= 20,38$ V✓

[14]

10.2.2

OPTION 1/*OPSIE 1* $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $220 = \frac{V_{max}}{\sqrt{2}}$ $V_{max} = 311{,}13\ V$ $I_{max} = \frac{V_{max}}{R} = \frac{331{,}13}{40{,}33}$ ✓ $= 7{,}71\ A$ ✓   **OR/OF** $P_{ave} = \frac{V_{max}I_{max}}{2}$ $1200{,}1 = \frac{(311{,}13)I_{max}}{2}$ $I_{max} = 7{,}71\ A$
OPTION 2/*OPSIE 2* $P_{average} = V_{rms}I_{rms}$ ✓ $1200{,}1 = (220)I_{rms}$ ✓ $I_{rms} = 5{,}455\ A$ $I_{max} = \sqrt{2}(5{,}455)$ $= 7{,}71\ A$ ✓ (7,715 A)
OPTION 3/*OPSIE 3* $P_{average} = I_{rms}^2R$ ✓ $1200{,}1 = I_{rms}^2(40{,}33)$ ✓ $I_{rms} = 5{,}455\ A$ $I_{max} = \sqrt{2}\,I_{rms}$ $= \sqrt{2}(5{,}455)$ $= 7{,}71\ A$ ✓

(3)

(3)

(3)

OPTION 4/*OPSIE 4* $V_{rms} = I_{rms}R$ ✓ $220 = I_{rms}(40{,}33)$ ✓ $I_{rms} = 5{,}455\ A$ $I_{max} = \sqrt{2}\,I_{rms}$ $= \sqrt{2}(5{,}455)$ $= 7{,}71\ A$ ✓

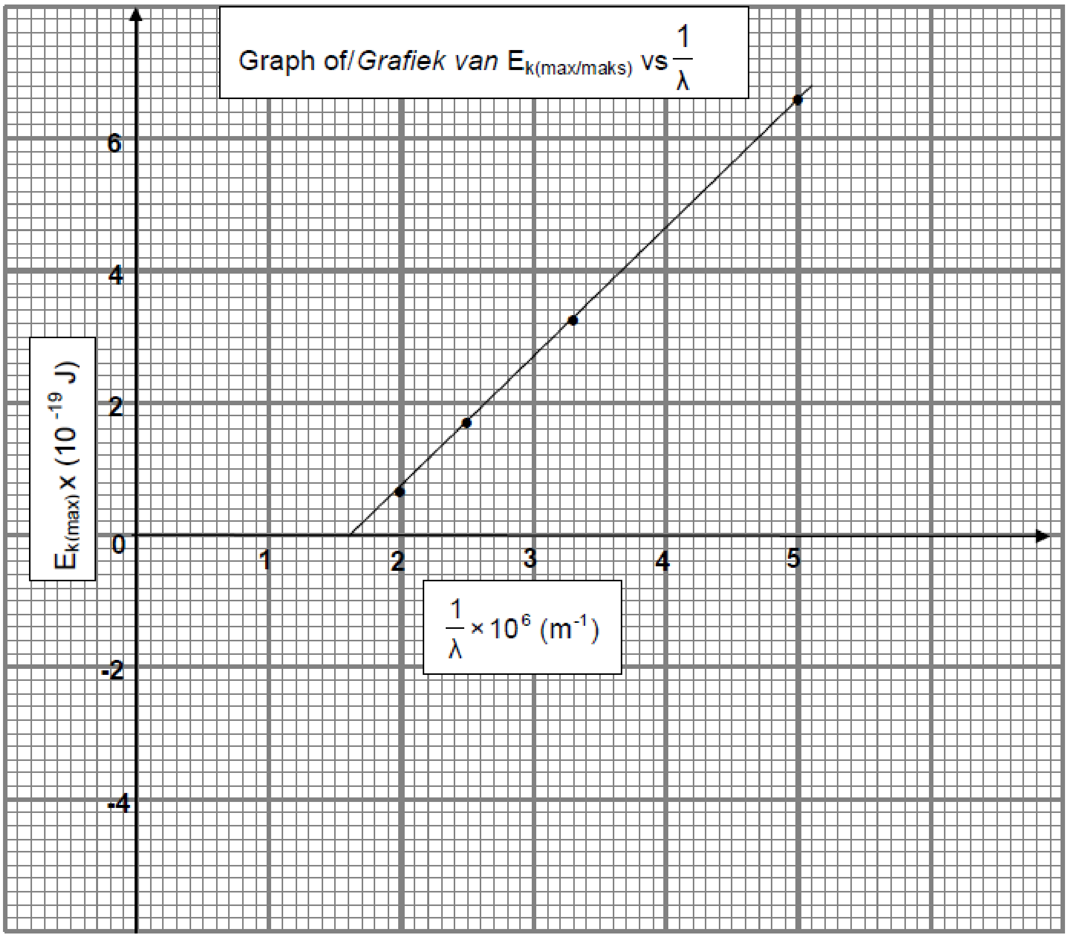
(3)

[11]

QUESTION 11/*VRAAG 11*

11.1 It is the process whereby electrons are ejected from a metal surface when light (of suitable frequency) is incident on it. ✓✓
Dit is die proses waartydens elektrone vanaf 'n metaaloppervlak vrygestel word wanneer van geskikte frekwensie daarop inval✓✓ (2)

11.2



11.3.1

OPTION 1/OPSIE 1

$\frac{1}{\lambda} = 1{,}6 \times 10^{6}\ m^{-1}$ ✓

$f_o = c\frac{1}{\lambda}$ ✓

$= (3 \times 10^8)(1{,}6 \times 10^6)$ ✓

$= 4{,}8 \times 10^{14}$ Hz✓ (**Accept/*Aanvaar*** $4{,}8 \times 10^{14}$ Hz to/*tot* $5{,}1 \times 10^{14}$ Hz) (4)

OPTION 2/OPSIE 2

By extrapolation: y-intercept = $-W_o$/*Deur ekstrapolasie : y-afsnit* = $-W_o$

$W_o = hf_o$ ✓

$3{,}2 \times 10^{-19}$✓ = $(6{,}63 \times 10^{-34})f_o$ ✓

$f_o = 4{,}8 \times 10^{14}$ Hz✓ (**Accept/*Aanvaar*** $4{,}8 \times 10^{14}$ Hz to/*tot* $4{,}83 \times 10^{14}$ Hz) (4)

OPTION 3/OPSIE 3 (Points from the graph/ *Punte vanaf grafiek*)

$E = W_o + E_{k(max)}$

$\frac{hc}{\lambda_0} = hf_0 + E_{k(max)}$ ✓

$(6{,}63 \times 10^{-34})(3 \times 10^{8})(1{,}6 \times 10^{6})$✓$= (6{,}63 \times 10^{-34})f_0 + 0$ ✓

$f_o = 4{,}8 \times 10^{14}$ Hz ✓

OR/*OF*

$(6{,}63 \times 10^{-34})(3 \times 10^{8})(5 \times 10^{6}) = (6{,}63 \times 10^{-34})f_0 + 6{,}6 \times 10^{-19}$

$f_o = 4{,}92 \times 10^{14}$ Hz

OR/*OF*

$(6{,}63 \times 10^{-34})(3 \times 10^{8})(3{,}3 \times 10^{6}) = (6{,}63 \times 10^{-34})f_0 + 3{,}3 \times 10^{-19}$

$f_o = 4{,}8 \times 10^{14}$ Hz

OR/OF

$(6{,}63 \times 10^{-34})(3 \times 10^{8})(2{,}5 \times 10^{6}) = (6{,}63 \times 10^{-34})f_0 + 1{,}7 \times 10^{-19}$

$f_o = 4{,}94 \times 10^{14}$ Hz

OR/OF

$(6{,}63 \times 10^{-34})(3 \times 10^{8})(2{,}2 \times 10^{6}) = (6{,}63 \times 10^{-34})f_0 + 0{,}7 \times 10^{-19}$

$f_o = 5{,}54 \times 10^{14}$ Hz (4)

11.3.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
hc = Gradient/ *Helling* ✓ $= \frac{\Delta y}{\Delta x}$ $= \frac{6{,}6 \times 10^{-19}}{(5 - 1{,}6) \times 10^{6}}$ ✓ $= 1{,}941 \times 10^{-25}$ (J·m) $h = \frac{\text{gradient / helling}}{c}$ $h = \frac{1{,}941 \times 10^{-25}}{3 \times 10^{8}}$ ✓ $= 6{,}47 \times 10^{-34}$ J·s ✓	W_0 = y intercept/*afsnit* = $3{,}2 \times 10^{-19}$ J ✓ **Accept /*Aanvaar*** $3{,}2 \times 10^{-19}$ J to/*tot* $3{,}4 \times 10^{-19}$ J) $W_o = hf_o$ $3{,}2 \times 10^{-19}$ ✓ = h($4{,}8 \times 10^{14}$) ✓ h = $6{,}66 \times 10^{-34}$ J·s ✓ **Accept /*Aanvaar*** $6{,}66 \times 10^{-34}$ J·s to/*tot* $7{,}08 \times 10^{-34}$ J·s)

(4)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
(Points from the graph *(Punte vanaf grafiek*) $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$ ✓ $+ 6{,}6 \times 10^{-19}$ ✓ $h = \frac{9{,}8 \times 10^{-19}}{(3 \times 10^{8})(5 \times 10^{6})}$ ✓ $= 6{,}53 \times 10^{-34}$ ✓ J·s **OR/*OF*** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$ ✓ $+ 3{,}3 \times 10^{-19}$ ✓ $h = \frac{6{,}5 \times 10^{-19}}{(3 \times 10^{8})(3{,}3 \times 10^{6})}$ ✓ $= 6{,}57 \times 10^{-34}$ ✓ J·s **OR/*OF*** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$ ✓ $+ 1{,}7 \times 10^{-19}$ $h = \frac{4{,}7 \times 10^{-19}}{(3 \times 10^{8})(2{,}5 \times 10^{6})}$ ✓ $= 6{,}27 \times 10^{-34}$ J·s **OR/*OF*** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$ ✓ $+ 0{,}7 \times 10^{-19}$ ✓ $h = \frac{3{,}9 \times 10^{-19}}{(3 \times 10^{8})(2 \times 10^{6})}$ ✓ $= 6{,}5 \times 10^{-34}$ J·s	**OPTION 4/*OPSIE 4*** $W_o = \frac{hc}{\lambda_o}$ or / of $W_o = hc\frac{1}{\lambda_o}$ $3{,}2 \times 10^{-19}$ ✓ = h(3×10^{8})($1{,}6 \times 10^{6}$) ✓ h = $6{,}66 \times 10^{-34}$ J·s ✓

(4)
[13]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2015

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 D ✓✓ (2)

1.3 A ✓✓ (2)

1.4 A ✓✓ (2)

1.5 B ✓✓ (2)

1.6 C ✓✓ (2)

1.7 B ✓✓ (2)

1.8 D ✓✓ (2)

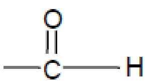
1.9 B ✓✓ (2)

1.10 C ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1
2.1.1 B ✓ (1)

2.1.2



✓ (1)

2.1.3 C_nH_{2n-2} ✓ (1)

2.1.4 4-ethyl-5-methylhept-2-yne / 4-ethyl-5-methyl-2-heptyne

4-etiel-5-metielhept-2-yn / 4-etiel-5-metiel-2-heptyn

Marking criteria/*Nasienriglyne:*
- 4-ethyl / *4-etiel* ✓ **OR/*OF*** 4 ethyl / *4 etiel*
- 5-methyl / *5-metiel* ✓ **OR/*OF*** 5 methyl / *5 metiel*
- hept-2-yne / 2-heptyne / *hept-2-yn / 2-heptyn* ✓
  OR/*OF* hept 2 yne / 2 heptyne / *hept 2 yn / 2 heptyn*

IF/*INDIEN:*
Any error e.g. hyphens omitted and/or incorrect sequence:
Enige fout bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./*Maks.* $^2/_3$ (3)

2.1.5 Butan-2-one / 2-butanone / Butanone
Butan-2-oon / 2-butanoon / Butanoon

Marking criteria/*Nasienriglyne:*
- Functional group / *Funksionele groep* ✓
- Whole name correct / *Hele naam korrek* ✓ (2)

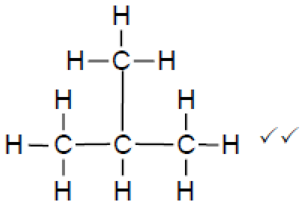
2.2

2.2.1 Alkanes / *Alkane* ✓ (1)

2.2.2 2-methylpropane ✓✓
2-metielpropaan

OR/***OF***

Methylpropane ✓✓
Metielpropaan



Notes/*Aantekeninge:*   **IF/*INDIEN*:**   2 methylpropane / *2 metielpropaan* ✓ $\frac{1}{2}$ **IF** sequence incorrect/***INDIEN*** *volgorde verkeerd:* Max./*Maks.* $\frac{1}{2}$
Marking criteria structural formula: ***Nasienriglyne struktuurformule:***   • Three carbons in longest chain. ✓   *Drie koolstowwe in die langste ketting.*   • Methyl group on second carbon.   *Metielgroep op tweede koolstof.* ✓
Notes/*Aantekeninge*:   • One or more H atoms omitted: *Een of meer H-atome uitgelaat:* $\frac{1}{2}$ • Condensed or semi-structural formula: *Gekondenseerde of semi-struktuur-formule:* $\frac{1}{2}$

(4)

2.2.3 Chain / *Ketting* ✓ (1)

2.3

2.3.1 Haloalkanes / Alkyl halides ✓
Haloalkane / Alkielhaliede (1)

2.3.2 Substitution / halogenation / bromonation ✓
Substitusie / halogenering / halogenasie / bromonering (1)

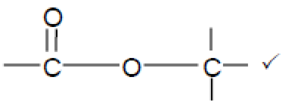
[16]

QUESTION 3/*VRAAG 3*

3.1

3.1.1 Esterification / Condensation ✓
Esterifikasie / Verestering / Kondensasie (1)

3.1.2



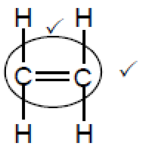
(1)

3.1.3 Propanoic acid / *Propanoësuur* ✓ (1)

3.1.4 Dehydration / elimination ✓
Dehidrasie / dehidratering / eliminasie (1)

3.1.5 (Concentrated) H_2SO_4 / sulphuric acid / H_3PO_4 / phosphoric acid ✓
(Gekonsentreerde) H_2SO_4 / / swaelsuur / swawelsuur / H_3PO_4 / fosforsuur (1)

3.1.6



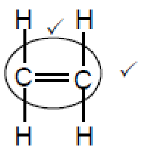
Notes/*Aantekeninge*

- Functional group: ✓
  Funksionele groep:
- Whole structure correct: ✓
  Hele struktuur korrek:

(2)

3.2

3.2.1



Notes/*Aantekeninge*

- Functional group: ✓
  Funksionele groep:
- Whole structure correct: ✓
  Hele struktuur korrek:

(2)

3.2.2 Addition / *Addisie* ✓ (1)

[10]

QUESTION 4/*VRAAG 4*

4.1 A bond/an atom or a group of atoms ✓ that determine(s) the (physical and chemical) properties of a group of organic compounds. ✓
'n Binding of 'n atoom of 'n groep atome wat die (fisiese en chemiese) eienskappe van 'n groep organiese verbindings bepaal. (2)

4.2
4.2.1 D / ethanoic acid / *etanoësuur* ✓

- Lowest vapour pressure. ✓
Laagste dampdruk. (2)

4.2.2 A / butane / *butaan* ✓ (1)

4.3
- Between molecules of **A** / butane / alkanes are London / induced dipole / dispersion forces. ✓
*Tussen molekule van **A** / butaan / alkane is London / geïnduseerde dipole / dispersiekragte.*
- Between molecules of **B** / propan-2-one / ketones are dipole-dipole forces ✓ in addition to London / induced dipole / dispersion forces.
*Tussen molekule van **B** / propan-2-oon / ketone is dipool-dipool-kragte tesame met London / geïnduseerde dipool /dispersiekragte.*
- Intermolecular forces in **A** are weaker than those in **B**. / Less energy is needed in **A** to break/overcome intermolecular forces. ✓
*Intermolekulêre kragte in **A** is swakker as die in **B**./ Minder energie word by **A** benodig om intermolekulêre kragte te breek/oorkom.*

OR/*OF*
Intermolecular forces in **B** are stronger than those in **A**. / More energy is needed in **B** to break/overcome intermolecular forces.
*Intermolekulêre kragte in **B** is sterker as die in **A**. / Meer energie word by **B** benodig om intermolekulêre kragte te breek/oorkom.*

OR/*OF*
- Between molecules of **A** / butane / alkanes are weak London / induced dipole / dispersion forces.
*Tussen molekule van **A** / butaan/alkane is swak London / geïnduseerde dipool / dispersiekragte.*
- Between molecules of **B** /propan-2-one / ketone are strong(er) dipole-dipole forces in addition to London/induced dipole / dispersion forces.
*Tussen molekule van **B** / propan-2-oon / ketone is sterk(er) dipool-dipool/dispersiekragte.* (3)

4.4 London forces/dispersion forces/induced dipole forces/dipole-dipole forces. ✓
Londonkragte/dispersiekragte/geïnduseerde dipoolkragte/dipool-dipoolkragte.

OR/*OF*
A and **B** do not have hydrogen bonding./**C** and D have hydrogen bonding.
***A** en **B** het nie waterstofbinding nie./**C** en **D** het waterstofbinding.* (1)

4.5 **OPTION 1/*OPSIE 1***

- **D** has more sites for hydrogen bonding than **C** / forms dimers / is more polar than **C**. ✓
  ***D** het meer punte vir waterstofbinding as **C** / vorm dimere / is meer polêr as **C**.*
- **D** has stronger / more intermolecular forces / dipole-dipole forces. ✓
  ***D** het sterker / meer intermolekulêre kragte / dipool-dipoolkragte.*

  OR/*OF*
  D needs more energy to overcome/break the intermolecular forces.
  ***D** het meer energie nodig om die intermolekulêre kragte te oorkom/breek.*

OPTION 2/*OPSIE 2*

- **C** has less sites for hydrogen bonding than **D**. / **C** does not form dimers / **C** is less polar.
  ***C** het minder plekke vir waterstofbinding as **D**. / **C** vorm nie dimere nie / **C** is minder polêr.*
- **C** has weaker / less intermolecular forces / dipole-dipole forces./ **C** needs less energy to overcome/break intermolecular forces / dipole-dipole forces.
  ***C** het swakker / minder intermolekulêre kragte / dipool-dipoolkragte./ **C** benodig minder energie om intermolekulêre kragte / dipool-dipoolkragte te oorkom/breek.* (2)

4.6 **Marking criteria/*Nasienriglyne***

- Mole ratio for $V(CO_2)$ correctly used. / *Molverhouding vir* $V(CO_2)$ *korrek gebruik.*
- Mole ratio for $V(H_2O)$ correctly used. / *Molverhouding vir* $V(H_2O)$ *korrek gebruik.*
- Mole ratio for $V(O_2$ reacted) correctly used. / *Molverhouding vir* $V(O_2$ *reageer) korrek gebruik.*
- $V(O_2$ excess/*oormaat*) = $V(O_2$ initial/*aanvanklik*) – $V(O_2$ change/*verandering*).
- $V_{tot} = 80\ cm^3$

OPTION 1/*OPSIE 1*

$V(CO_2) = 4V(C_4H_{10})$
$= (4)(8)$ ✓
$= 32\ cm^3$

$V(H_2O) = 5V(C_4H_{10})$
$= (5)(8)$ ✓
$= 40\ cm^3$

$V(O_2$ reacted/*reageer*):
$V(O_2) = \frac{13}{2}V(C_4H_{10})$
$= (\frac{13}{2})(8)$ ✓ $= 52\ cm^3$

$V(O_2$ excess/*oormaat*):
$V(O_2) = 60 - 52$ ✓ $= 8\ cm^3$

$V_{tot} = 32 + 40 + 8 = 80\ cm^3$ ✓

OPTION 2/*OPSIE 2*

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (cm^3) *Begin*V (cm^3)	8	60	0	0
Change in V (cm^3) *Verandering* V (cm^3)	8	52 ✓	32 ✓	40 ✓
Final V (cm^3) *Finale* V (cm^3)	0	8 ✓	32	40

Total/*totale* volume = 8 + 32 + 40 = 80 cm^3 ✓

OPTION 3/*OPSIE 3*

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (dm^3) *Begin* V (dm^3)	0,008	0,06	0	0
Change in V (dm^3) *Verandering* V (dm^3)	0,008	0,052 ✓	0,032 ✓	0,04 ✓
Final V (dm^3) *Finale* V (dm^3)	0	0,008 ✓	0,032	0,04

Total/*totale* volume = 0,008 + 0,032 + 0,04 = 0,08 dm^3 ✓ (5)

[16]

QUESTION 5/*VRAAG 5*

5.1 Time/Tyd: (Stop) watch / *(Stop)horlosie* ✓

Volume: (Gas) syringe / Burette / Measuring cylinder / (Chemical) balance / Erlenmeyer flask / Graduated flask ✓
(Gas)spuit / Buret / Maatsilinder / (Chemiese) balans / Erlenmeyer fles / Gegradueerde fles

Notes/*Aantekeninge*
- Only one mark per type of apparatus. / *Slegs een punt per tipe apparaat.* (2)

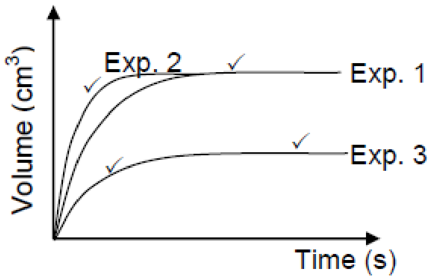
5.2

5.2.1 t_1 ✓ (1)

5.2.2 t_3 ✓ (1)

5.3 Between t_1 and t_2 ✓
Tussen t_1 en t_2 (1)

5.4



Marking criteria/*Nasienriglyne*		
Exp. 2	Initial gradient higher than that of Exp.1. *Aanvanklike gradient groter as die van Eksp 1.*	✓
	Curve reaches same constant volume as for Exp. 1 (but earlier). *Kurwe bereik dieselfde konstante volume as in Eksp 1 (maar gouer).*	✓
Exp. 3	Initial gradient lower than that of Exp.1. *Aanvanklike gradient kleiner as die van Eksp. 1.*	✓
	Curve reaches a smaller constant volume as for Exp. 1 (at a later stage). *Kurwe bereik (later) 'n kleiner konstante volume as vir Eksp. 1.*	✓

(4)

5.5.1

Marking criteria/*Nasienriglyne*	
• $n(HC\ell) = (0,1)(100 \times 10^{-3})$ • Use mole ratio/*Gebruik molverhouding*: $n(Zn) = \frac{1}{2}n(HC\ell)$ • Substitute 65 into/ Vervang 65 in $n = \frac{m}{M}$. • $n(Zn_{final/finaal}) = n(Zn_{initial/aanvanklik}) - n(Zn_{used/gebruik})$ $m(Zn_{final/finaal}) = m(Zn_{initial/aanvanklik}) - m(Zn_{used/gebruik})$ • Final answer/Finale antwoord: Range/*gebied*: 0,33 g – 0,48 g	
OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
$n(HC\ell) = cV$ $= (0,1)(100 \times 10^{-3})$ ✓ $= 0,01$ mol n(Zn reacted/*gereageer*): $n(Zn) = \frac{1}{2}n(HC\ell)$ $= \frac{1}{2}(0,01)$ ✓ $= 5 \times 10^{-3}$ mol n(Zn reacted/*gereageer*): $m(Zn) = (5 \times 10^{-3})(65)$ ✓ $= 0,325$ g $m(Zn_f) = 0,8 - 0,325$ ✓ $= 0,48$ g ✓ (0,475 g)	$n(HC\ell) = cV$ $= (0,1)(100 \times 10^{-3})$ ✓ $= 0,01$ mol n(Zn reacted/*gereageer*) $= \frac{1}{2}n(HC\ell)$ $= \frac{1}{2}(0,01)$ ✓ $= 5 \times 10^{-3}$ mol $n(Zn)_i = \frac{m}{M}$ $= \frac{0,8}{65}$ ✓ $= 1,23 \times 10^{-2}$ mol $n(Zn)_f = 1,23 \times 10^{-2} - 5 \times 10^{-3}$ ✓ $= 7,3 \times 10^{-3}$ mol $m(Zn) = nM$ $= (7,3 \times 10^{-3})(65) = 0,47$ g ✓

(5)

5.5.2 Smaller than / *Kleiner as* ✓ (1)

[15]

QUESTION 6/*VRAAG 6*

6.1 Equal to / *Gelyk aan* ✓ (1)

6.2

$$K_c = \frac{[X_3]^2}{[X_2]^3} ✓$$
$$= \frac{(0,226)^2 ✓}{(0,06)^3 ✓}$$
$$= 236,46 ✓$$

No K_c expression, correct substitution /*Geen K_c- uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{3}{4}$ Wrong K_c expression /*Verkeerde K_c-uitdrukking* Max./*Maks.* $\frac{0}{4}$
If one or more exponents are omitted in substitution step but correct answer obtained: Max $\frac{3}{4}$ *Indien een of meer eksponente uitgelaat by substitusie stap, maar korrekte antwoord verkry: Maks* $\frac{3}{4}$

(4)

6.3 (1)

6.3.1 Increases / *Vermeerder* ✓

6.3.2
- The <u>increase in $[X_3]$ is opposed</u>. / <u>Change is opposed</u>. ✓
  Die <u>verhoging in $[X_3]$ word teengewerk</u>. / <u>Verandering word teenwerk</u>.
- The reverse reaction is favoured. / X_3 is used / $[X_3]$ decreases. ✓
  Die terugwaartse reaksie word bevoordeel./X_3 word gebruik / $[X_3]$ neem af. (2)

6.4 Higher than / *Hoër as* ✓ (1)

6.5 Exothermic / *Eksotermies* ✓

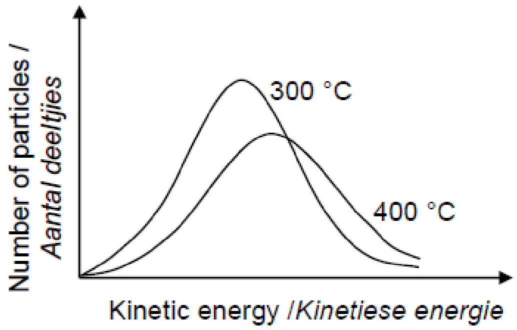
- The concentration of the product/$X_3(g)$ is lower / the concentration of the reactant / $X_2(g)$ is higher. ✓
  Die konsentrasie van die produkte/$X_3(g)$ is laer / die konsentrasie van die reaktans / $X_2(g)$ is hoër.
- The increase in temperature favoured the reverse reaction. ✓
  Die toename in temperatuur het die terugwaartse reaksie bevoordeel.
- According to Le Chatelier's principle an increase in temperature favours the endothermic reaction. ✓
  Volgens Le Chatelier se beginsel bevoordeel 'n toename in temperatuur die endotermiese reaksie.

OR/***OF***

Exothermic / *Eksotermies* ✓

- $[X_3]$ decreases and $[X_2]$ increases. / *$[X_3]$ neem af en $[X_2]$ neem toe.* ✓
- K_c decreases if temperature increases./*K_c neem af as die temperatuur afneem.* ✓
- Decrease in temperature favoured the forward reaction. / *Verlaging in temperatuur het die voorwaartse reaksie bevoordeel.* ✓ (4)

6.6



Marking criteria/*Nasienriglyne*	
Peak of curve at 400 °C lower than at 300 °C and shifted to the right. *Piek van kurwe by* 400 °C laer as by 300 °C en skuif na regs.	✓
Curve at 400 °C has larger area at the higher E_k. *Kurwe by 400 °C het groter oppervlak by hoë E_k.*	✓

(2)
[15]

QUESTION 7/VRAAG 7

7.1

7.1.1 Hydrolysis / *Hidrolise* ✓ (1)

7.1.2 Acidic / *Suur* ✓

Forms H_3O^+ ions during hydrolysis./*Vorm H_3O^+ ione gedurende hidrolise.* ✓

OR/***OF***

Salt of strong acid and weak base./*Sout van sterk suur en swak basis.*

OR/***OF***

(NH_4^+) acts as proton donor. / *(NH_4^+) tree op as 'n protonskenker.* (2)

7.2

7.2.1 n = cV ✓

= (0,1)(0,1) ✓

= 0,01 mol ✓ (3)

7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1.**
POSITIEWE NASIEN VAN VRAAG 7.2.1.

Marking criteria/*Nasienriglyne*

- Substitute volume and concentration to calculate n(HCℓ) ✓
  Vervang volume en konsentrasie om n(HCℓ) te bereken.
- Use mole ratio/*Gebruik molverhouding:* n(NaOH) = n(HCℓ) = 1:1 ✓
- n(NaOH) x 4 **OR**/***OF*** V(HCℓ) x 4 **OR**/***OF*** n(HCℓ) x 4 ✓
- Subtraction/*Aftrekking:* $n(NaOH_{initial/aanvanklik})$ - $n(NaOH_{excess/oormaat})$ ✓
- Use mole ratio/*Gebruik molverhouding:* n(NaOH) = $n(NH_4Cℓ)$ = 1:1 ✓
- Substitute/*Vervang* 53,5 $g·mol^{-1}$ in $n = \frac{m}{M}$. ✓
- Percentage calculation/*Persentasieberekening* ✓
- Final answer/*Finale antwoord*: 0,11 g - 0,21 g ✓

OPTION 1/*OPSIE 1*

$n(HC\ell) = c_aV_a = (0,11)(14,55 \times 10^{-3})$ ✓ $= 1,6 \times 10^{-3}$ mol

$n(NaOH) = n(HC\ell) = 1,6 \times 10^{-3}$ mol ✓

n(NaOH excess/*oormaat*) in 100 cm^3 $= 1,6 \times 10^{-3} \underline{\times 4}$ ✓
$= 6,4 \times 10^{-3}$ mol

n(NaOH reacted/*gereageer*) $= 0,01 - 6,4 \times 10^{-3}$ ✓
$= 3,6 \times 10^{-3}$ mol

$n(NH_4C\ell) = n(NaOH) = 3,6 \times 10^{-3}$ mol ✓ (0,003598 mol)

$m(NH_4C\ell) = nM$ $= (3,6 \times 10^{-3})(53,5)$ ✓ $= 0,193$ g 92% : 0,193 g 100% : x $\therefore x = \frac{0,193 \times 100}{92}$ ✓ $= 0,21$ g ✓	$n(NH_4C\ell) = 0,92\frac{x}{53,5}$ ✓ ✓ $\therefore 3,6 \times 10^{-3} = 0,92\frac{x}{53,5}$ $\therefore x = 0,21$ g ✓	$n(NH_4C\ell) = \frac{m}{53,5}$ ✓ $\therefore 3,6 \times 10^{-3} = \frac{m}{53,5}$ $n(NH_4C\ell) = 0,192$ g m(fertiliser/*kunsmis*): $m = \frac{0,192 \times 100}{92}$ ✓ $= 0,21$ g ✓

OPTION 2/*OPSIE 2* V(HCℓ) to neutralise 100 cm^3 NaOH: *V(HCℓ) neutraliseer* 100 cm^3 *NaOH:* $V(HC\ell) = 14,55 \underline{\times 4}$ ✓ $= 58,2$ cm^3 $n(HC\ell) = cV$ $= (0,11)(0,0582)$ ✓ $= 0,006402$ mol $n(NaOH) = n(HC\ell)$ $= 0,006402$ mol ✓ n(NaOH reacted/*gereageer*): $n(NaOH) = 0,01 - 0,006402$ ✓ $= 0,003598$ mol $n(NH_4C\ell) = n(NaOH)$ $= 0,003598$ mol ✓ $m(NH_4C\ell) = nM$ $= (0,003598)(53,5)$ ✓ $= 0,192$ g 92% : 0,192 g 100% : $\frac{0,192 \times 100}{92}$ ✓ $= 0,21$ g ✓	**OPTION 3/*OPSIE 3*** n(HCℓ) to neutralise 100 cm^3 NaOH: *n(HCℓ) neutraliseer* 100 cm^3 *NaOH:* $n(HC\ell) = cV$ $= (0,11)(0,01455 \underline{\times 4}$ ✓$)$ ✓ $= 0,006402$ mol ($6,4 \times 10^{-3}$ mol) n(NaOH excess/*oormaat):* $n(NaOH) = n(HC\ell) = 6,4 \times 10^{-3}$ mol ✓ n(NaOH reacted/*gereageer*): $n(NaOH) = 0,01 - 0,006402$ ✓ $= 0,003598$ mol $n(NH_4C\ell) = n(NaOH)$ $= 0,003598$ mol ✓ $m(NH_4C\ell) = nM$ $= (0,003598)(53,5)$ ✓ $= 0,192$ g 92% : 0,192 g 100% : $0,192 \times \frac{100}{92}$ ✓ $= 0,21$ g ✓

OPTION 4/*OPSIE 4*

$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25}=\frac{1}{1}$ ✓ ✓

c_b = 0,064 mol·dm^{-3}

n(NaOH in excess in 100 cm^3):
n(NaOH in oormaat in 100 cm^3):

n(NaOH) = cV
= (0,064)(0,1) ✓
= 6,4 x 10^{-3} mol

n(NaOH reacted/*gereageer*):
n(NaOH) = 0,01 - 0,006402 ✓
= 0,003598 mol

n($NH_4C\ell$) = n(NaOH)
= 0,003598 mol ✓

m($NH_4C\ell$) = nM
= (0,003598)(53,5) ✓
= 0,192 g

92% : 0,192 g
100% : 0,192 x $\frac{100}{92}$ ✓ = 0,21 g ✓

OPTION 5/*OPSIE 5*

$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25}=\frac{1}{1}$ ✓ ✓

$\therefore c_b$ = 0,064 mol·dm^{-3}

Δc(NaOH) = 0,1 - 0,064 ✓✓
= 0,036 mol·dm^{-3}

n(NaOH reacted/*gereageer*):
n(NaOH) = cV
= 0,036 x 0,1
= 0,0036 mol

n($NH_4C\ell$) = n(NaOH) = 0,0036 mol ✓

$n = \frac{m}{M}$

$\therefore 0,0036 = \frac{\frac{92}{100}x}{53,5}$ ✓ ✓

0,0036(53,5) = 0,92x
x = 0,21 g ✓

(8)

7.3

OPTION 1/*OPSIE 1*

[OH^-] = [NaOH] = 0,5 mol·dm^{-3}

K_w = [H_3O^+][OH^-]
1 x 10^{-14} = [H_3O^+]0,5 ✓
$\therefore$ [H_3O^+] = 2 x 10^{-14} mol·dm^{-3}

pH = -log[H^+] ✓
= -log(2 x 10^{-14}) ✓
= 13,7 ✓

OPTION 2/*OPSIE 2*

pOH = -log[OH^-] ✓
= -log(0,5) ✓
= 0,301

pH + pOH = 14
pH = 14 – 0,301 ✓
= 13,7 ✓ (13,699)

Notes/*Aantekeninge*
IF/*INDIEN*:
Wrong formula/*Verkeerde formule*: pH = -log[OH^-]; pOH = -log[NaOH]
No marks for substitution and answer./*Geen punte vir vervanging en antwoord.*

(4)
[18]

QUESTION 8/*VRAAG 8*

8.1 Temperature/*Temperatuur*: 25 °C / 298 K ✓
Pressure/*Druk*: 101,3 kPa / 1,013 x 10^5 Pa / 1 atm / 100 kPa ✓
Concentration/*Konsentrasie*: 1 $mol \cdot dm^{-3}$ ✓ (3)

8.2
8.2.1 Cd(s) / Cadmium / *Kadmium* / Cd|Cd^{2+} / Cd^{2+}|Cd ✓

> **Notes/*Aantekeninge***
> Ignore phases. / *Ignoreer fases.*

(1)

8.2.2
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓
$0,13$ ✓ $= E^\theta_{cathode} - (-0,40)$ ✓
$E^\theta_{cathode} = 0,13 - 0,40$
$= -0,27$ (V) ✓

Q is Ni/nickel/*nikkel* ✓

> **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:* $\frac{4}{5}$

(5)

8.3
8.3.1 $Cd(s) \rightarrow Cd^{2+}(aq) + 2e^-$ ✓✓
Ignore phases. / *Ignoreer fases.*

> **Notes/*Aantekeninge***
>
> | | | | |
> |---|---|---|---|
> | $Cd^{2+} + 2e^- \leftarrow Cd$ | ($\frac{2}{2}$) | $Cd \rightleftharpoons Cd^{2+} + 2e^-$ | ($\frac{1}{2}$) |
> | $Cd \leftarrow Cd^{2+} + 2e^-$ | ($\frac{0}{2}$) | $Cd^{2+} + 2e^- \rightleftharpoons Cd$ | ($\frac{0}{2}$) |

(2)

8.3.2 Pt/Platinum ✓ (1)

8.4 **OPTION 1/*OPSIE 1***

Compare/*Vergelyk* **Q^{2+}** & **Cd^{2+}**	**Q^{2+}** is reduced / **Cd** is oxidised and therefore **Q^{2+}** is a stronger oxidising agent than **Cd^{2+}**. ***Q^{2+}*** *word gereduseer /* ***Cd*** *word geoksideer, en dus is* ***Q^{2+}*** *'n sterker oksideermiddel as* ***Cd^{2+}***.	✓
Compare/*Vergelyk* **R_2** & **Cd^{2+}**	***R_2*** *is reduced /* ***Cd*** is oxidised and therefore *R_2* is a stronger oxidising agent than *Cd^{2+}*. ✓ ***R_2*** *word gereduseer /* ***Cd*** *word geoksideer, dus is* ***R_2*** *'n sterker oksideermiddel as* ***Cd^{2+}***.	✓
Compare/*Vergelyk* **R_2** & **Q^{2+}**	The cell potential of combination **II** is higher than that of combination **I**, therefore **R_2** is a stronger oxidising agent than **Q^{2+}**. *Die selpotensiaal van kombinasie* ***II*** *is hoër as dié van kombinasie* ***I*** *en dus is* ***R_2*** *'n sterker oksideermiddel as* ***Q^{2+}***.	✓
Final answer/ *Finale antwoord*	Cd^{2+}; Q^{2+};R_2 **OR/*OF*** Cd^{2+} ; Ni^{2+} ; $C\ell_2$	✓

OPTION 2/*OPSIE 2*

- The reduction potential of $C\ell^-|C\ell_2$ = 1,36 V ✓ because the cell potential of combination II is 1,76 V and the reduction potential of $Cd|Cd^{2+}$ is 0,4 V.
  Die reduksiepotensiaal van $C\ell^-/C\ell_2$ = 1,36 V omdat die selpotensiaal van kombinasie II 1,76 V is en die reduksiepotensiaal van Cd/Cd^{2+} 0,4 V is.

  OR/*OF*
  R_2 is $C\ell_2$ because the cell potential of combination II is 1,76 V and the reduction potential of $Cd|Cd^{2+}$ is 0,4 V./ *R_2 is $C\ell_2$ omdat die selpotensiaal van kombinasie II 1,76 V is en die reduksiepotensiaal van Cd/Cd^{2+} 0,4 V is.*

- $Cd|Cd^{2+}$ has the lowest reduction potential (-0,4 V) and therefore Cd^{2+} is the weakest oxidising agent. / $Cd|Cd^{2+}$ *het die laagste reduksiepotensiaal (0,4 V) en dus is Cd^{2+} die swakste oksideermiddel.* ✓

- $C\ell^-|C\ell_2$ has the highest reduction potential and therefore $C\ell_2$ is the strongest oxidising agent. / $C\ell^-|C\ell_2$ *het die hoogste reduksiepotensiaal en dus is* $C\ell_2$ *die sterkste oksideermiddel.* ✓

- Final answer/*Finale antwoord*: Cd^{2+}; Q^{2+};R_2 ✓ **OR/*OF*** Cd^{2+} ; Ni^{2+} ; $C\ell_2$ (4)

[16]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE/*ENIGE EEN:***

- The chemical process in which electrical energy is converted to chemical energy. ✓✓
  Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.
- The use of electrical energy to produce a chemical change.
  Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.
- Decomposition of an ionic compound by means of electrical energy.
  Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.
- The process during which and electric current passes through a solution/ionic liquid/molten ionic compound.
  Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg. (2)

9.2 **ANY ONE/*ENIGE EEN:***

- To keep the polarity of the electrodes the same. ✓
  Om die polariteit van die elektrodes dieselfde te hou.
- To prevent the anode and cathode from swopping.
  Om te verhoed dat die anode en katode omruil.
- DC provides a one way flow of electrons ensuring that the same chemical reaction occurs all the time at the electrodes.
  GS verskaf *'n eenrigting vloei van elektrone en verseker dat dieselfde chemiese reaksie altyd by die elektrodes plaasvind.*
- If you use AC the polarity of the electrodes will keep changing.
  Wanneer jy WS gebruik word hou die polariteit van die elektrodes aan om te verander.
- Pure copper deposited on only one electrode.
  Suiwer koper slaan slegs op een elektrode neer. (1)

9.3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓
Ignore phases. / *Ignoreer fases.*

Notes/*Aantekeninge*			
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	$(\frac{1}{2})$	$Cu \leftarrow Cu^{2+} + 2e^-$	$(\frac{2}{2})$
$Cu \rightleftharpoons Cu^{2+} + 2e^-$	$(\frac{0}{2})$	$Cu^{2+} + 2e^- \leftarrow Cu$	$(\frac{0}{2})$

(2)

9.4
- Cu^{2+} is a stronger oxidising agent ✓ than Zn^{2+}. ✓
  Cu^{2+} is 'n sterker oksideermiddel as Zn^{2+}.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.* ✓

OR/*OF*
- Zn is a stronger reducing agent than Cu.
  Zn is 'n sterker reduseermiddel as Cu.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.*

OR/*OF*
- The standard reduction potential of Cu^{2+}|Cu is higher than that of Zn^{2+}|Zn.
  Die standaard reduksie potensiaal van Cu^{2+}|Cu is hoër as die van Zn^{2+}|Zn.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.*

OR/*OF*
- The standard reduction potential of Zn^{2+}|Zn is lower than that of Cu^{2+}|Cu.
  Die standaard reduksie potensiaal van Zn^{2+}|Zn is laer as die van Cu^{2+}|Cu.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.* (3)

9.5

$$n = \frac{m}{M}$$

$$\overset{\checkmark}{2{,}85 \times 10^{-2}} = \frac{m}{63{,}5\checkmark}$$

$$m = 1{,}81\ \text{g}$$

$$\%\ \text{purity} = \frac{1{,}81}{2} \times 100\checkmark$$

$$= 90{,}49\ \%\ \checkmark$$

Marking guidelines/*Nasienriglyne*
- Substitute 63,5 ✓and 2,85 x 10^{-2} ✓ in $n = \frac{m}{M}$
  Vervang 63,5 en 2,85 x 10^{-2} in $n = \frac{m}{M}$
- Percentage purity. ✓
  Persentasie suiwerheid.
- Final answer/*Finale antwoord:*
  90,49% ✓ (Accept/*Aanvaar: 90,5%*)

(4)

[12]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Haber (process) / *Haber(proses)* ✓ (1)

10.1.2 $N_2 + 3H_2$ ✓ $\rightleftharpoons 2NH_3$ ✓ 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)

10.1.3 Air / *Lug* ✓ (1)

10.2

10.2.1 40% ✓ (1)

10.2.2
- High yield / percentage ✓
  Hoë opbrengs / persentasie
- High rate due to higher concentration. ✓
  Hoë tempo weens hoër konsentrasie.

(2)

10.2.3 Low reaction rate / *Lae reaksietempo* ✓ (1)

10.3

Marking guidelines/*Nasienriglyne* $\frac{28}{80}$ ✓ x 50 ✓ 17,5 kg ✓	
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
% N in $NH_4NO_3 = \frac{28}{80}$ ✓ $\times 100$ = 35% m(N) in 50 kg: $\frac{35}{100} \times 50$ ✓ = 17,5 kg ✓	m(N in NH_4NO_3) = $\frac{28}{80}$ ✓ x 50 ✓ = 17,5 kg ✓

(3)

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

FEBRUARY/MARCH/*FEBRUARIE/MAART* 2016

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	B ✓✓	(2)
1.4	D ✓✓	(2)
1.5	A ✓✓	(2)
1.6	C✓✓	(2)
1.7	B✓✓	(2)
1.8	B ✓✓	(2)
1.9	C ✓✓	(2)
1.10	A ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

2.1 **For the 5 kg mass/*Vir die 5 kg massa*:**

2.1.1 $T - f = ma$

$T - \mu_k(mg) = ma$✓

$T - (0,4)(5)(9,8)$✓ $= 5a$✓.........(1)

NOTE/*LET WEL*:
1 mark for any of the 2 formulae
1 punt vir enige van die 2 formules

For the 20 kg mass/*Vir die 20 kg massa*

$mg - T = ma$

$\underline{20(9,8) - T = 20a}$✓..........(2)

$176,4 = 25a$ (1) + (2)

$\therefore a = 7,06\ (7,056)\ m\cdot s^{-2}$✓

(5)

<u>ACCEPT/*AANVAAR* (4 marks/*4 punte*)</u>

$F_{net} = ma$

$Mg - f = (M + m)\,a$✓

$[20(9,8) - (0,4)(5)(9,8)]$✓ $= 25a$✓

$\therefore a = 7,06\ m\cdot s^{-2}$✓ (4)

2.1.2

POSITIVE MARKING FROM QUESTION 2.1.1

POSITIEWE NASIEN VANAF VRAAG 2.1.1

<u>OPTION 1/*OPSIE 1*</u>

$v_f^{\ 2} = v_i^2 + 2a\Delta y$✓

$= 0$✓ $+ (2)(7,056)(6)$✓

$v_f = 9,20\ m\cdot s^{-1}$✓

POSITIVE MARKING FROM QUESTION 2.1.1

POSITIEWE NASIEN VANAF VRAAG 2.1.1

<u>OPTION 2/*OPSIE 2*</u>

The 5 kg mass travels as fast as the 20 kg mass

Die 5 kg massa beweeg net so vinnig soos die 20 kg massa

$W_{net} = \Delta K$✓

$\underline{(5)(7,056)(6\cos 0^{o})}$✓ $\underline{= ½(5)(v_f^2 - 0)}$✓

$v_f = 9,20\ m\cdot s^{-1}$✓

<u>OPTION 3/*OPSIE 3*</u>

For the 20 kg mass/*Vir die 20 kg massa*

$W_{net} = \Delta K$✓

$Mg - T = Ma$

$(20)(9,8) - T = (20)(7,056)$✓

$T = 54,88\ N$

$W_{net} = \Delta K$

$W_T + W_g = ½m(v_f^2 - v_i^2)$

$\underline{(54,88)(6)(\cos 180) + 20(9,8)(6)(\cos 0) = ½(20)\ (v_f^{\ 2} - 0)}$✓

$v_f = 9,202\ m\cdot s^{-1}$✓

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta K + \Delta U$✓

$W_{nc} = f_k\Delta x\cos\theta = \mu_k N\Delta x\cos\theta = \Delta U + \Delta K$

$(0,4)(5)(9,8)(6)\cos 180^\circ$✓ $= (20)(9,8)(0 - 6) + \frac{1}{2}(25)(v_f^2 - 0)$ ✓

$-117,6 = (20)(9,8)(-6) + \frac{1}{2}(25)(v_f^2 - 0)$

$v_f = 9,202\ m\cdot s^{-1}$✓ (4)

2.1.3 6 m✓ (1)

2.2

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.* ✓ (2)

2.2.2 $F = \frac{Gm_1m_2}{r^2}$ ✓

On the mountain/*Op die berg*

$F_g = \frac{(6,67\times10^{-11})(5,98\times10^{24})(65)}{(6,38\times10^6 + 6\times10^3)^2}$ ✓ ✓

$= 627,2\ N$

On the ground/*Op die grond*

$F_g = W = mg$

$= (65 \times 9,8)$✓

$= 637\ N$

$\boxed{F_g = \frac{(6,67\times10^{-11})(5,98\times10^{24})(65)}{(6,38\times10^6)^2} = 636,94\ N}$

Difference/*Verskil* = (637 – 627,2)✓

= 9,8 N✓ (6)

[18]

QUESTION 3/*VRAAG 3*

3.1

3.1.1

<table>
<tr><td colspan="2">

OPTION 1/*OPSIE 1*
Upwards positive/*Opwaarts positief*:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (-2)^2 + 2(-9,8)(-45)$ ✓
$v_f = 29,76\ m\cdot s^{-1}$ ✓

Downwards positive/*Afwaarts positief:*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (2)^2 + 2(9,8)(45)$ ✓
$v_f = 29,76\ m\cdot s^{-1}$ ✓ $(29,77\ m\cdot s^{-1})$

</td></tr>
</table>

<table>
<tr><td>

OPTION 2/*OPSIE 2*
Upwards positive/*Opwaarts positief*:
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
for either equation/*vir beide vergelykings*
$-45 = -2\Delta t + ½(-9,8)\Delta t^2$
$-4,9\ \Delta t^2 - 2\Delta t + 45 = 0$
$4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓
$\Delta t = 2,83$

$v_f = v_i + a\ \Delta t$
$v_f = 0 + (-9,8)(2,83)$
$v_f = -29,73\ m\ s^{-1}$ ✓

</td><td>

Downwards positive/*Afwaarts positief:*
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
for either equation/*vir beide vergelykings*
$45 = 2\Delta t + ½(9,8)\Delta t^2$
$4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓
$\Delta t = 2,83$
$v_f = v_i + a\ \Delta t$
$v_f = 0+(9,8)(2,83)$
$v_f = 29,73\ m\ s^{-1}$ ✓

</td></tr>
</table>

<table>
<tr><td>

OPTION 3/*OPSIE 3*
Downwards positive/*Afwaarts positief:*
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
for either equation/*vir beide vergelykings*
$45 = 2\Delta t + ½(9,8)\Delta t^2$
$4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓
$\Delta t = 2,83$
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$45 = \frac{2 + v_f}{2}\ 2,83$
$v_f = 29,80\ m\ s^{-1}$ ✓

</td><td>

Upwards positive/*Opwaarts positief*:
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
for either equation/*vir beide vergelykings*
$-45 = -2\Delta t + ½(-9,8)\Delta t^2$
$-4,9\ \Delta t^2 - 2\Delta t + 45 = 0$
$4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓
$\Delta t = 2,83$
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$-45 = \frac{-2 + v_f}{2}\ 2,83$ ✓
$v_f = -29,80\ m\ s^{-1}$ ✓

</td></tr>
</table>

OPTION 4/*OPSIE 4*
$E_{mech\ at\ top} = E_{mech\ at\ surface\ of\ water}$
$\frac{1}{2} mv_i^2 + mgh_i = \frac{1}{2} mv_f^2 + mgh_f$ ✓
$\frac{1}{2}(2)^2 + 9{,}8(45) = \frac{1}{2} v_f^2 + 0$ ✓
$v_f = 29{,}76\ m \cdot s^{-1}$ ✓

OPTION 5/OPSIE 5
$W_{net} = \Delta K$ ✓
$F_g\ \Delta h \cos\theta = \frac{1}{2} m (v_f^2 - v_i^2)$
$mg\ \Delta h \cos\theta = \frac{1}{2} m (v_f^2 - v_i^2)$
$9{,}8(45)\cos 0 = \frac{1}{2}(v_f^2 - 2^2)$ ✓
$v_f = 29{,}76\ m \cdot s^{-1}$ ✓

(3)

3.1.2

POSITIVE MARKING FROM 3.1 **POSITIEWE NASIEN VANAF 3.1** **OPTION 1/*OPSIE 1*** **Upwards positive/*Opwaarts positief*:** The balls hit the water at the same instant./*Die balle tref die water gelyktydig* $v_f = v_i + a\Delta t$ ✓ Ball/*Bal* **A** $-29{,}76 = -2+(-9{,}8)\ \Delta t$ $\Delta t = 2{,}83\ s$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ✓	**POSITIVE MARKING FROM 3.1** **POSITIEWE NASIEN VANAF 3.1** **OPTION1/*OPSIE 1*** **Downwards positive/*Afwaarts positief*** The balls hit the water at the same instant./*Die balle tref die water gelyktydig* $v_f = v_i + a\Delta t$ ✓ Ball/*Bal* **A** $29{,}76 = 2 + (9{,}8)\ \Delta t$ $\Delta t = 2{,}83\ s$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ✓

OPTION 2 **Upwards positive/*Opwaarts positief*:** Ball/*Bal* A $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-45 = -2\Delta t + \frac{1}{2}(-9{,}8)\Delta t^2$ $-4{,}9\ \Delta t^2 - 2\Delta t + 45 = 0$ $4{,}9\ \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2{,}83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ✓	**Downwards positive/*Afwaarts positief:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $45 = 2\Delta t + \frac{1}{2}(9{,}8)\Delta t^2$ $4{,}9\ \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2{,}83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ✓

OPTION 3	
Downwards positive/*Afwaarts positief:* Ball/*Bal* A $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $45 = \frac{2 + 29{,}76}{2}\ \Delta t$ $\Delta t = 2{,}83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83$ s ✓	**Upwards positive/*Opwaarts positief*:** Ball/*Bal* A $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-45 = \frac{-2 - 29{,}76}{2}\ \Delta t$ $\Delta t = 2{,}83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83$ s ✓

(3)

3.1.3

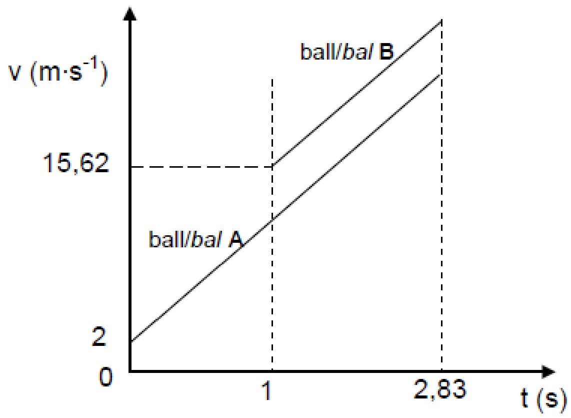
POSITIVE MARKING FROM 3.2/*POSITIEWE NASIEN VANAF 3.2*	
Upwards positive/*Opwaarts positief*: $\Delta t_B = 1.83$s ✓ $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ -45 ✓ $= v_i\,(1{,}83) + ½\,(-9.8)(1{,}83)^2$ ✓ $v_i = -15{,}62$ m·s^{-1} ✓	**Downwards positive/*Afwaarts positief:*** $\Delta t_B = 1.83$s ✓ $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ 45 ✓ $= v_i\,(1{,}83) + ½\,(9.8)(1{,}83)^2$ ✓ $v_i = 15{,}62$ m·s^{-1} ✓

(5)

3.2

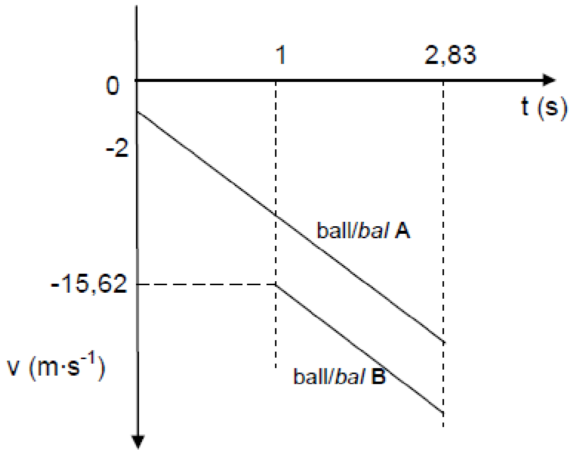
POSITIVE MARKING FROM 3.1.2; 3.1.3/*POSITIEWE NASIEN VANAF 3.1.2; 3.1.3*

CONSIDER MOTION DOWNWARD AS POSITIVE/*BESKOU BEWEGING AFWAARTS AS POSITIEF*



CRITERIA FOR MARKING/*KRITERIA VIR NASIEN*	
1 mark for each initial velocity shown/*1 punt vir elke beginsnelheid aangedui* (For/*Vir* A 2 m·s^{-1} for/*vir* B 15,62 m·s^{-1})	✓✓
Time of release of ball/*Tyd van vrystelling van bal* **B** t= 1s	✓
Time of flight for both balls must be indicated as same on time axis/*Vlugtyd van beide balle moet op dieselfde tydas aangetoon word* (2,83 s)	✓
Shape: Lines must be parallel or nearly so/*Vorm: Lyne moet parallel of amper parallel wees*	✓

CONSIDER MOTION UPWARD AS POSITIVE/*BESKOU OPWAARTSE BEWEGING AS POSITIEF*



CRITERIA FOR MARKING/*KRITERIA VIR NASIEN*	
1 mark for each initial velocity shown/*1 punt vir elke beginsnelheid aangedui* (For/*Vir* A -2 $m \cdot s^{-1}$ for/*vir* B -15,62 $m \cdot s^{-1}$)	✓✓
Time of release of ball/*Tyd van vrystelling van bal* **B** t= 1s	✓
Time of flight for both balls must be indicated as same on time axis/*Vlugtyd van beide balle moet op dieselfde tydas aangetoon word* (2,83 s)	✓
Shape: Lines must be parallel or nearly so/*Vorm: Lyne moet parallel of amper parallel wees*	✓

(5)
[16]

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum in a closed system✓ remains constant./is conserved ✓/*Die totale lineêre momentum in 'n geslote stelsel✓ bly konstant/bly behoue.* ✓

OR/*OF*

In a closed/isolated system, the total momentum before a collision is equal to the total momentum after the collision./*In 'n geslote/geïsoleerde stelsel is die totale momentum voor 'n botsing gelyk aan die totale momentum na die botsing.* (2)

4.2

4.2.1 $\sum p_i = \sum p_f$✓

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$

0✓ = $(0,4)v_{1f} + 0,6\,(4)$✓

$v_{1f} = -6\ m\cdot s^{-1}$

$= 6\ m\cdot s^{-1}$ to the left/*na links*✓

NOTE: Mark for final answer to be forfeited if direction is not given/ ***LET WEL:*** *Punt vir finale antwoord word verbeur indien rigting nie gegee word nie.*

(4)

4.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\Delta p = F_{net}\Delta t$✓ $[(0,6)(4) - 0]$✓ = $F_{net}\ (0,3)$✓ $F_{net} = 8\ N$✓ **OR/*OF*** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,6(4 - 0)$✓= $F_{net}(0,3)$✓ $F_{net} = 8\ N$✓	$v_f = v_i + a\Delta t$ $4 = 0 + a(0,3)$ $a = 13,33\ m\cdot s^{-2}$ $F_{net} = ma$ $= 0,6(13,33)$ $F_{net} = 8\ N$✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$\Delta p = F_{net}\Delta t$✓ $[(0,4)(6) - 0]$✓ = $F_{net}\ (0,3)$✓ $F_{net} = 8\ N$✓ **OR/*OF*** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,4(6 - 0)$✓= $F_{net}(0,3)$✓ $F_{net} = 8\ N$✓	$v_f = v_i + a\Delta t$ $6 = 0 + a(0,3)$ $a = 20\ m\cdot s^{-2}$ $F_{net} = ma$ $= 0,4(20)$ $F_{net} = 8\ N$✓

(4)

4.3 No/*Nee*✓ (1)

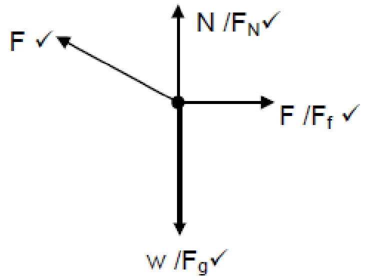
[11]

QUESTION 5/*VRAAG 5*

5.1 It is a ratio of two forces ✓ (hence units cancel out)./*Dit is 'n verhouding van twee kragte ✓ (dus word eenhede uitgekanseleer)* (1)

5.2 The net work done on an object is equal ✓to the change in kinetic energy of the object✓/*Die netto arbeid wat op 'n voorwerp verrig word, is gelyk ✓ aan die verandering in kinetiese energie van die voorwerp*✓ (2)

5.3



(4)

5.4 $F\sin 20^{\circ} + N = mg$✓
$N = mg - F\sin 20^{\circ}$

$W_{fk} = fk\Delta x \cos\theta = \mu_k N\Delta x \cos\theta$✓
$= \mu_k(mg - F\sin 20)(3)\cos\theta$
$= \underline{(0{,}2)[200(9{,}8) - F\sin 20](3)\cos 180^{\circ}}$✓
$= (-1176 + 0{,}205\ F)\ J$✓ (4)

5.5 $W_{tot} = [W_g] + W_f + W_F$ ✓
0 ✓ $= \underline{[0]} + \underline{[(-1176 + 0{,}205\ F)]} + \underline{[F\ (\cos 20)\ (3)\ (\cos 0)]}$✓
$F = 388{,}88\ N$✓
NOTE: Do not penalise if value of W_g is not indicated/
LET WEL: *Moenie penaliseer indien die waarde van* W_g *nie aangedui word nie.* (4)
[15]

QUESTION 6/*VRAAG 6*

6.1 $v = f\lambda$ ✓
$= (222 \times 10^3)(1,5 \times 10^{-3})$✓
$= 333\ m.s^{-1}$ ✓ (3)

6.2
6.2.1 Towards the bat/*Na die vlermuis toe* ✓ (1)

6.2.2 **POSITIVE MARKING FROM QUESTION 6.1/*POSITIEWE NASIEN VANAF VRAAG 6.1***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$\overset{✓}{230,3} = \frac{333\ ✓}{333 - v_s ✓}(222)$✓

$76689,9 - 230,3\ v_s = 73\ 926$
$v = 12\ m.s^{-1}$ ✓ (towards bat/*na die vlermuis toe*)

Notes/*Notas*: • Any other Doppler formula, e.g./*Enige ander Doppler-formule, bv.*: $f_L = \frac{v - v_L}{v - v_s}$ - Max./*Maks.* $\frac{3}{4}$ • Marking rule 1.5: No penalisation if zero substitutions are omitted./*Nasienreël 1.5: Geen penalisering indien nulvervangings uitgelaat is nie.*

(6)
[10]

QUESTION 7/*VRAAG 7*

7.1 The magnitude of the charges are equal✓/ The balls repel each other with the same/identical force or force of equal magnitude✓/*Die grootte van die ladings is gelyk*✓/*Die balle stoot mekaar af met dieselfde/identiese kragte of krag van dieselfde grootte.* ✓ (1)

7.2 The electrostatic force of attraction 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 aantrekkingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings*✓ *en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.*✓ (2)

7.3
7.3.1 $T\cos 20° = w$✓
$= mg$
$= (0,1)(9,8)$✓ $= 0,98\ N$
$\therefore T = 1,04\ N$✓ (3)

7.3.2 **POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3***

$F_{electrostatic/elektrostaties} = T\sin 20^\circ$ ✓

$\frac{kQ_1Q_2}{r^2}$ ✓ $= (1{,}04)\sin 20^\circ$

$\frac{kQ_1Q_2}{r^2} = 0{,}356$

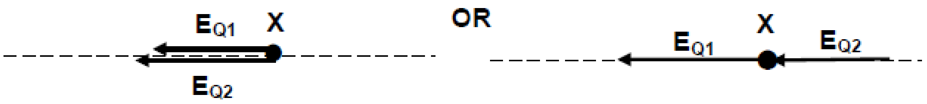
$\frac{(9\times10^9)(250\times10^{-9})(250\times10^{-9})}{r^2}$ ✓ $= 0{,}356$ ✓

$\therefore r = 0{,}0397$ m ✓ (5)

[11]

QUESTION 8/*VRAAG 8*

8.1



Vectors E_{Q1} and E_{Q2} in the same direction✓✓/*Vektore E_{Q1} en E_{Q2} in dieselfde rigting*✓✓

Correct drawing of vectors E_{Q1} and E_{Q2}✓✓/*Korrekte tekening van vektore E_{Q1} en E_{Q2}*✓✓/

The fields due to the two charges add up because they come from the same direction. Hence the field cannot be zero./*Die velde as gevolg van die twee ladings word bymekaar getel omdat hulle uit dieselfde rigting inwerk. Die veld kan dus nie nul wees nie.* (4)

8.2 $E = k\frac{Q}{r^2}$ ✓

$E_{-2,5\mu C} = k\frac{Q}{r^2} = \frac{(9\times10^9)(2{,}5\times10^{-6})}{(0{,}3)^2}$ ✓ $= 250\ 000$ N.C^{-1} to the left/*na links*

$E_{6\ \mu C} = k\frac{Q}{r^2} = \frac{(9\times10^9)(6\times10^{-6})}{(1{,}3)^2}$ ✓ $= 31\ 952{,}66$ N.C^{-1} to the left/*na links*

$E_P = E_{6\mu C} + E_{-2,5\mu C}$ ✓

$= 31\ 952{,}66 + 250\ 000$

$= 281\ 952{,}66$ N.C^{-1} ✓to the left/*na links* ✓ (6)

[10]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 $V = IR$✓
$= (0,2)(\underline{4+8})$✓
$= 2,4\ V$✓ (3)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1/*POSITIEWE NASIEN VANAF VRAAG 9.1.1***

$V = IR$ $2,4 = I_2(2)$ ✓ $I_{2\Omega} = 1,2\ A$✓ $I_T = I_2 + 0,2\ A$✓ $= 1,4\ A$✓	OR $I_2 = 6 \times 0,2$ ✓ $I_2 = 1,2\ A$✓ $I_T = I_2 + 0,2$ ✓ $= 1,4\ A$✓

(4)

9.1.3 **POSITIVE MARKING FROM QUESTION 9.1.2/*POSITIEWE NASIEN VANAF VRAAG 9.1.2***

OPTION 2/*OPSIE* 2 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{R_p} = \frac{1}{12} + \frac{1}{2}$ $R_P = 1,72\ \Omega$✓ $\varepsilon = I(R+r)$ ✓ $= 1,4(1,72+ 0,5)$ ✓ $= 3,11\ V$✓	**OR/*OF*** $R_P = \frac{R_1R_2}{R_1 + R_2}$ ✓ $R_P = \frac{(12)(2)}{12+2}$ $= 1,71\ \Omega$✓ $\varepsilon = I(R+r)$ ✓ $= 1,4(1,71+0,5)$ ✓ $= 3,09\ V$✓

OPTION 2/*OPSIE* 2 $V_{int} = Ir$✓ $=(1,4)(0,5)$ $= 0,7\ V$✓ $\varepsilon = V_{ext/eks} + V_{int}$✓ $= 2,4 + 0,7$✓ $= 3,1\ V$✓

(5)

9.2 Removing the 2 Ω resistor increases the total resistance of the circuit. ✓ Thus the <u>total current decreases, decreasing the V_{int} (V_{lost}).</u> ✓ Therefore the voltmeter reading increases. V✓/*Wanneer die 2 Ω-resistor verwyder word, verhoog dit die totale weerstand van die kring.* ✓ *Dus <u>verklein die totale stroom, wat die V_{int} ($V_{verloor}$) verlaag.</u>* ✓ *Dus verhoog die voltmeterlesing V.* ✓ (3)

[15]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 North pole/*Noordpool*✓ (1)

10.1.2 Q to P✓ (1)

10.2

10.2.1

OPTION 1/*OPSIE 1*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{8}{\sqrt{2}}$ ✓

= 5,66 A

$V_{rms} = I_{rms} R$✓

220 = (5,66)R✓

R = 38,87 Ω✓

(5)

OPTION 2/*OPSIE 2*

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$220 = \frac{V_{max}}{\sqrt{2}}$ ✓

V_{max} = 311,12 V

$V_{max} = I_{max} R$✓

311,12 = (8)R✓

R = 38,89 Ω✓

10.2.2

POSITIVE MARKING FROM QUESTION 10.4.1/*POSITIEWE NASIEN VANAF VRAAG 10.4.1*

OPTION 1/*OPSIE 1*

$P_{average} = V_{rms} I_{rms}$✓

= (220)(5,66)✓

= 1 245,2 W

$P = \frac{W}{\Delta t}$ ✓

$1245,2 = \frac{W}{7200}$ ✓

W = 8 965 440 J ✓

$P_{average} = I_{rms}^2 R$

= $(5,66)^2(38,89)$

= 1245,86

E = Pt

= (1245,86)(7200)

= 8970192J

(5)

OPTION 2/*OPSIE 2*

$P_{average} = I^2_{rms}R$ ✓

$= (5,66)^2(38,87)$ ✓

$= 1\ 245,22$ W ✓

$1245,22 = \frac{W}{7200}$ ✓

W = 8 965 584 J ✓

OPTION 3/*OPSIE 3*

$P_{average} = \frac{V^2_{rms}}{R}$ ✓

$P_{average} = \frac{220^2}{38,87}$ ✓

= 1245,18 W

$P = \frac{W}{\Delta t}$ ✓

✓

$1245,18 = \frac{W}{7200}$ ✓

W = 8 965 296 J ✓

$P_{average} = \frac{V^2_{rms}}{R}$

$P_{average} = \frac{220^2}{38,89}$

= 1244,54 W

E = Pt

= (1244,54)(7200)

= 8960688 J

OPTION 3/*OPSIE 3*

$W = I^2_{rms}R\Delta t$

$= \left(\frac{I_{max}}{\sqrt{2}}\right)^2 R\Delta t$

$= \left(\frac{8}{\sqrt{2}}\right)^2 (38,87)(7200)$

W = 8 965 296 J ✓ (5)

[12]

QUESTION 11/*VRAAG 11*

11.1 It is the minimum energy that an electron in the metal needs to be emitted from the metal surface. ✓/*Dit is die minimum energie wat 'n elektron in die metaal benodig om elektrone uit die metaaloppervlak vry te stel.* ✓ (2)

11.2 Frequency/Intensity ✓/*Frekwensie/Intensiteit* (1)

11.3 The minimum frequency required to remove an electron from the surface of the metal✓/*Die minimum frekwensie benodig om 'n elektron vanaf die oppervlak van die metaal te verwyder*✓ (2)

11.4 **POSITIVE MARKING FROM QUESTION 11.4/**
POSITIEWE NASIEN VANAF VRAAG 11.4

$\left.\begin{array}{l} E = W_0 + E_k \\ hf = hf_0 + E_k \end{array}\right\}$ ✓ Any one/*Enige een*

$(6{,}63 \times 10^{-34})(6{,}50 \times 10^{14})$✓$=(6{,}63 \times 10^{-34})(5{,}001 \times 10^{14})$ ✓$+ \frac{1}{2}(9{,}11 \times 10^{-31})v^2$✓

$\therefore$ $v = 4{,}67 \times 10^5\ m \cdot s^{-1}$✓

<u>OR/*OF*</u>

$\left.\begin{array}{l} E_K = E_{light} - W_o \\ \quad = hf_{light} - hf_o \end{array}\right\}$ ✓ Any one/*Enige een*

$= (6{,}63 \times 10^{-34})(6{,}50 \times 10^{14} - 5{,}001 \times 10^{14})$ ✓

$= 9{,}94 \times 10^{-20}\ J$

$E_K = \frac{1}{2} mv^2$ ✓

$v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{(2)(9{,}94 \times 10^{-20})}{9{,}11 \times 10^{-31}}}$✓

$v = 4{,}67 \times 10^5\ m \cdot s^{-1}$ ✓ (5)

11.5 The <u>photocurrent is directly proportional to the intensity of the incident light.</u>✓✓/*Die <u>fotostroom is direk eweredig aan die intensiteit van die invallende lig.</u>* ✓✓ (2)
[12]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2016

MEMORANDUM

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]

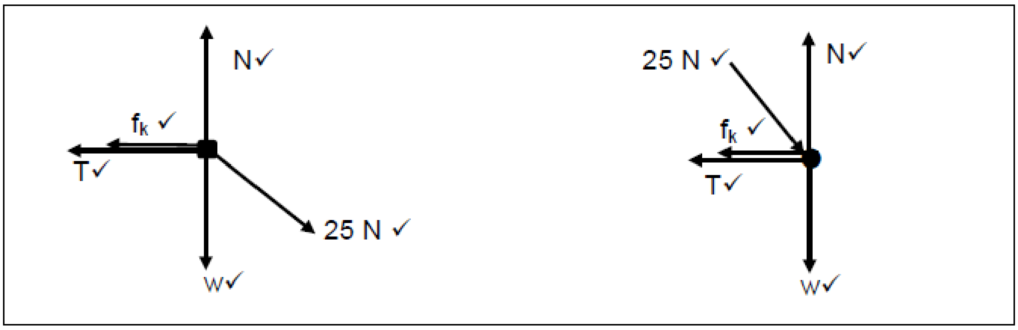
QUESTION 2/*VRAAG 2*

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
$f_k = \mu_k N$✓$= \mu_k mg$
$= \underline{(0,15)(3)(9,8)}$✓
$= 4,41$ 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 *F_g/F_w/krag van Aarde op blok/gewig/14,7 N/mg/gravitasiekrag*
N	F_N/F_{normal}/normal force F_N/$F_{normaal}$/normalekrag
T	Tension/F_T *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 $F_{toegepas}$/F_A/F

2.4.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$f_k = \mu_k N = \mu_k(25\sin 30^\circ + mg)$ $= 0{,}15[(25\sin30^\circ)✓ + (1{,}5)(9{,}8)✓]$ $= 4{,}08$ N✓	$f_k = \mu_k N = \mu_k(25\cos 60^\circ + mg)$ $= 0{,}15[(25\cos60^\circ)✓ + (1{,}5)(9{,}8)✓]$ $= 4{,}08$ 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*

$$\left.\begin{array}{l} F_{net} = ma \\ F_x + (-T) + (-f_k) = ma \end{array}\right\} ✓$$

$25\cos 30^\circ - T - f_k = 1{,}5a$
$\underline{(25\cos 30^\circ - T) - 4{,}08}$ ✓ $= 1{,}5a$
$17{,}571 - T = 1{,}5a$ ....(1)

✓either one
enigeen

For the 3 kg block
Vir die 3 kg blok
$T - f_k = 3a$
$\underline{T - 4{,}41}$✓ $= 3a$ ....(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* $F_{net} = ma$ $F_x + (-T) + (-f_k) = ma$ ✓ $25 \cos 30^\circ - T - f_k = 1{,}5a$ $(25 \cos 30^\circ - T) - 4{,}08$ ✓ $= 1{,}5a$ $17{,}571 - T = 1{,}5a$ ....(1) ✓either one *enigeen* For the 3 kg block *Vir die 3 kg blok* $T - f_k = 3a$ $T - 4{,}41$ ✓ $= 3a$ ....(2) $35{,}142 - 2T = T - 4{,}41$ $T = 13{,}18$ N ✓	For the 1,5 kg block/*Vir die 1,5 kg blok* $F_{net} = ma$ $F_x + (-T) + (-f_k) = ma$ ✓ $25 \cos 30^\circ - T - f_k = 1{,}5a$ $(25 \cos 30^\circ - T) - 4{,}08$ ✓ $= 1{,}5a$ $17{,}571 - T = 1{,}5a$ ....(1) $a = \frac{17{,}571 - T}{1{,}5}$ ✓either one *enigeen* For the 3 kg block *Vir die 3 kg blok* $T - f_k = 3a$ $T - 4{,}41$ ✓ $= 3a$ ....(2) $a = \frac{T - 4{,}41}{3}$ $\frac{17{,}571 - T}{1{,}5} = \frac{T - 4{,}41}{3}$ $T = 13{,}18$ 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:* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + (2)(-9{,}8)$ ✓ (-20) ✓ $v_f = 19{,}80$ m·s^{-1} ✓ **Downwards positive** ***Afwaarts positief*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + (2)(9{,}8)$ ✓ (20) ✓ $v_f = 19{,}80$ m·s^{-1} ✓	**Upwards positive/*Opwaarts positief:*** $\Delta y = v_i\Delta t + ½ a\Delta t^2$ $-20 = 0 + ½ (-9{,}8) \Delta t^2$ ✓ ✓either one *enigeen* $\Delta t = 2{,}02$ s $v_f = v_i + a\Delta t$ $= 0 + (-9{,}8)(2{,}02)$ ✓ $= -19{,}80$ m·s^{-1} $= 19{,}80$ m·s^{-1} ✓ **Downwards positive** ***Afwaarts positief*** $\Delta y = v_i\Delta t + ½ a\Delta t^2$ $20 = 0 + ½ (9{,}8) \Delta t^2$ ✓ ✓either one *enigeen* $\Delta t = 2{,}02$ s $v_f = v_i + a\Delta t$ $= 0 + (9{,}8)(2{,}02)$ ✓ $= 19{,}80$ m·s^{-1} ✓

OPTION 3/*OPSIE 3*

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$
$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$
$(mgh + \frac{1}{2} mv^2)_{Top/Bo} = (mgh + \frac{1}{2} mv^2)_{Bottom/Onder}$
$(9,8)(20) + 0$ ✓ $= (0 + \frac{1}{2}v_f^2)$ ✓
$v_f = 19,80 \text{ m·s}^{-1}$ ✓

✓ 1 mark for any
1 punt vir enige

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$0 = mg\Delta h + \frac{1}{2} m\Delta v^2$
0 ✓ $= m(9,8)(0 - 20) + \frac{1}{2} m(v_f^2 - 0)$ ✓
$v_f = 19,80 \text{ m·s}^{-1}$ ✓

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$ ✓
$mg\Delta x\cos 0^\circ = \frac{1}{2} m(v_f^2 - 0)$
$m(9,8)(20)(1)$ ✓ $= \frac{1}{2} mv_f^2$ ✓
$v_f = 19,80 \text{ m·s}^{-1}$ ✓ (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*
$v_f = v_i + a\Delta t$ ✓
$19,80 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 2,02 \text{ s}$ ✓

Upwards positive/*Opwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$-19,80 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 2,02 \text{ s}$ ✓

OPTION 2/*OPSIE 2*

Upwards positive/*Opwaarts positief:*
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$-20 = 0 + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 2,02 \text{ s}$ ✓

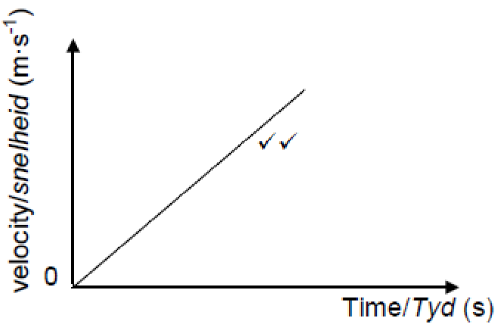
Downwards Positive/*Afwaarts positief*
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$20 = 0 + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 2,02 \text{ s}$ ✓

OPTION 3/*OPSIE 3*

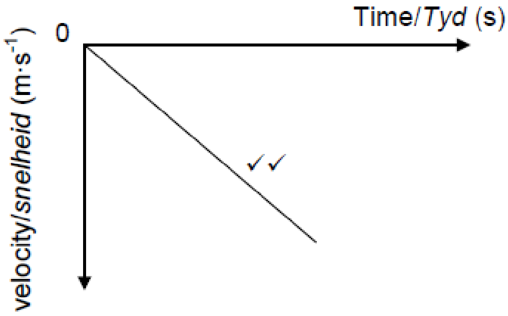
Downwards positive/*Afwaarts positief:*
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$$
$$20 = \left(\frac{0 + 19,80}{2}\right)(\Delta t) \checkmark$$
$\Delta t = 2,02 \text{ s}$ ✓

Upwards positive/*Opwaarts positief:*
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$$
$$-20 = \left(\frac{0 - 19,80}{2}\right)(\Delta t) \checkmark$$
$\Delta t = 2,02 \text{ s}$ ✓ (3)

3.3 **Downward positive/*Afwaarts positief***



Upward positive/*Opwaarts positief*



Notes/*Aantekeninge*

✓✓	Straight line through the origin. *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*
$\left.\begin{array}{l}\sum p_i = \sum p_f \\ m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}\end{array}\right\}$ ✓ 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*
$\left.\begin{array}{l}\Delta p_A = -\Delta p_B \\ p_f - p_i = -(mv_f - mv_i)\end{array}\right\}$ 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*

Slope/*Helling* $= \frac{\Delta p}{\Delta t} = F_{net}$✓

$= \frac{(14\ 000 - 30\ 000)}{(20{,}2 - 20{,}1)}$ ✓ ✓

$= -160\ 000$

$F_{net} = 160\ 000\ N$ ✓

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 $E_k/K = \frac{1}{2}mv^2$ ✓

$= \frac{1}{2}(2)(4{,}95)^2$ ✓

$= 24{,}50\ J$ ✓ (3)

5.1.2

POSITIVE MARKING FROM QUESTION 5.1.1/*POSITIEWE NASIEN VANAF 5.1.1*

OPTION 1/*OPSIE 1*

$E_{mech\ before} = E_{mech\ after}$

$[(E_{mech})_{bob} + (E_{mech})_{block}]_{before/voor} = [(E_{mech})_{Block} + (E_{mech})_{bob}]_{after/na}$

$(mgh + \frac{1}{2}mv^2)_{before/voor} = (mgh + \frac{1}{2}mv^2)_{after/na}$

Any one/ *Enige een*✓

$(5)(9{,}8)h + 0 + 0$ ✓ $= 5(9{,}8)\frac{1}{4}h + 0 + 24{,}50$ ✓

$h = 0{,}67\ m$✓

OPTION 2/*OPSIE 2* $W_{nc} = \Delta E_p + \Delta E_k$ $0 = \Delta E_p + \Delta E_k$ $-\Delta E_p = \Delta E_k$ Any one/ *Enige een*✓ $-[(5)(9{,}8)(\frac{1}{4}h) - (5)(9{,}8)h]$✓ $= 24{,}50$✓ $h = 0{,}67\ m$ ✓	**OPTION 3/*OPSIE 3*** Loss Ep bob = Gain in Ek of block ✓ $mg(\frac{3}{4}h) = 24{,}5$ $(5)(9{,}8)(\frac{3}{4}h)$✓ $= 24{,}5$ ✓ $h = 0{,}67\ m$ ✓

(4)

OPTION 4 /*OPSIE 4*

Before/*Voor*

$(mgh + \frac{1}{2}mv^2)_{top/bo} = (mgh + \frac{1}{2}mv^2)_{bottom/onder}$

$(5)(9{,}8)h + 0 = (5)(9{,}8)h_o + \frac{1}{2}(5)v^2$

$v_i^2 = 19{,}6h - 19{,}6h_o$

After/*Na*

$(mgh + \frac{1}{2}mv^2)_{bottom/onder} = (mgh + \frac{1}{2}mv^2)_{top/bo}$

$(5)(9{,}8)h_o + \frac{1}{2}(5)v_f^2 = (5)(9{,}8)(\frac{1}{4}h) + 0$

$v_f^2 = 4{,}9h - 19{,}6h_o$

$E_{mech/meg}$ before collision/*voor botsing* $= E_{mech/meg}$ after collision/*na botsing*✓

$\frac{1}{2}mv_i^2$(bob/skietlood) + 0 = $\frac{1}{2}mv_f^2$(bob/skietlood)+ $\frac{1}{2}mv^2$(block/blok)

$\frac{1}{2}(5)(19{,}6h - 19{,}6h_o)$ ✓ $= \frac{1}{2}(5)(4{,}9h - 19{,}6h_o) + 24{,}5$ ✓

$h = 0{,}67\ m$✓

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* $W_{net} = \Delta E_K$ ✓ $W_f + mg\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$ $W_f + (2)(9,8)(0,5)\cos 180^\circ$ ✓ $= ½(2)(2^2 - 4,95^2)$ ✓ $W_f = -10,7$ J ✓
OPTION 2/*OPSIE 2* $\left.\begin{array}{l} W_{nc} = \Delta E_K + \Delta U \\ W_{nc} = \Delta E_K + \Delta E_P \end{array}\right\}$ ✓ $W_f = ½(2)(2^2 - 4,95^2)$ ✓ $+ (2)(9,8)(0,5-0)$ ✓ $= -10,7$ 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
$F \propto \frac{1}{r^2}$ ✓

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* = $\dfrac{\Delta F_E}{\Delta \frac{1}{r^2}}$ ✓ = $\dfrac{(0,027 - 0)}{(5,6 - 0)}$ ✓

= 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} ✓ = $\underline{9 \times 10^9}$ $\underline{Q^2}$ ✓

∴ 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*

$F = \dfrac{kQ_1Q_2}{r^2}$ ✓

$(\quad)$ ✓ = $\dfrac{(9 \times 10^9)Q^2}{(\quad)}$ ✓ ✓✓

Q = 7,32 x 10^{-7}C ✓ (7,32 x 10^{-7} – 7,45 x 10^{-7} C)

Examples/*Voorbeelde*

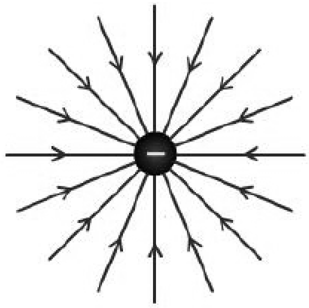
(0,005) ✓ = $\dfrac{(9 \times 10^9)Q^2}{(1)}$ ✓ ✓✓

Q = 7,45 x 10^{-7} C ✓

(0,027) ✓ = $\dfrac{(9 \times 10^9)Q^2}{\left(\frac{1}{5,6}\right)}$ ✓ ✓✓

Q = 7,32 x 10^{-7} C ✓ (6)

7.2.1



Criteria for drawing electric field: *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*

$E_{PA} = \frac{(9 \times 10^9)(0,75 \times 10^{-6})}{(0,09)^2}$ ✓

$= 8,33 \times 10^5\ N{\cdot}C^{-1}$ to the left/*na links*

$E_{PB} = \frac{(9 \times 10^9)(0,8 \times 10^{-6})}{(0,03)^2}$ ✓

$= 8 \times 10^6\ N{\cdot}C^{-1}$ 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*

$E_{PA} = \frac{(9 \times 10^9)(0,75 \times 10^{-6})}{(0,09)^2}$ ✓

$= 8,33 \times 10^5\ N{\cdot}C^{-1}$ to the left/*na links*

$E_{PB} = \frac{(9 \times 10^9)(0,8 \times 10^{-6})}{(0,03)^2}$ ✓

$= 8 \times 10^6\ N{\cdot}C^{-1}$ 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 $\left.\begin{array}{l}\varepsilon = I(R + r)\\ \varepsilon = V_{ext} + V_{int}\end{array}\right\}$ ✓

$12 = 11,7 + Ir$

$\underline{0,3 = I_{tot}(0,2)}$ ✓

$I_{tot} = 1,5$ A ✓

OR/*OF*

$V = IR$ ✓ (Accept/Aanvaar: $V_{\text{"lost"}} = Ir$)

$\underline{0,3 = I_{tot}(0,2)}$ ✓

$I_{tot} = 1,5$ A✓ (3)

8.1.5

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\left.\begin{array}{l}\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}\\ \frac{1}{R} = \frac{1}{10} + \frac{1}{15}\end{array}\right\}$ ✓Any one *Enigeen* $R = 6\ \Omega$ ✓	$\left.\begin{array}{l}R_{\parallel} = \frac{R_1R_2}{R_1 + R_2}\\ = \frac{(10)(15)}{10+15}\end{array}\right\}$ ✓Any one *Enigeen* $= 6\ \Omega$ ✓

(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*

	OR/*OF*
$V = IR$ ✓ $11,7$✓ $= \underline{1,5(6 + R)}$ ✓ $R = 1,8\ \Omega$ ✓	$V = IR$ ✓ $\underline{11,7 = 1,5R}$ ✓ $R = 7,8\ \Omega$ ↓ $R_R = 7,8 - 6$ ✓ $= 1,8\ \Omega$ ✓

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*

$P = VI$

$1,37 = (3)I$ ✓

$I = 0,46\ A$

✓Any one
Enigeen

$\varepsilon = I(R + r)$

$12 = (0,46)(R + 0,2)$ ✓

$R = 25,87\ \Omega$

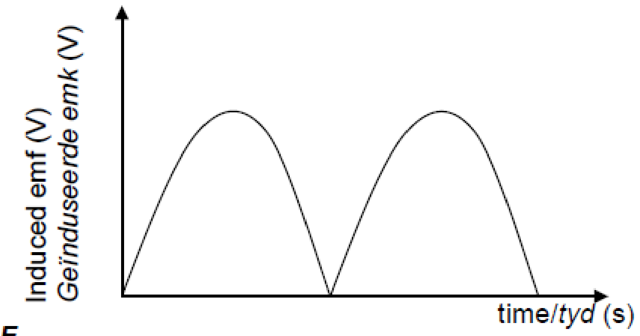
$V = IR$ $3 = (0,46)R$✓ $R = 6,52\ \Omega$ $R_T = 25,87 - 6,52$ $= 19,35\ \Omega$ ✓	$P = I^2R$ $1,37 = (0,46)^2R$✓ $R = 6,47\ \Omega$ $R_T = 25,87 - 6,47$ $= 19,4\ \Omega$ ✓	$P_{motor} = \frac{V^2}{R}$ $1,37 = \frac{3^2}{R}$ ✓ $R = 6,56\ \Omega$ $R_T = 25,87 - 6,56$ $= 19,31\ \Omega$ ✓

(5)
[21]

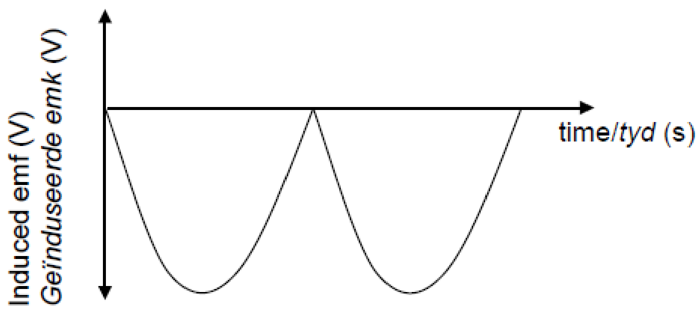
QUESTION 9/*VRAAG 9*

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***
$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$	$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}} = \frac{340}{\sqrt{2}} = 240{,}416$
$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓	$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓
$800 = \frac{340}{\sqrt{2}}(I_{rms/wgk})$ ✓	$800 = I_{rms/wgk}(240{,}416)$ ✓
$I_{rms/wgk} = 3{,}33$ A ✓	$I_{rms/wgk} = 3{,}33$ 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*

$P_{ave/gemid} = V_{rms/wgk}\, I_{rms/wgk}$ ✓ $= \dfrac{V_{max/maks} I_{max/maks}}{2}$

$2\,800$✓ $= \dfrac{(340)\, I_{max/maks}}{2}$ ✓

$I_{max/maks} = 16{,}47$ A

$I_{rms} = \dfrac{I_{max/maks}}{\sqrt{2}} = \dfrac{16{,}47}{\sqrt{2}}$

$I_{rms/wgk} = 11{,}65$ A✓

OPTION 4/*OPSIE 4*

$P_{ave/gemid} = V_{rms/wgk}\, I_{rms/wgk}$✓

$2\,800$ ✓$= \dfrac{340}{\sqrt{2}}\, I_{rms/wgk}$✓

$I_{rms/wgk} = 11{,}65$ 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*✓
$W_o \propto f_o$ / $W_o = hf_o$ ✓
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* = $(\frac{5}{100})(60 \times 10^{-3})$ ✓ = 3×10^{-3} J·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

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2016

MEMORANDUM

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]**

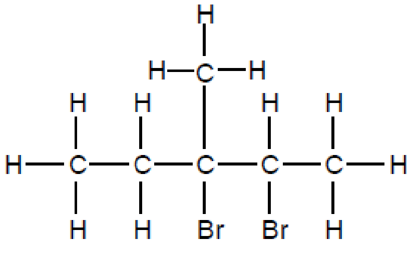
QUESTION 2/*VRAAG 2*

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)

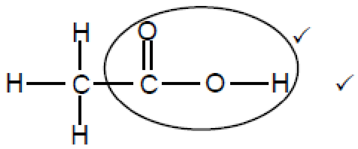
2.2

2.2.1



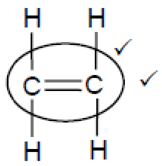
Marking criteria/*Nasienriglyne:*
- Five C atoms in longest chain. ✓
  Vyf C-atome in langste ketting.
- Two Br and one methyl substituents. ✓
  Twee Br- en een metielsubstituente.
- Whole structure correct.
  Hele struktuur korrek. ✓

(3)

2.2.2 

Marking criteria/*Nasienriglyne:*
- Whole structure correct:
  Hele struktuur korrek: $\frac{2}{2}$
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: $\frac{1}{2}$
- Accept -OH as condensed.
  Aanvaar -OH as gekondenseerd.

IF/*INDIEN*:
More than one functional group/*Meer as een funksionele groep* $\frac{0}{2}$ (2)

2.2.3 

Marking criteria/*Nasienriglyne:*
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek* Max: $\frac{1}{2}$

IF/*INDIEN*:
More than one functional group/*Meer as een funksionele groep* $\frac{0}{2}$ (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 struktuurformules gebruik:* Max/*Maks.* $\frac{2}{3}$

(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.
Gekondenseerde struktuurformule en struktuurformule.
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*

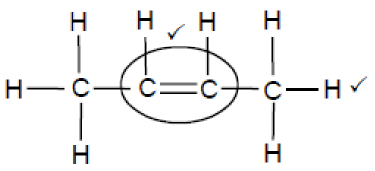
- Butane is an alkane **OR** butane is saturated. ✓
  *Butaan is 'n alkaan **OF** butaan is versadig.*
- Butane can only undergo substitution. ✓
  Butaan kan slegs substitusie ondergaan.
- Butane will only react in the presence of light / heat **OR** butane is less reactive. ✓
  *Butaan sal slegs in 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



<u>Marking criteria/*Nasienriglyne:*</u>
- Whole structure correct/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* $\frac{1}{2}$

IF/*INDIEN*:
More than one functional group/*Meer as een funksionele groep* $\frac{0}{2}$

4.3.4 Hydration / *Hidrasie / Hidratering* ✓ (1)

[13]

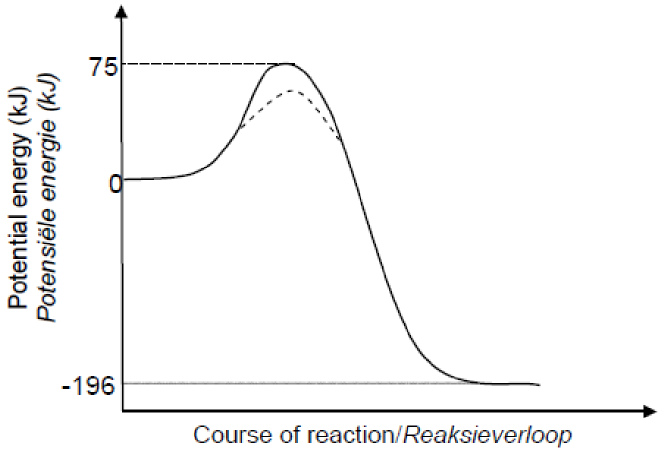
QUESTION 5/*VRAAG 5*

5.1

5.1.1 The <u>minimum</u> <u>energy needed</u> for a <u>reaction</u> to take place. ✓✓
Die <u>minimum</u> <u>energie benodig</u> vir 'n <u>reaksie</u> 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. *Vorme van kurwe vir eksotermiese reaksie soos getoon.*	✓
Energy of activated complex shown as 75 kJ in line with the peak. *Energie van geaktiveerde kompleks aangetoon as 75 kJ in lyn met die piek.*	✓
Energy of products shown as − 196 kJ below the zero. *Energie van produkte getoon as − 196 kJ onderkant die nulpunt.*	✓
IF/*INDIEN*: Wrong shape, e.g. straight line./*Verkeerde vorm bv. reguitlyn.*	$\frac{0}{3}$

(3)

5.1.3 ***<u>Marking criteria/Nasienriglyne</u>***

- 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.

<u>Note/*Aantekening*:</u> 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 <u>lower activation energy</u>. ✓
  'n Katalisator voorsien 'n alternatiewe pad van <u>laer aktiveringsenergie</u>.
- <u>More molecules have sufficient / enough (kinetic) energy</u>. ✓
  <u>Meer molekule het voldoende / genoeg (kinetiese) energie</u>.
  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.
- <u>More effective collisions per unit time / second</u>. ✓
  <u>Meer effektiewe botsings per eenheidstyd / sekonde.</u>
  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* $= \frac{\Delta V}{\Delta t}$

$= \frac{52 - 16 ✓}{40 - 10 ✓}$

$= 1,2\ (dm^3 \cdot s^{-1})$ ✓

<u>Accept/*Aanvaar*</u>: • 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***
$n(O_2) = \frac{V}{V_M}$ $= \frac{60}{24}$ ✓ $= 2,5$ mol $n(H_2O_2) = 2n(O_2)$ $= 2(2,5)$ ✓ $= 5$ mol $n(H_2O_2) = \frac{m}{M}$ $\therefore 5 = \frac{m}{34}$ ✓ $\therefore m = 170$ g ✓	$24\ dm^3$: 1 mol $60\ dm^3$: 2,5 mol ✓ $n(H_2O_2) = 2n(O_2)$ $= 2(2,5)$ ✓ $= 5$ mol 34 g ✓: 1 mol x : 5 mol x = 170 g ✓	$n(O_2) = \frac{V}{V_M}$ $= \frac{60}{24}$ ✓ $= 2,5$ mol $n(O_2) = \frac{m}{M}$ $\therefore 2,5 = \frac{m}{32}$ $\therefore m = 80$ g ✓2(34) g✓ H_2O_2 ....32 g O_2 x g H_2O_2 .... 80 g O_2 $m(H_2O_2) = 170$ 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 <u>rate of forward reaction equals the rate of reverse reaction</u>. ✓✓ **(2 marks or no marks)**

Die stadium in 'n chemiese reaksie wanneer die <u>tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie</u>. ✓✓
(2 punte of geen punte nie)

OR/*OF*
The state where the <u>concentrations / quantities of reactants and products remain constant</u>.
Die toestand wanneer die <u>konsentrasies / hoeveelhede van reaktanse en produkte konstant bly.</u> (2)

6.2
6.2.1 Remains the same / *Bly dieselfde* ✓ (1)

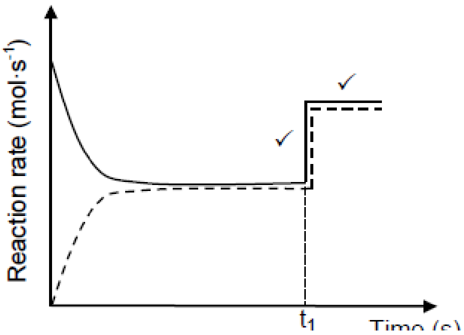
6.2.2 Decreases / *Verlaag* ✓

- 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 voorwaartse 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

<u>Marking criteria/*Nasienriglyne*</u>:
• 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*

$n(PbS) = \frac{m}{M} = \frac{2{,}39}{239\checkmark} = 0{,}01 \text{ mol}$

$n(H_2S)_{equilibrium/by\ ewewig} = n(PbS)$ ✓ $= 0{,}01$ mol

	H_2	H_2S	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,16	0	
Change (mol) *Verandering (mol)*	0,01	0,01 ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,15 ✓	0,01	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,075	0,005	divide by 2 ✓ *deel deur 2*

$$K_c = \frac{[H_2S]}{[H_2]}\checkmark$$
$$= \frac{0{,}005}{0{,}075}\checkmark$$
$$= 0{,}067 \approx 0{,}07\checkmark$$

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.*

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.* $^8/_9$

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) *Aanvangshoeveelheid (mol)*	0,16	0	
Change (mol) *Verandering (mol)*	x	x ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,16 - x ✓	x	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{0,16 - x}{2}$	$\frac{x}{2}$	divide by 2 ✓ *deel deur 2*

$$n(PbS) = \frac{m}{M} = \frac{2,39}{239} ✓ = 0,01 \text{ mol}$$

$n(H_2S)_{equilibrium/\textit{by ewewig}} = n(PbS)$ ✓ $\therefore$ x = 0,01 mol

$$[H_2]_{equilibrium/\textit{by ewewig}} = \frac{0,16 - 0,01}{2} = 0,075 \text{ mol}\cdot\text{dm}^{-3}$$

$$[H_2S]_{equilibrium/\textit{by ewewig}} = \frac{0,01}{2} = 0,005 \text{ mol}\cdot\text{dm}^{-3}$$

$$K_c = \frac{[H_2S]}{[H_2]} ✓$$
$$= \frac{0,005}{0,075} ✓$$
$$= 0,067 \approx 0,07 ✓$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{8}{9}$

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*

$n(PbS) = \frac{m}{M}$

$= \frac{2,39}{239}$

$= 0,01\ mol$

$n(H_2S)_{equilibrium/by\ ewewig} = n(PbS)$ ✓ $= 0,01\ mol$

$[H_2S]_{equilibrium/by\ ewewig} = \frac{n}{V}$

$= \frac{0,01}{2}$

$= 0,005\ mol \cdot dm^{-3}$

$[H_2]_{initial/aanvanklik} = \frac{n}{V}$

$= \frac{0,16}{2}$

$= 0,08\ mol \cdot dm^{-3}$

$[H_2S]_{formed/gevorm} = [H_2S]_{equilibrium/by\ ewewig} - [H_2S]_{initial/aanvanklik}$

$= 0,005 - 0$ ✓

$= 0,005\ mol \cdot dm^{-3}$

$[H_2]_{reacted/gereageer} = [H_2S]_{formed/gevorm}$ ✓ $= 0,005\ mol$

$[H_2]_{equilibrium/ewewig} = [H_2]_{initial/aanvanklik} - [H_2]_{reacted/gereageer}$

$= 0,08 - 0,005$ ✓

$= 0,075\ mol$

$K_c = \frac{[H_2S]}{[H_2]}$

$= \frac{0,005}{0,075}$

$= 0,067 \approx 0,07$

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^8/_9$

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.*

(9)

[18]

QUESTION 7/*VRAAG 7*

7.1

7.1.1 Hydrolysis is the <u>reaction</u> (of a salt) <u>with water</u>. ✓✓
Hidrolise is die <u>reaksie</u> (van 'n sout) <u>met water</u>.
(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*:
$NH_4Cl + H_2O \rightarrow NH_3 + H_3O^+ + Cl^-$

$NH_4^+ \rightarrow NH_3 + H^+$

<u>Note/*Aantekening:*</u>
- Mark equation independently of first answer./*Sien vergelyking onafhanklik van eerste antwoord na.*
- If incorrect balancing/*Indien verkeerde balansering:* Max/*Maks.* $^{2}/_{3}$

<u>Marking criteria for equation/*Nasienriglyne vir vergelyking:*</u>
- Reactants ✓ *Reaktanse* Products ✓ *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 **<u>Marking guidelines/*Nasienriglyne:*</u>**
- Substitution of/*Substitusie van* 98 g·mol^{-1}. ✓
- Final answer/*Finale antwoord:* 0,08 mol ✓

<u>Note/Let wel:</u>
If not rounded/*Indien nie afgerond nie*: (0,075 mol)

<u>OPTION 1/*OPSIE 1*</u>

$n = \frac{m}{M}$

$= \frac{7,35}{98}$

$= 0,08$ mol ✓ (0,075 mol)

<u>OPTION 2/*OPSIE 2*</u>

98 g ✓: 1 mol
7,35 :0,08 mol ✓

<u>OPTION 3/*OPSIE 3*</u>

$c = \frac{m}{MV}$

$= \frac{7,35}{98 \times 0,5}$

$= 0,15$ mol·dm^{-3}

$n = cV$

$= 0,15 \times 0,5$

$= 0,08$ mol ✓

(2)

7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1.**
POSITIEWE NASIEN VAN VRAAG 7.2.1.

OPTION 1/*OPSIE 1*	**Marking guidelines/*Nasienriglyne:***
$pH = -\log[H_3O^+]$ ✓ 1,3 ✓ $= -\log[H_3O^+]$ $[H_3O^+] = 0{,}05\ mol{\cdot}dm^{-3}$ $[H_2SO_4] = ½[H_3O^+]$ = 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)	• 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(H₂SO₄) = 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*
OR/*OF* $n(NaOH) = \frac{m}{M}$ $0{,}125 = \frac{m}{40}$ ✓ m = 5 g ✓ (4,8 g)	1 mol : 40 g ✓ 0,125 mol : 5 g ✓

Q7.2.1

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)

$n(H_3O^+)_{in/aanv} = 2n(H_2SO_4)$
$= 0{,}075 \times 2$ ✓
$= 0{,}15\ mol$ (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)

$n(NaOH) = \frac{m}{M}$

$0{,}125 = \frac{m}{40}$ ✓

$m = 5\ g$ ✓ (5,2 g)

OR/*OF*

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

Q7.2.1

OPTION 3/*OPSIE 3*

$[H_2SO_4]_{in/aanv} = \frac{n}{V}$ ✓

$= \frac{0,075}{0,5}$ ✓

$= 0,15\ mol\cdot dm^{-3}$ (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)

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

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)

OR/*OF*

$[H_2SO_4] : [NaOH]$

1 : 2

0,125 : 0,25 ✓ (0,28)

$m = cMV$

$= 0,25 \times 40$ ✓ $\times 0,5$

$= 5\ g$ ✓ (5,6 g)

(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 ✓ *Reaktanse* Products ✓ *Produkte* Balancing: ✓ *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

<table>
<tr>
<td>

OPTION 1/*OPSIE 1*

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓

$= 0{,}80$ ✓ $- (-0{,}27)$ ✓

$= 1{,}07$ V ✓

</td>
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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:* $\frac{3}{4}$

</td>
</tr>
<tr>
<td colspan="2">

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 ✓

</td>
</tr>
</table>

(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)

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)

10.2

Marking guidelines/*Nasienriglyne:*
- Calculate the mass of fertiliser./*Bereken die massa kunsmis.*
- Add %N and %P OR/*OF* mass N and mass P.
  Tel %N en%P OR/*OF massa N en massa P bymekaar.*
- Subtraction/*Aftrekking*: 100 – (%N + %P)
  OR/*OF* m(fertiliser/*kunsmis*) – [m(N) + m(P)]
  OR/*OF* %fertiliser/*kunsmis* – [%N + %P]
- Final answer/*Finale antwoord:* 8:1:5

OPTION 1/*OPSIE 1*

m(fertiliser/*kunsmis*) = $\frac{36}{100} \times 20$ ✓
= 7,2 kg

$\%N = \frac{4,11}{7,2} \times 100$
= 57,08%

$\%P = \frac{0,51}{7,2} \times 100$
= 7,08%

%K = 100 – ✓ (57,08 + 7,08) ✓
= 35,84%

57,08 : 7,08 : 35,84
8 : 1 : 5 ✓

OPTION 2/*OPSIE 2*

m(fertiliser/*kunsmis*) = $\frac{36}{100} \times 20$ ✓
= 7,2 kg

m(K) = 7,2 – ✓ (4,11 + 0,51) ✓
= 2,58 kg

4,11 : 0,51 : 2,58
8 : 1 : 5 ✓

OPTION 3/*OPSIE 3*

$\left.\begin{array}{l} \%N = \frac{4,11}{20} \times 100 = 20,55\% \\ \%P = \frac{0,51}{20} \times 100 = 2,55\% \end{array}\right\}$ ✓

%K = 36 – ✓ (20,55 + 2,55) ✓ = 12,9%

20,55 : 2,55 : 12,9
8 : 1 : 5 ✓

(4)
[14]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

FEBRUARY/MARCH/*FEBRUARIE/MAART* 2017

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1 D✓✓ (2)

1.2 C✓✓ (2)

1.3 A✓✓ (2)

1.4 D✓✓ (2)

1.5 B✓✓ (2)

1.6 C✓✓ (2)

1.7 B✓✓ (2)

1.8 A✓✓ (2)

1.9 D✓✓ (2)

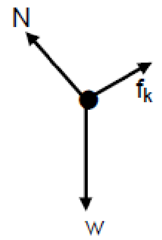
1.10 B✓✓ (2)

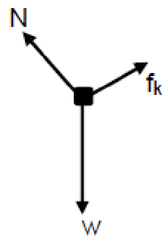
[20]

QUESTION 2/*VRAAG 2*

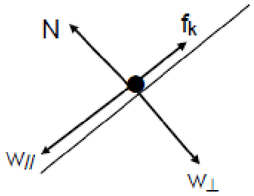
2.1 0 N/zero/*nul*✓ (1)

2.2





ACCEPT/*AANVAAR*



	Accepted labels/*Aanvaarde benoemings*
w	F_g/F_w/weight/mg/gravitational force/N/19,6 N *F_g/F_w/gewig/mg/gravitasiekrag/19,6 N*
f	$F_{friction}/F_f$/friction/f_k *$F_{wrywing}/F_w$/wrywing/f_k*
N	F_N/F_{normal}/normal force *$F_N/F_{normaal}$/normaalkrag*
	Deduct 1 mark for any additional force. *Trek een punt af vir enige addisionel krag*
	Mark is given for both arrow and label *Punt word toegeken vir beide pylpunt en benoeming*

1 mark if BOTH components of weight are shown.
All other rules in the table apply.
1 punt indien BEIDE komponente van die gewig getoon is
Al die ander reels in die tabel geld

(3)

2.3.1 $F_{net} = ma$

$f_k - mg\sin\theta = 0$ ✓ 1 mark for any of these/*1 punt vir enige van hierdie*

$f_k = mg\sin\theta$

$f_k = (2)(9,8)\sin 7^\circ$ ✓

$f_k = 2,39$ N ✓ (2,389) N (3)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.3.1/*POSITIEWE NASIEN VANAF VRAAG 2.3.1***

$f_k = \mu_k N$

$= \mu_k mg\cos 7^\circ$ ✓ 1 mark for any of these/*1 punt vir enige van hierdie*

$2,389 = \mu_k(2)(9,8)\cos 7^\circ$ ✓

$\mu_k = 0,12$ ✓ (3)

2.3.3 **POSITIVE MARKING FROM QUESTION 2.3.2/*POSITIEWE NASIEN VANAF VRAAG 2.3.2***

OPTION 1/*OPSIE 1*

$F_{net} = ma$
$- f_k = ma$
$- \mu_k N = ma$
$- \mu_k(mg) = ma$
✓ 1 mark for any of these/ *1 punt vir enige van hierdie*

$- (0,12)(2)(9,8)$ ✓ $= 2a$✓
$a = -1,176\ m.s^{-2}$ (-1,18)

$v_f^2 = v_i^2 + 2a\Delta x$
$0 = (1,5)^2 + 2(-1,176)\Delta x$✓
$\Delta x = 0,96\ m$

Distance is/*Afstand is* 0,96 m✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$

$W_{net} = \Delta E_K$

$W_{nc} = \Delta K + \Delta U$

$W_{nc} = \Delta E_K + \Delta E_P$

$\mu_k N\Delta x \cos\theta = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$

1 mark for any of these/ *1 punt vir enigie van hierdie*

NOTE: substituting into any of the above equations will lead to the following:
LET WEL: *vervanging in enige van hierdie vergelyking sal lei to die volgende*

$(0,12)(2)(9,8)$ ✓ $\Delta x \cos 180^o$ ✓ $= 0 - \frac{1}{2}(2)(1,5)^2$✓

$\Delta x = 0,957\ m$✓

(5)
[15]

QUESTION 3/*VRAAG 3*

3.1 (Motion of) an object in which the only force acting is the gravitational force. ✓✓
Beweging van 'n voorwerp waarop die gravitasiekrag die enigste krag is wat op die voorwerp inwerk.

OR/*OF*
(Motion of)an object which has been given an initial velocity and which follows a path *entirely* determined by the effects of gravitational acceleration/force. ✓✓
Beweging van 'n voorwerp waaraan 'n beginsnelheid gegee is en wat 'n baan volg wat deur die effekte van gravitasionele versnelling bepaal word/ gravitasiekrag.

OR/*OF*
The (motion of)an object that is projected, thrown or shot either upwards or downwards into the air and on which the only force considered/acting is gravitational. ✓✓ (2)
Die beweging van 'n voorwerp wat geprojekteer word, gegooi word of wat opwaarts geskiet is of afwaarts geskiet is in die lug en waar die enigste krag op die voorwerp inwerk, gravitasie is.

Note/: ***Let Wel*** 2 or/*of* 0

3.2 No/*Nee* ✓
The balloon is not accelerating at the rate of 9,8 $m{\cdot}s^{-2}$/moving with constant velocity/acceleration is 0 $m{\cdot}s^{-2}$ ✓

Die ballon versnel nie teen 9,8 $m{\cdot}s^{-2}$ nie/beweeg teen konstante snelheid dus is versnelling 0 $m{\cdot}s^{-2}$ (2)

OR/OF
There are other forces (e.g.,friction) acting on the balloon besides gravity./*Daar is ander kragte wat op die ballon inwerk behalwe (buiten) gravitasie* ✓
Net force acting on the balloon is zero/*Die nettokrag (resultante krag) op die ballon is nul*

3.3

OPTION 1/*OPSIE 1*
Upward positive/*Opwaarts positief*
$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
-22 ✓ $= (-1,2)\ \Delta t + ½\ (-9,8)\Delta t^2$ ✓
$\Delta t = 2$ s ✓

Downward positive/*Afwaarts positief*
$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
22 ✓ $= (1,2)\ \Delta t + ½\ (9,8)\Delta t^2$ ✓
$\Delta t = 2$ s ✓

<u>OPTION 2/*OPSIE 2*</u>

Upward positive/*Opwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (-1,2)^2 + (2)(-9,8)(-22)$ ✓

$v_f = -20,8\ m \cdot s^{-1}$

$v_f = v_i + a\Delta t$

$\underline{-20,8 = -1,2 + -9,8\Delta t}$ ✓

$\Delta t = 2\ s$ ✓

For both equations/*vir beide vergelykings* ✓

Downward positive/*Afwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (1,2)^2 + (2)(9,8)(22)$ ✓

$v_f = 20,8\ m \cdot s^{-1}$

$v_f = v_i + a\Delta t$

$\underline{20,8 = 1,2 + 9,8\Delta t}$ ✓

$\Delta t = 2\ s$ ✓

For both equations/*vir beide vergelykings* ✓

<u>OPTION 3/*OPSIE 3*</u>

Upward positive/*Opwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = [(-1,2)^2 + (2)(-9,8)(-22)]$ ✓

$v_f = -20,8\ m \cdot s^{-1}$

$\Delta y = \frac{v_i + v_f}{2}\Delta t$

$-22 = \left(\frac{-1.2 + -20,8}{2}\right)\Delta t$ ✓

$\Delta t = 2\ s$ ✓

For both equations/*vir beide vergelykings* ✓

Downward positive/*Afwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = [1,2^2 + (2)(9,8)(22)]$ ✓

$v_f = 20,8\ m \cdot s^{-1}$

$\Delta y = \frac{v_i + v_f}{2}\Delta t$

$22 = \left(\frac{1.2 + 20,8}{2}\right)\Delta t$ ✓

$\Delta t = 2\ s$ ✓

For both equations/*vir beide vergelykings* ✓

OPTION 4/ *OPSIE 4* $(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$ $(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$ $(mgh + \frac{1}{2} mv^2)_{Top/Bo} = (mgh + \frac{1}{2} mv^2)_{Bottom/Onder}$ $W_{net} = \Delta E_K$ (1 mark for any / *1 punt vir enige*) $\underline{(9,8)(22) + \frac{1}{2}(1,2)^2 = 0 + (\frac{1}{2})(v_f^{\ 2})}$ ✓ $v_f = 20,80 \text{ m·s}^{-1}$ $v_f = v_i + a\Delta t$ $\underline{20,8 = 1,2 + 9,8\Delta t}$ ✓ $\underline{\Delta t = 2 \text{ s}}$ ✓
NOTES/*AANTEKENINGE*:   Each substitution must include the correct values of 22 m and the velocity of 1,2 m·s⁻¹   *Elke vervanging moet die korrekte waardes van 22 m en die snelheid van 1,2 m.s⁻¹ insluit.*   The values of v_f and v_i can also be used with $F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$ *Die waardes van v_f en v_i kan ook met $F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$ gebruik word.*

(4)

3.4

Upward positive/Opwaarts positief

POSITIVE MARKING FROM QUESTION 3.3/*POSITIEWE NASIEN VANAF VRAAG 3.3*

$v_f = v_i + a\Delta t$ ✓

$0 = 15 + (-9,8)\Delta t$ ✓

$\Delta t = 1,53$ s

Total time elapsed = $\underline{2 + 1,53 + 0,3}$ ✓ (For addition/*vir optelling*)

Totale tyd verstryk = 3,83 s

OR/OF

Displacement of the balloon/ *Verplasing van ballon*:

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$= -(1,2)(3,83)$ ✓

$= -4,6$ m

Height /*Hoogte:*

$= \underline{22 - 4,6}$ ✓

$= 17,4$ m ✓

OR/OF

$y_f = y_i + \Delta y$

$= [22 - (1,2)(3,83)]$ ✓ ✓

$= 17,4$ m

Height/*Hoogte* = 17,4 m ✓

Downward Positive/Afwaarts positief
POSITIVE MARKING FROM QUESTION 3.3/*POSITIEWE NASIEN VANAF VRAAG 3.3*
$v_f = v_i + a\Delta t$ ✓
$0 = -15 + (9,8)\Delta t$ ✓
$\Delta t = 1,53$ s
Total time elapsed = $\underline{2 + 1,53 + 0,3}$ ✓
Totale tyd verstryk = 3,83 s

For addition/*vir optelling*

OR/OF

Displacement of the balloon/
Verplasing van ballon:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (1,2)(3,83)$ ✓
$= 4,6$ m
Height /*Hoogte:*
$= \underline{22 - 4,6}$ ✓
$= 17,4$ m ✓

OR/OF

$y_f = y_i + \Delta y$
$= [-22 + (1,2)(3,83)]$ ✓ ✓
$= -17,4$ m
Height/*Hoogte* = 17,4 m ✓

(6)
[14]

QUESTION 4/*VRAAG 4*

4.1 It is the product of the resultant/net force acting on an object✓ and the time the resultant/net force acts on the object. ✓
Dit is die produk van die resulterende/netto krag wat op die voorwerp inwerk en die tyd wat die resulterende/netto krag op die voorwerp inwerk. (2)
NOTE: **ONLY 1 MARK FOR "CHANGE IN MOMENTUM"/*SLEGS 1 PUNT VIR VERANDERING IN MOMENTUM***

4.2.1
$p = mv$ ✓
$= (0,03)(700)$ ✓
$= 21 \text{ kg·m·s}^{-1}$ ✓

Note: 2/3 if $\Delta p = (p_f - p_i) = (mv_f - mv_i)$ is used.
Let Wel: 2/3 indien $\Delta p = (p_f - p_i) = (mv_f - mv_i)$ gebruik is. (3)

4.2.2

OPTION 1/*OPSIE 1*

POSITIVE MARKING FROM 4.2.1/*POSITIEWE NASIEN VANAF 4.2.1*

Δt for a bullet = $\frac{60}{220}$ ✓= 0,27 s

$F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$

$F_{ave\ gun\ on\ bullet/gem\ geweer\ op\ koeël} = \frac{\Delta p}{\Delta t}$ ✓ 1 mark for any one/*1 punt vir enige een*

$= \frac{21-0}{0,27}$ ✓

= 77,01 N ✓ (77,78 N)

∴average force of bullet on gun/*gemiddelde krag van koeël op geweer*

= 77,01 N/ 77,8 N to the west/na wes ✓OR/*OF*

-77,01 N / - 77,78 N

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM 4.2.1/*POSITIEWE NASIEN VANAF 4.2.1*

$F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$

$F_{av} = \frac{\Delta p}{\Delta t}$ ✓ 1 mark for any one/*1 punt vir enige een*

$\Delta p_{tot} = (21)(220) = 4\ 620\ kg{\cdot}m{\cdot}s^{-1}$ ✓

$F_{ave\ gun\ on\ bullet/gem\ geweer\ op\ koeël} = \frac{4\ 620 - 0}{60}$ ✓

= 77,00 N✓

∴average force of bullet on gun/*gemiddelde krag van koeël op geweer*

= 77,01 N /77,78 N to the west/*na wes* ✓

OR/*OF*

- 77,01 N / -77,78 N

OPTION 3/*OPSIE 3*

$v_f = v_i + a\Delta t$

$a = \frac{700-0}{(60/220)}$ ✓

$a = 2592,59\ m{\cdot}s^{-2}$

$F_{net} = ma$ ✓

$F_{net} = (0,03)(2592,59)$ ✓

$F_{av} = 77,78$ N✓

∴average force of bullet on gun/*gemiddelde krag van koeël op geweer*

= 77,01 N / 77,78 N to the west/*na wes* ✓ OR

= - 77,01 N/ -77,78 (5)

NOTE: ACCEPT RANGE: 77 N - 77,78 N

4.3

POSITIVE MARKING FROM 4.2.2/*POSITIEWE NASIEN VANAF 4.2.2*

77 N/77,78 N✓ to the east/*na oos*✓ (2)

[12]

QUESTION 5/*VRAAG 5*

5.1

The rate at which work is done/ Rate at which energy is expended. ✓✓
Die tempo waarteen arbeid verrig word / Die tempo waarteen energie verbruik is. (2)

5.2.1

OPTION 1/*OPSIE 1*

$W = F\Delta x\cos\theta$ ✓

$W_{gravity/gravitasie} = mg\Delta y\cos\theta$
$= (1\ 200)(9,8)(55)\cos 180^\circ$ ✓
$= -\ 646\ 800$ J ($6,47 \times 10^5$ J) ✓

OPTION 2/*OPSIE 2*

$W = -\ \Delta E_p$ ✓
$= -(1200)(9,8)(55\ -0)$ ✓
$= -646800$ J ✓

-1 if either negative is omitted or $E_p = mgh$ is used instead of W / *-1 indien negatief weggelaat is of indien $E_p = mgh$ gebruik is in plaas van W* (3)

5.2.2

$W_{counterweight} = mg\Delta y\cos\theta$
$= (950)(9,8)(55)\cos 0^\circ$ ✓
$= 512\ 050$ J ($5,12 \times 10^5$ J) ✓ (2)

5.3

OPTION 1/*OPSIE 1*

POSITIVE MARKING FROM QUESTIONS 5.2.1 AND 5.2.2
POSITIEWE NASIEN VANAF VRAE 5.2.1 en 5.2.2

$$\left.\begin{array}{l} W_{net} = \Delta E_K \\ W_{gravity} + W_{countweight} + W_{motor} = 0 \\ W_{motor} = -\ (W_{gravity} + W_{countweight}) \\ W_{nc} = \Delta E_K + \Delta E_p \end{array}\right\} ✓$$

1 mark for any one/ 1 punt vir enige een

NOTE: Substituting into any of the above equations will lead to:
LET WEL: *Vervanging in enige van die bogenoemde vergelykings sal lei tot*

-646800 ✓ $+ 512050$ ✓ $+ W_{motor} = 0$

$\therefore W_{motor} = 134\ 750$ J

$P_{ave\ motor} = \dfrac{W}{\Delta t}$ ✓

$= \dfrac{134750}{180}$ ✓

$= 748,61$ W ✓

OPTION 2/*OPSIE 2*

$F_{net} = 0$
$F_{gcage} + F_{gcount} + F_{motor} = F_{net}$ ✓ 1 mark for any one/*1 punt vir enige een*

-117600✓ $+ 9310$✓ $+ F_{motor} = 0$
$F_{motor} = 2450$ N

$P_{ave} = Fv_{ave}$✓
$= 2450 \dfrac{55}{180}$ ✓
$= 748{,}61$ W

OPTION 3/*OPSIE 3*

$P_{ave} = Fv_{ave}$ ✓✓
$= [1200(9{,}8)$✓ $- 950(9{,}8)$✓$] \dfrac{55}{180}$ ✓
$= 748{,}61$ W✓ (6)

[13]

QUESTION 6/*VRAAG 6*

6.1.1 The Doppler effect./*Die Doppler-effek*✓ (1)

6.1.2 Measuring the rate of blood flow/*Meet die tempo van bloedvloei*

OR/*OF*
Ultrasound (scanning)/*Ultraklank (skandering)*✓ (1)

6.1.3

$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \dfrac{v}{v - v_s} f_s$ **OR/*OF*** $f_L = \dfrac{v}{v + v_s} f_s$ ✓

2600✓ $= \dfrac{340✓}{(340 - v_s)✓} f_s$

$1750 = \dfrac{340}{(340 + v_s)✓} f_s$

$2600(340 - v_s) = 1750(340 + v_s)$
$v_s = 66{,}44 \text{ m·s}^{-1}$ ✓ (6)

6.1.4 (a) Increase/*Toeneem*✓ (1)

(b) Decrease/*Afneem* ✓ (1)

6.2.1 The spectral lines (light) from the star are shifted towards longer wavelengths. ✓✓
Die spektraallyne van die ster (lig) is na ander golflengtes toe verskuif. (2)

6.2.2 Decrease/*Neem af* ✓ (1)

[13]

QUESTION 7/*VRAAG 7*

7.1.1 Removed/*Verwyder* ✓ (1)

7.1.2

$n = \frac{Q}{e}$ ✓

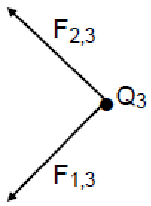
Do not penalise for negative sign of charge used in calculation

$= \frac{6 \times 10^{-6}}{1{,}6 \times 10^{-19}}$ ✓

$= 3{,}75 \times 10^{13}$ ✓electrons/*elektrone* (3)

7.2.1 Negative/*Negatief* ✓ (1)

7.2.2



NOTE/*LET WEL*:
Vectors not drawn to scale/*Vektore nie volgens skaal geteken nie.*
Learners forfeit 1 mark for:/*Kandidate sal 1 punt verbeur vir:*
(i) Wrong directions/*verkeerde rigtings*

OR/*OF*
(ii) Arrows not shown/*Pyltjies nie aangedui nie*

Give credit to the required forces even if a triangle of forces is drawn./*Gee krediet vir die vereiste kragte*

ACCEPT/*AANVAAR*: two separate diagrams /*twee aparte diagramme*
ACCEPT/*AANVAAR*:*correctly drawn vector but no labels/korrek getekende vektore sonder byskifte* (2)

7.2.3

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{1,3x} = \frac{(9 \times 10^9)(2 \times 10^{-6})(6 \times 10^{-6})}{r^2}(\cos 45°)$ ✓ $= \frac{(0{,}0764)}{r^2}$ ✓

ACCEPT/*AANVAAR*

$F = \frac{kQ_1Q_2}{r^2}$

$F_{1,3x} = \frac{k(Q_1)(Q_3)}{r^2}(\cos 45°)$ (3)

7.2.4

POSITIVE MARKING FROM QUESTION 7.2.3/*POSITIEWE NASIEN VANAF VRAAG 7.2.3*

OPTION 1/*OPSIE 1*

$F = \frac{kQ_1Q_2}{r^2}$

$F_{2,3x} = \frac{(9\times10^9)(2\times10^{-6})(6\times10^{-6})}{r^2}(\cos 45°)$ ✓ $= \frac{0,0764}{r^2}$

$F_x = F_{1,3x} + F_{2,3x}$

$F_x = \frac{0,0764}{r^2} + \frac{0,0764}{r^2} = 2\frac{0,0764}{r^2}$

1 mark for the addition
1 punt vir optelling

NOTE/*LET WEL*: $F_{y\ net} = 0$

$(0,12)$ ✓ $= \frac{0,1528}{r^2}$

r = 1,128 m ✓

OPTION 2/*OPSIE 2*

$F_{net}^2 = (F_{1,3})^2 + (F_{2,3})^2$

$= (k\frac{Q_1Q_3}{r^2})^2 + (k\frac{Q_2Q_3}{r^2})^2$

$= 2(k\frac{Q_1Q_3}{r^2})^2$

✓ 1 mark for any of the three
1 punt vir enige van die vier

$= 2\left[(9\times10^9)\frac{(2\times10^{-6})(6\times10^{-6})}{r^2}\right]^2$ ✓

$= 2\frac{(0,108)^2}{r^4}$

$(0,12)^2$ ✓ $= 2\frac{(0,108)^2}{r^4}$

$\therefore r = 1,128$ m✓

NOTE/*LET WEL*
$F_{net} = F_{net(x)}$ since/*aangesien* $F_{net\ (y)} = 0$

(4)

7.3.1 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 eenheid positiewe lading ✓wat by daardie punt ✓geplaas word, ervaar word. (2)

7.3.2

OPTION 1/*OPSIE 1*

$E = \frac{kQ}{r^2}$ ✓

$\overset{✓}{100} = \frac{(9 \times 10^9)Q}{(0,6)^2}$ ✓

$Q = 4 \times 10^{-9}$ C

When the electric field strength 50 is $N \cdot C^{-1}$/
Waar die elektrieseveld sterkte 50 $N \cdot C^{-1}$ *is*

$E = \frac{kQ}{r^2}$

$50 = \frac{(9 \times 10^9)(4 \times 10^{-9})}{r^2}$ ✓

For the equation/*vir die vergelyking*

r = 0,85 m (0,845) m✓

OPTION 2/*OPSIE 2*

$E = \frac{kQ}{r^2}$ ✓

$\therefore \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$

$\frac{100 ✓}{50 ✓} = \frac{r^2}{(0,6)^2}$ ✓

$\therefore r = 0,85$ m (0,849 m)✓

(5)
[21]

QUESTION 8/*VRAAG 8*

NEGATIVE MARKING FOR 8.1.1,8.1.2 AND 8.1.3/NEGATIEWE *NASIEN VIR VRAAG 8.1.1, 8.1.2 EN 8.1.3*

8.1.1 **P** and **Q** burn with the same brightness ✓ same potential difference/same current✓
P en Q brand met dieselfde helderheid ✓dieselfde potensiaalverskil / dieselfde stroom✓ (2)

8.1.2 **P is dimmer (less bright) than R/*P is minder helder as P***
OR/OF
R is brighter than P/*R is helderder as P*✓
R is connected across the battery alone therefore the voltage (terminal pd) is the same as the emf source (energy delivered by the source). ✓
R is alleen aan die battery gekoppel ✓ dus is die potensiaalverskil (terminale potensiaalverskil)dieselfde as die emk bron (energie gelewer deur die bron).✓

OR/*OF*
The potential difference across **R** is twice (larger/greater than) that of **P**./The current through **R** is twice (larger/greater than) that of **P.**
*Die potensiaalverskil oor **R** is twee maal dié van **P**./Die stroom deur **R** is twee maal dié van **P**.*

OR/*OF*

P and **Q** are in series and are both connected across the same battery, ✓ hence the voltage (terminal pd) is shared equally ✓(P and Q are potential dividers) Therefore R is brighter.
P en Q is in serie en beide is oor dieselfde battery gekoppel, ✓ dus word die potensiaalverskil gelyk verdeel ✓(P en Q is potensiaal verdelers) Dus is R helderder.

OR/*OF*

Potential difference across **P** is half that across **R**/*Die potensiaalverskil oor **P** is die helfte die oor **R*** (2)

8.1.3 **T** does not light up at all✓
***T** brand glad nie*

ACCEPT/*AANVAAR*
T is dimmer (less bright) than R/T *is minder helder as R*✓

R is brighter than **T**✓
R** is helderder as **T

Reason/*Rede*
The wire acts as a short circuit. ✓
Die draad dien as 'n kortsluiting

OR/*OF*
The potential difference across T / current in T is zero.✓
Die potensiaalverskil oor T/stroom in T is nul. (2)

8.2.1 **<u>OPTION 1/*OPSIE 1*</u>**

$$\frac{1}{R_{//}} = \frac{1}{R_5} + \frac{1}{R_{10}} \checkmark$$

$$\frac{1}{R_{//}} = \frac{1}{5} + \frac{1}{10} \checkmark$$

$\therefore R_{//}$ = 3,33 Ω (3,333 Ω)

$$R_{//} = \frac{R_5 R_{10}}{R_5 + R_{10}} \checkmark$$

$$= \frac{(5)(10)}{(5+10)} \checkmark = 3{,}33\ (3{,}333)\ \Omega$$

$R_{tot} = R_8 + R_{//} + r$
= (8 + 3,33 + 1)✓
= 12,33 Ω

$$I = \frac{V}{R} \checkmark$$

$$I_{tot} = \frac{20}{12{,}33} \checkmark = 1{,}62\ \text{A}$$

$\therefore I_8$ = 1,62 A✓

ε = I(R + r)✓
20 = I[(11,33 + 1)✓] ✓
I = 1,62 A✓

<u>OPTION 2/*OPSIE 2*</u>

$\frac{1}{R_{//}} = \frac{1}{R_5} + \frac{1}{R_{10}}$ ✓

$\frac{1}{R_{//}} = \frac{1}{5} + \frac{1}{10}$ ✓

$\therefore R_{//} = 3{,}33\ \Omega\ (3{,}333\ \Omega)$

$R_{//} = \frac{R_5 R_{10}}{R_5 + R_{10}}$ ✓

$= \frac{(5)(10)}{(5+10)}$ ✓ $= 3{,}33\ (3{,}333\ )\Omega$

$R_{tot} = R_8 + R_{//} + r$

$= (8 + 3{,}33 + 1)$ ✓

$= 12{,}33\ \Omega$

$V_8 = \frac{8}{12{,}33} \times 20 = 12{,}973\ V$

$I = \frac{V}{R}$ ✓

$\therefore I_{tot} = I_8 = \frac{12{,}973}{8}$ ✓

$= 1{,}62\ A$ ✓

(6)

8.2.2

<u>OPTION 1/*OPSIE 1*</u>

$V = IR$

$V_5 = \varepsilon - (V_8 + V_1)$

$\left.\right\}$ Any one/*Enige een* ✓

$= 20$ ✓ $- [\ \underline{1{,}62(8 + 1)}]$ ✓

$= 5{,}42\ V$ ✓

<u>OPTION 2/*OPSIE 2*</u>

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

$R_{//} = \frac{(5)(10)}{(5+10)} = 3{,}33\Omega$

$V_{R//} = \frac{R_{//}}{R_{tot}} \times V_{tot}$ ✓

$V_{R//} = \frac{(3{,}33)}{(12{,}33)}(20)$ ✓✓

$= 5{,}41\ V$ ✓

$V_{\parallel} = IR_{\parallel}$ ✓

$= (1{,}62)(3.33)$ ✓✓

$= 5{,}39\ V$ ✓

<u>OPTION 3/*OPSIE 3*</u>

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

$I_5 R_5 = I_{10} R_{10}$ ✓

$\underline{5I_5 = 10(1{,}62 - I_5)}$ ✓

$I_5 = 1{,}08\ A$

$V_5 = (1{,}08\ )(5)$ ✓

$= 5{,}4\ V$ ✓

(4)

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 4/*OPSIE 4*
$I_5 = \frac{10}{15} \times I_{tot}$ ✓
$= \frac{2}{3}(1{,}62)$
$= 1{,}08$ A
$V_5 = I_5 R_5$ ✓
$V_5 = (1{,}08)(5)$ ✓
$= 5{,}4$ V ✓

(4)

8.2.3

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 1/*OPSIE 1*
$P = IV = I\mathcal{E}$ ✓
$= (1{,}62)(20)$ ✓
$= 32{,}4$ W ✓

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 2/*OPSIE 2*
$P = IV$ ✓
$P_{tot} = P_{8\Omega} + P_{//} + P_{1\Omega}$
$= IV_8 + IV_{//} + IV_1$
$= I^2(R_8 + R_{//} + R_1)$
$= (1{,}62)^2[8 + 3{,}33 + 1)]$ ✓
$= 32{,}36$ W ✓

POSITIVE MARKING FROM 8.2.1 AND 8.2.2/*POSITIEWE NASIEN VANAF*
OPTION 3/*OPSIE 3*
8.2.1 EN 8.2.2
$P = I^2R$ ✓
$I_5 = \frac{V_5}{R_5} = \frac{5{,}4}{5} = 1{,}08$ A
$\therefore I_{10} = 0{,}54$ A
$P_{tot} = I_8^2R_8 + I_1^2R_1 + I_5^2R_5 + I_{10}^2R_{10}$
$= (1{,}62)^2[8 + 1] + (1{,}08)^2(5) + (0{,}54)^2(10)$ ✓ $= 32{,}37$ W ✓

OPTION 4/*OPSIE 4*	
$P = \frac{V^2}{R}$ ✓ $P = \frac{20^2}{(8+1+3{,}33)}$ ✓ $= 32{,}44$ W ✓	$P = I^2R_{tot}$ ✓ $= (1{,}62)^2(12{,}33)$ ✓ $= 32{,}36$ W ✓

(3)

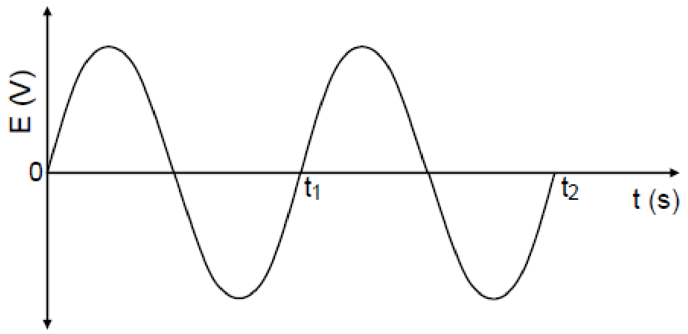
NOTE/*LET WEL*: Range/*Gebied* 32,35- 32,45

[19]

QUESTION 9/*VRAAG 9*

9.1 Slip rings/*Sleepringe* ✓ (1)

9.2



Marking criteria/*Nasienriglyne*	
Sine graph starts from 0. *Sinusgrafiek begin by 0*	✓
Two complete waves (between t_0 and t_2) *Twee volledige golwe tussen (t_0 en t_2)*	✓

(2)

9.3 Any TWO/*Enige TWEE*
Increase the speed of rotation/*Verhoog die rotasie spoed*✓
Increase the number of coils (turns)/*Verhoog die getal spoele*✓
Use stronger magnets/*Gebruik sterker magnete*
ACCEPT/*AANVAAR*: Increase surface area/*Verhoog die oppervlakarea* (2)

9.4 The rms value of an AC voltage it that value of the AC voltage which will dissipate the same amount of energy as DC.
Die wgk waarde van WS potensiaalverskil/stroom hoeveelheid energie as GS verkwis

OR/*OF*
The rms value of an AC voltage it that value of the AC voltage which will produce the same joule heating effect as DC.
Die wgk waarde van WS potensiaalverskil is die waarde van die WS potensiaalverskil wat dieselfde joule verhittingseffek as GS lewer. (2)

9.5

OPTION 1/OPSIE 1	**OPTION 2/OPSIE 2**
$P_{ave/gem} = I_{rms/wgk}V_{rms/wgk}$ ✓ $1500 = I_{rms/wgk}(240)$ ✓ $I_{rms/wgk} = \frac{1500}{240}$ $= 6{,}25$ A ✓	$P_{ave} = \frac{V^2}{R}$ ✓ $1500 = \frac{240^2}{R}$ $R = 38{,}4\ \Omega$ $I_{rms} = \frac{V}{R}$ $= \frac{240}{38{,}4}$ ✓ $= 6{,}25$ A ✓

(3)
[10]

QUESTION 10/*VRAAG 10*

10.1 The minimum frequency of light ✓needed to emit electrons from a certain metal surface.✓
Die minimum frekwensie van lig benodig om elektrone vanaf die oppervlak van 'n sekere metaal vry te stel.

OR/***OF***
The minimum frequency of light✓ below which electrons will not be emitted from the surface of a certain metal. ✓
Die minimum frekwensie van lig waaronder elektrone nie vanaf die oppervlak van 'n sekere metaal vrygestel sal word nie. (2)

10.2 The speed remains unchanged. ✓
Die spoed bly onveranderd. (1)

10.3

OPTION 1/*OPSIE 1*
$c = f\lambda$ ✓,
$3 \times 10^8 = f(6 \times 10^{-7})$ ✓

$\therefore f = 5 \times 10^{14}$ Hz✓

The value of f is less than the threshold frequency of the metal, ✓ therefore photoelectric effect is not observed.✓
Die waarde van f is laer as die drumpelfrekwensie van die metal, ✓en gevolglik sal foto- nie waargeneem word nie. ✓

OPTION 2/*OPSIE 2*
For the given metal/*Vir die gegewe metaal*
$W_0 = hf_0$ ✓
$= (6{,}63 \times 10^{-34})(6{,}8 \times 10^{14})$ ✓
$= 4{,}51 \times 10^{-19}$ J

For the given wavelength/*Vir die gegewe golflengte*

$$E_{photon/foton} = \frac{hc}{\lambda} = \frac{(6{,}63\times10^{-34})(3\times10^{8})}{6\times10^{-7}} \checkmark = 3{,}32 \times 10^{-19} \text{ J}$$

$E_{photon/foton} = hf$
$= (6{,}63 \times 10^{-34})(5 \times 10^{14})$ ✓
$= 3{,}32 \times 10^{-19}$ J

This energy is less than the work function✓ of the metal,therefore photoelectric effect is not observed.✓
Hierdie energie is minder as die werksfunksie ✓of die metal, en gevolglik sal foto-elektriese nie waargeneeme word nie. ✓ (5)

OPTION 3/*OPSIE 3*

$c = f_0\lambda_0$ ✓
$3 \times 10^8 = 6,8 \times 10^{14}(\lambda_0)$ ✓
$\lambda_0 = 4,41 \times 10^{-7}$ m ✓

The threshold wavelength (λ_0) is smaller than 6×10^{-7} m ✓ therefore photoelectric effect is not observed. ✓
Die drumpelgolflengte (λ_0) is kleiner *as* 6×10^{-7} *m* ✓ *en gevolglik sal foto-elektriese effek nie waargeneem word nie.* ✓

10.4

$$\left.\begin{aligned} E &= W_o + E_{k(max)} \\ E &= W_o + \frac{1}{2}mv^2_{max} \\ h\frac{c}{\lambda} &= hf_0 + \frac{1}{2}mv^2_{max} \\ hf &= hf_0 + \frac{1}{2}mv^2_{max} \end{aligned}\right\}$$

Any one of the three/*Enige van die drie* ✓

$(6,63 \times 10^{-34})(7,8 \times 10^{14})$ ✓ $= (6,63 \times 10^{-34})(6,8 \times 10^{14})$ ✓ $+ \frac{1}{2}mv^2_{max}$

$\frac{1}{2} mv^2_{max} = 6,63 \times 10^{-20}$ J
$\frac{1}{2} (9,11 \times 10^{-31}) v^2_{max/maks}$ ✓ $= 6,63 \times 10^{-20}$
$v_{max/maks} = 3,82 \times 10^5$ m·s^{-1} ✓ (5)

[13]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

FEBRUARY/MARCH/*FEBRUARIE/MAART* 2017

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 A ✓✓ (2)

1.4 A ✓✓ (2)

1.5 C ✓✓ (2)

1.6 D ✓✓ (2)

1.7 C ✓✓ (2)

1.8 B ✓✓ (2)

1.9 C ✓✓ (2)

1.10 A ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1
2.1.1 B ✓ (1)

2.1.2 D **OR/*OF*** E ✓ (1)

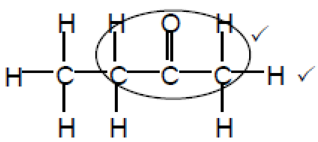
2.1.3 F ✓ (1)

2.2
2.2.1 Butanal / *Butanaal* ✓ (1)

2.2.2 2,3,3-trimethyl✓but-1-ene ✓ / *2,3,3-trimetielbut-1-een*
Accept/Aanvaar:
2,3,3- trimethyl ✓-1- butene /*2,3,3-trimetiel-1-buteen*

Marking criteria/*Nasienriglyne:*
- Correct stem i.e. but-1-ene / 1-butene. ✓
  Korrekte stam d.i. but-1-een / 1-buteen.
- Substituents correctly identified. / *Substituente korrek geïdentifiseer.* ✓
- Substituents correctly numbered, hyphens and commas correctly used. ✓
  Substituente korrek genommer, koppeltekens en kommas korrek gebruik.

(3)

2.3 

Marking criteria/*Nasienriglyne:*
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Maks:* $\frac{1}{2}$

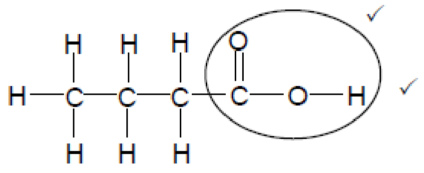
(2)

2.4

2.4.1 Esterification / Condensation ✓
Esterifikasie / Verestering/Kondensasie (1)

2.4.2 Propan-1-ol ✓✓
If propanol (1 mark) / *Indien propanol (1 punt)* (2)

2.4.3



Marking criteria/*Nasienriglyne:*
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Max:* $\frac{1}{2}$

(2)

2.4.4 Propyl ✓ butanoate ✓/*Propielbutanoaat* (2)
[16]

QUESTION 3/*VRAAG 3*

3.1 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 of 0) (2)

3.2 Flammable / Catch fire easily. / Volatile ✓
Vlambaar / Vat maklik vlam. / Vlugtig (1)

3.3

3.3.1 Use straight chain ✓ primary alcohols ✓
Gebruik reguitketting primêre alkohole (2)

3.3.2. **OPTION 1/*OPSIE 1***

- **Structure/*Struktuur*:**
  Chain length / more C atoms in chain / molecular size / molecular mass / surface area increases from top to bottom / butan-1-ol to hexan-1-ol. ✓
  Kettinglengte / meer C-atome in ketting) / molekulêre grootte / molekulêre massa / oppervlak neem toe van bo na onder / butan-1-ol na heksan-1-ol.
- **Intermolecular forces/*Intermolekulêre kragte:***
  Intermolecular forces / Van der Waals forces / London forces / dispersion forces increases from top to bottom / butan-1-ol to hexan-1-ol. ✓
  Intermolekulêre kragte / Van der Waalskragte / Londonkragte / dispersiekragte neem toe van bo na onder / butan-1-ol na heksan-1-ol.
- **Energy/*Energie*:**
  Energy needed to overcome / break intermolecular forces increases from top to bottom / butan-1-ol to hexan-1-ol.
  Energie benodig om intermolekulêre kragte te oorkom / breek neem toe van bo na onder / butan-1ol na heksan-1ol. ✓

OPTION 2/*OPSIE 2*

- **Structure/*Struktuur*:**
  Chain length / number of C atoms in the chain / molecular size / molecular mass/surface area decreases from bottom to top / hexan-1-ol to butan-1-ol. ✓
  Kettinglengte / aantal C-atome in ketting / molekulêre grootte / molekulêre massa / oppervlak neem af van onder na bo / heksan-1-ol na butan-1-ol.
- **Intermolecular forces/*Intermolekulêre kragte:***
  Intermolecular forces / Van der Waals forces/London forces / dispersion forces decreases from bottom to top/hexan-1-ol to butan-1-ol. ✓
  Intermolekulêre kragte / Van der Waalskragte / Londonkragte / dispersiekragte neem af van bo na onder / heksan-1-ol na butan-1-ol.
- **Energy/*Energie*:**
  Energy needed to overcome / break intermolecular forces decreases from bottom to top / hexan-1-ol to butan-1-ol.
  Energie benodig om intermolekulêre kragte te oorkom / breek neem af vanonder na bo / heksan-1-ol na butan-1ol. ✓ (3)

3.4 Remains the same / *Bly dieselfde* ✓ (1)

3.5

3.5.1 Functional group / Type of homologous series ✓
Funksionele groep / Soort homoloë reeks (1)

3.5.2

- **Type of intermolecular forces/*Tipe intermolekulêre kragte*:**
  Between molecules of aldehyde / hexanal are dipole-dipole forces. ✓
  Tussen molekule van aldehyde / heksanaal is dipool-dipoolkragte.
- Between molecules of alcohols / hexan-1ol are (in addition to dipole-dipole forces and London forces) hydrogen bonds. ✓
  Tussen molekule van alkohole / heksan-1-ol is (in toevoeging tot dipool-dipoolkragte en Londonkragte) waterstofbindings.
- **Strength of intermolecular forces/*Sterkte van intermolekulêre kragte*:**
  Dipole-dipole forces are weaker than hydrogen bonds. ✓
  Dipool-dipoolkragte is swakker as waterstofbindings.
  OR/*OF*
  Hydrogen bonds are stronger than dipole-dipole forces.
  Waterstofbindings is sterker as dipool-dipoolkragte.
- **Energy/*Energie*:**
  More energy needed to overcome / break intermolecular forces in hexan-1-ol. ✓
  Meer energie benodig om intermolekulêre kragte in heksan-1-ol te oorkom / breek.
  OR/*OF*
  Less energy needed to overcome / break intermolecular forces in hexanal.✓
  Minder energie benodig om intermolekulêre kragte in heksanaal te oorkom / breek (4)

[14]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

4.1.2 H_2O/water ✓

OR/***OF***
Dilute sodium hydroxide /NaOH(aq) / *Verdunde natriumhidroksied*

OR/***OF***
Dilute potassium hydroxide/KOH(aq) / *Verdunde kaliumhidroksied* (1)

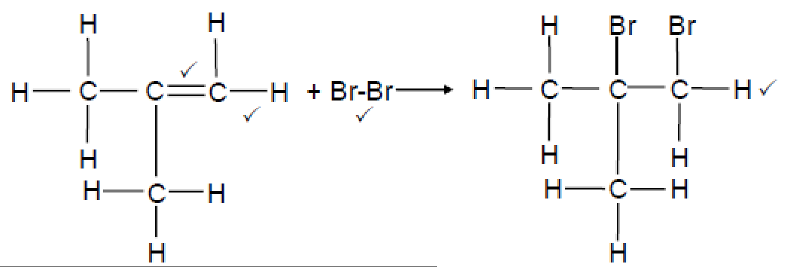
4.1.3 Tertiary / *Tersiêr* ✓ (1)

4.1.4 Elimination / dehydrohalogenation / dehydrobromination ✓
Eliminasie / dehidrohalogenering / dehidrohalogenasie / dehidrobrominering / dehidrobrominasie (1)

4.1.5 2-methyl✓prop-1✓-ene / methylpropene / 2-methylpropene
2-metielprop-1-ene / metielpropeen / 2-metielpropeen (2)

4.1.6 Halogenation / bromination ✓
Halogenering / halogenasie / brominering / brominasie (1)

4.1.7



- Whole structure correct. ✓✓
  Hele struktuur korrek.
- Only functional group correct. ✓
  Slegs funksionele groep korrek.

Notes/*Aantekeninge*:
- Ignore/*Ignoreer* ⇌
- Accept Br_2 if condensed./*Aanvaar* Br_2 *as gekondenseerd.*
- Marking rule 3.9/*Nasienreël 3.9*
- Condensed or semi-structural formula:
  Gekondenseerde of semi-struktuurformule: Max./*Maks.* $^3/_4$
- Molecular formula/*Molekulêre formule:* $^1/_4$
- Any additional reactants or products:
  Enige addisionele reaktanse of produkte: Max./*Maks.* $^3/_4$
- Everything correct, arrow in equation omitted:
  Alles korrek, pyltjie in vergelyking uitgelaat is: Max./*Maks.* $^3/_4$

(4)

4.2

4.2.1 Monomers / *Monomere* ✓ (1)

4.2.2 Alkenes / *Alkene* ✓ (1)

4.2.3 Addition (polymerisation) / *Addisie (polimerisasie)* ✓ (1)
[14]

QUESTION 5/*VRAAG 5*

5.1 **ANY TWO/*ENIGE TWEE*:**

- Increase temperature of HCℓ. / *Toename in temperatuur van HCℓ.* ✓
- Add a catalyst. / *Voeg 'n katalisator by.* ✓
- Increase the concentration of HCℓ. / *Toename in konsentrasie van HCℓ.*
- Increase the state of division of $CuCO_3$. / *Toename in toestand van verdeeldheid van $CuCO_3$.*
- Agitation / Stirring / *Roer mengsel.* (2)

5.2 Accepted range / *Aanvaarde gebied:* 42 s to 50 s ✓ (1)

5.3

5.3.1

$$\text{average/ } \textit{gem.tempo} = -\frac{\Delta m}{\Delta t}$$

$$= -\frac{(169{,}76 - 170{,}00)✓}{(20 - 0)✓}$$

$$= 0{,}012 (g \cdot s^{-1}) \quad ✓$$

If answer is negative (minus 1 mark) / *Indien antwoord negatief is (minus 1 punt)* (3)

5.3.2 Pure sample/*Suiwer monster*:

$m(CO_2)_{formed/gevorm}$ = 170,00 – 169,73 ✓
= 0,27 g

Impure sample/*Onsuiwer monster*:

$m(CO_2)_{formed/gevorm}$ = 170,00 - 169,78 ✓
= 0,22 g

$$\%\text{Purity/}\textit{suiwerheid} = \frac{0{,}22}{0{,}27} \times 100 \ ✓$$

= 81,48% ✓ (4)

5.3.3 **POSITIVE MARKING FROM QUESTION 5.3.2.**
POSITIEWE NASIEN VAN VRAAG 5.3.2.

$$n(CO_2)_{formed/gevorm} = \frac{m}{M}$$

$$= \frac{0{,}27}{44✓}$$

$$= 6{,}13 \times 10^{-3} \text{ mol}$$

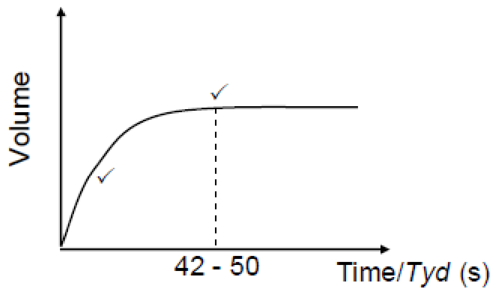
$$n(CO_2) = \frac{V}{V_m}$$

$$6{,}13 \times 10^{-3} = \frac{V}{22{,}4} \ ✓$$

$$V = 0{,}137 \text{ dm}^3 \ ✓$$

(3)

5.4 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VAN VRAAG 5.2.



Marking criteria for sketch graph: ***Nasienriglyne vir sketsgrafiek:***	
Graph drawn from origin with decreasing gradient. *Grafiek geteken uit oorsprong met afnemende gradiënt.*	✓
Constant volume after (42 -50) s.**or** graph stops at (42 -50) s *Konstante volume na (42 – 50) s* ***of*** *grafiek stop by (42 – 50) s*	✓
If no labels on axes: minus 1./***Indien*** *geen benoemings op asse: minus 1*	

(2)
[15]

QUESTION 6/*VRAAG 6*

6.1 Amount / number of moles / volume of (gas) reactants equals amount/number of moles/volume of (gas) products. ✓
Hoeveelheid / Aantal mol van gas-reaktanse is gelyk aan die hoeveelheid/getal mol gasprodukte.

OR/*OF*
A change in pressure will change the concentration of the reactants and products equally.
'n Verandering in die druk sal die konsentrasie van die reaktanse en produkte dieselfde verander. (1)

6.2 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation/*Puntetoekenning:*
- Divide equilibrium amounts of H_2 and I_2 by 2 dm^3. ✓
  Deel ewewigshoeveelhede van H_2 en I_2 deur 2 dm^3.
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitution of equilibrium concentrations into K_c expression. ✓
  Vervanging van ewewigskonsentrasies in K_c-uitdrukking.
- Substitution of K_c value/*Vervanging van K_c-waarde.* ✓
- Change in n(HI) = n(HI at equilibrium). ✓
  Verandering in n(HI) = n(HI by ewewig)
- **USING** ratio/***GEBRUIK*** *verhouding:* $H_2 : I_2 ; HI = 1 : 1 : 2$ ✓
- Initial n(I_2) = equilibrium n(I_2) + change in n(I_2) ✓
  Aanvanklike n(I_2) = ewewigs n(I_2) + verandering in n(I_2)
- Substitute 254 $g \cdot mol^{-1}$ as molar mass for I_2.✓
  Vervang 254 $g \cdot mol^{-1}$ as molêre massa van for I_2.
- Final answer/*Finale antwoord*: 24,89 - 24,92 (g) ✓

OPTION 1/*OPSIE 1*

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \checkmark$$

$$\therefore 55{,}3 \checkmark = \frac{[HI]^2}{(0{,}014)(0{,}0085)} \checkmark$$

$$\therefore [HI] = 0{,}08112 \text{ mol·dm}^{-3}$$

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.* $^6/_9$

	H_2	I_2	HI	
Initial mass (g) Aanvangsmassa (g)		(0,09812)(254) ✓ = 24,92 g ✓		
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,1091	0,09812	0	
Change (mol) *Verandering (mol)*	0,08112	✓ 0,08112	0,1622 ✓	Using ratio ✓
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,028	0,017	0,1622	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,014	0,0085	0,08112	x 2

Divide by 2 ✓

OR/*OF*

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \checkmark$$

$$\therefore 55{,}3 \checkmark = \frac{x^2}{(0{,}014)(0{,}0085)} \checkmark$$

$$\therefore x = 0{,}08112 \text{ mol·dm}^{-3}$$

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.* $^6/_9$

	H_2	I_2	HI	
Initial mass (g) Aanvangsmassa (g)				
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x+0,028	x + 0,017	0	
Change (mol) *Verandering (mol)*	x	✓ x	2x✓	Using ratio ✓
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,028	0,017	2x	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,014	0,0085	x	x 2

Divide by 2 ✓

Initial quantity I_2(mol)/*Aanvangshoeveelheid I_2* (mol) = 0,08112 + 0,017
= 0,09812 mol

$m(I_2)$ = nM
= (0,09812)(254) ✓
= 24,92 g ✓

OPTION 2/*OPSIE 2*

$$\left.\begin{array}{ll} c(H_2) = \dfrac{n}{V} & c(I_2) = \dfrac{n}{V} \\ = \dfrac{0{,}028}{2} & = \dfrac{0{,}017}{2} \\ = 0{,}014\ mol\cdot dm^{-3} & = 0{,}0085\ mol\cdot dm^{-3} \end{array}\right\}\ \text{Divide by 2 dm}^3\ ✓$$

$$K_c = \frac{[HI]^2}{[H_2][I_2]}\ ✓$$

$$55{,}3\ ✓ = \frac{[HI]^2}{(0{,}014)(0{,}0085)}\ ✓$$

$[HI] = 0{,}08112\ mol{\cdot}dm^{-3}$

n(HI at equilibrium/*by ewewig*) = (0,08112)(2) = 0,1622 mol
n(HI formed/*gevorm*) = n(HI at equilibrium/*by ewewig*) = 0,1622 mol ✓
n(I_2 reacted/*gereageer*) = ½n(HI formed/*gevorm*) = 0,08112 mol ✓

n(I_2 initial/ *aanvanklik*) = n(I_2 reacted/*gereageer*) + n(I_2 equilibrium/*ewewig*)
= 0,08112 + 0,017 ✓
= 0,09812 mol
m(I_2 initial/*aanvanklik*) = nM
= (0,09812)(254) ✓
= 24,92 (g) ✓

<u>CALCULATIONS USING CONCENTRATION</u>
<u>BEREKENINGE WAT KONSENTRASIE GEBRUIK</u>
Mark allocation/*Puntetoekenning:*

- Divide equilibrium moles of H_2 and I_2 by 2 dm^3. ✓
  Deel ewewigshoeveelhede van H_2 en I_2 deur 2 dm^3.
- Correct K_c expression (<u>formulae in square brackets</u>). ✓
  Korrekte K_c-uitdrukking (<u>formules in vierkanthakies</u>).
- Substitution of equilibrium concentrations into K_c expression. ✓
  Vervanging van ewewigskonsentrasies in K_c-uitdrukking.
- Substitution of K_c value/*Vervanging van K_c-waarde.* ✓
- Change in n(HI) = n(HI at equilibrium). ✓
  Verandering in n(HI) = n(HI by ewewig)
- **<u>USING</u>** ratio/***<u>GEBRUIK</u>*** *verhouding:* $H_2 : I_2 : HI = 1 : 1 : 2$ ✓
- Initial [I_2] = equilibrium [I_2] + change in [I_2] ✓
  Aanvanklike n(I_2) = ewewigs n(I_2) + verandering in n(I_2)
- Substitute 254 $g{\cdot}mol^{-1}$ as molar mass for I_2.✓
  Vervang 254 $g{\cdot}mol^{-1}$ as molêre massa van for I_2.
- Final answer/*Finale antwoord*: 24,89 – 24,92 (g) ✓

OPTION 3/*OPSIE 3*

$K_c = \dfrac{[HI]^2}{[H_2][I_2]}$ ✓

$55{,}3$ ✓ $= \dfrac{[HI]^2}{(0{,}014)(0{,}0085)}$ ✓

$[HI] = 0{,}08112\ mol\cdot dm^{-3}$

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.* $6/9$

$c = \dfrac{m}{MV}$

$0{,}04905 = \dfrac{m}{(254)(2)}$ ✓

$\therefore m = 24{,}89\ g$ ✓

	H_2	I_2	HI	
Initial concentration ($mol\cdot dm^{-3}$) *Aanvangskonsentrasie ($mol\cdot dm^{-3}$)*		0,04905 ✓	0	
Change ($mol\cdot dm^{-3}$) *Verandering ($mol\cdot dm^{-3}$)*	0,04055	0,04055 ✓	0,08112 ✓	ratio ✓ *verhouding*
Equilibrium concentration ($mol\cdot dm^{-3}$) *Ewewigskonsentrasie ($mol\cdot dm^{-3}$)*	0,014	0,0085	0,08112	

(9)

6.3 (Chemical/dynamic) equilibrium / *(Chemiese/dinamiese) ewewig* ✓

OR/***OF***

The rate of the forward reaction equals the rate of the reverse reaction.
Die tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie. (1)

6.4 Addition of a <u>catalyst</u>. / *Byvoeging van 'n <u>katalisator.</u>* ✓
<u>Increase in pressure.</u> / *<u>Toename in druk.</u>* ✓ (2)

6.5.1 Endothermic / *Endotermies* ✓

- The rate of the forward reaction decreases more. / The rate of the reverse reaction decreases less. ✓
  Die tempo van die voorwaartse verminder meer. / Die tempo van die terugwaartse reaksie verminder minder.
- A decrease in temperature favours the exothermic reaction. ✓
  'n Afname in temperatuur bevoordeel die eksotermiese reaksie. (3)

6.5.2 Decreases / *Verlaag* ✓ (1)

6.6 Reactants / H_2 / I_2 removed ✓
Reaktanse / H_2 / I_2 verwyder (1)

[18]

QUESTION 7/*VRAAG 7*

7.1 A substance that ionises incompletely/to a small extent. ✓✓
'n Stof wat onvolledig ioniseer / in 'n klein mate ioniseer. (2)

7.2 Oxalic acid / *Oksaalsuur* ✓
Higher K_a value / *Hoër K_a-waarde* ✓

OR/*OF*
Carbonic acid has a lower K_a value ./ *Koolsuur het 'n laer K_a-waarde.* (2)

7.3
H_2O ✓
$(COO)_2^{2-}$ ✓ (2)

7.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$K_w = [OH^-][H_3O^+]$ $1 \times 10^{-14} = (0,1)[H_3O^+]$ ✓ $[H_3O^+] = 1 \times 10^{-13}$ mol·dm^{-3} $pH = -\log[H_3O^+]$ ✓ $= -\log(1 \times 10^{-13})$ ✓ $= 13$ ✓	$pOH = -\log[OH^-]$ ✓ $= -\log(0,1)$ ✓ $= 1$ $14 = pOH + pH$ $14 = 1 + pH$ ✓ $pH = 13$ ✓

(4)

7.5
7.5.1

OPTION 1/*OPSIE 1*	**Marking guidelines/*Nasienriglyne:***
$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓ $\frac{c_a \times 14,2 ✓}{0,1 \times 25,1 ✓} = \frac{1}{2}$ ✓ $c_a = 0,09 \text{ mol·dm}^{-3}$ ✓	• Formula/*Formule* • Substitution of 0,1 x 25,1. *Substitusie van* 0,1 x 25,1. • Use V_a = 14,2 cm^3. Gebruik V_a = 14,2 cm^3. • Use mol ratio 1:2. *Gebruik molverhouding 1:2.* • Final answer/*Finale antwoord:* 0,09 mol·dm^{-3}
OPTION 2/*OPSIE 2*	**Marking guidelines/*Nasienriglyne:***
$n(NaOH) = cV$ ✓ $= (0,1)(0,0251)$ ✓ $= 0,00251$ mol $n(COOH)_2 = \frac{1}{2}(0,00251)$ ✓ $= 0,00126$ mol $c_a = \frac{n}{V}$ $= \frac{0,00126}{0,0142 ✓}$ $= 0,09 \text{ mol·dm}^{-3}$ ✓	• Any ONE of formulae. *Enige EEN van formules* • Substitution of 0,1 x 0,0251. *Substitusie van* 0,1 x 0,0251. • Use mol ratio 1:2. *Gebruik molverhouding 1:2.* • Use V_a = 0,0142 dm^3. Gebruik V_a = 0,0142 dm^3 • Final answer/*Finale antwoord:* 0,09 mol·dm^{-3} Accept range/*Aanvaarde gebied:* 0,088 to 0,09 mol·dm^{-3}

(5)

7.5.2 C / phenolphthalein / *fenolftaleïen* ✓
Titration of weak acid and strong base. ✓
Titrasie van swak suur en sterk basis.

OR/***OF***
The endpoint will be at pH > 7 which is in the range of the indicator.
Die eindpunt sal by pH > 7 wees wat in die gebied van die indikator is. (2)
[17]

QUESTION 8/*VRAAG 8*

8.1
8.1.1 Salt bridge /*soutbrug* ✓ (1)

8.1.2 Voltaic / Galvanic cell ✓
Voltaïese / Galvaniese sel (1)

8.2
8.2.1 Decreases/*Verlaag* ✓ (1)

8.2.2 Increases / *Verhoog* ✓ (1)

8.3
8.3.1 $Y(s) \rightarrow Y^{2+}(aq) + 2e^-$ ✓✓ Ignore phases/*Ignoreer fases*

OR/***OF***
$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$

Notes/*Aantekeninge*

$Y(s) \rightleftharpoons Y^{2+}(aq) + 2e^-$ ($\frac{1}{2}$)	$Y^{2+}(aq) + 2e^- \leftarrow Y(s)$ ($\frac{2}{2}$)
$Y(s) \leftarrow Y^{2+}(aq) + 2e^-$ ($\frac{0}{2}$)	$Y^{2+}(aq) + 2e^- \rightleftharpoons Y(s)$ ($\frac{0}{2}$)

(2)

8.3.2 $Y(s) \mid \overset{\checkmark}{Y^{2+}(aq)} \parallel \overset{\checkmark}{A\ell^{3+}(aq)} \overset{\checkmark}{\mid} A\ell(s)$ **OR**/***OF*** $Mg(s) \mid Mg^{2+}(aq) \parallel A\ell^{3+}(aq) \mid A\ell(s$

OR/***OF***
$Y(s) \mid Y^{2+}$ (1 mol·dm^{-3}) $\parallel A\ell^{3+}$(1 mol·dm^{-3}) $\mid A\ell(s)$

Accept/*Aanvaar*:
$Y \mid Y^{2+} \parallel A\ell^{3+} \mid A\ell$ (3)

8.4

OPTION 1/*OPSIE 1*	Notes/*Aantekeninge*
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ $0,7$ ✓ $= -1,66$ ✓ $- E^\theta_{oxidation}$ $E^\theta_{oxidation} = -2,36$ (V) ✓ Y is Mg ✓	• 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*	
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	$E^\theta = -1,66$ V ✓
✓ $Y(s) \rightarrow Y^{2+}(aq) + 2e^-$	$E^\theta = +2,36$ V ✓
$Y(s) + Al^{3+}(aq) \rightarrow Y^{2+}(aq) + Al(s)$	$E^\theta = +0,7$ V ✓
Y is Mg ✓	

(5)
[14]

QUESTION 9/*VRAAG 9*

9.1 Bauxite / *Bauxiet* ✓ (1)

9.2 Oxidation / *Oksidasie* ✓ (1)

9.3 Reduce melting point ./ *Verminder smeltpunt.*

OR/OF

To lower the temperature / energy needed to melt the Al_2O_3. ✓
Om die temperatuur / energie benodig om die Al_2O_3 te smelt, te verlaag.

ACCEPT/*AANVAAR*
To dissolve the Al_2O_3 so that it can electrolysed easier *Om die Al_2O_3 op te los sodat dit makliker elektroliseer*

(1)

9.4 $Al^{3+}(aq) + 3e^- \rightarrow Al(s)$ ✓✓

Ignore phases/*Ignoreer fases*

Notes/*Aantekeninge*			
$Al \leftarrow Al^{3+} + 3e^-$	$(\frac{2}{2})$	$Al^{3+} + 3e^- \rightleftharpoons Al$	$(\frac{1}{2})$
$Al \rightleftharpoons Al^{2+} + 3e^-$	$(\frac{0}{2})$	$Al^{3+} + 3e \leftarrow Al$	$(\frac{0}{2})$

(2)

9.5 $C + O_2$ ✓ $\rightarrow CO_2$ ✓ Bal ✓

OR/*OF*

$2Al_2O_3 + 3C$ ✓ $\rightarrow 4Al + 3CO_2$ ✓ Bal ✓

Notes/*Aantekeninge:*
• Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓ • Ignore double arrows./*Ignoreer dubbelpyle.* • Marking rule 6.3.10./*Nasienreël 6.3.10.*

(3)
[8]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Ostwald (process) / *Ostwald(proses)* ✓ (1)

10.1.2 Catalyst/Speeds up the rate of the reaction ✓
Katalisator / Versnel die reaksietempo (1)

10.1.3 Nitrogen dioxide / *Stikstofdioksied* ✓ (1)

10.1.4 $3NO_2 + H_2O \rightleftharpoons 2HNO_3(aq) + NO$ ✓ Bal. ✓

Notes/*Aantekeninge:*

- Products ✓ / *Produkte* — Balancing ✓ / *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

(2)

10.1.5 Decrease pressure / Increase volume / *Verlaag druk / Verhoog volume* ✓
Decrease temperature / *Verlaag temperatuur* ✓ (2)

10.2

10.2.1 (Ratio of the) nitrogen, phosphorous and potassium in the fertiliser. ✓
Verhouding van die stikstof, fosfor en kalium in die kunsmis. (1)

10.2.2 **Marking criteria/*Nasienriglyne:***

- Use ratio/*Gebruik verhouding:* $\frac{3}{8}$ ✓
- x 50 kg ✓
- x 25 / 25 % ✓
- Divide previous answer by/*Deel vorige antwoord deur* 39 ✓
- Multiply by/*Vermenigvuldig met* 74,5 ✓
- Final answer/*Finale antwoord:* 8,94 kg ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$\%K = \frac{3}{8}✓ (\times 25)✓$ $= 9,38\%$ $m(K) = \frac{9,38}{100}(\times 50\text{ kg})✓$ $= 4,69\text{ kg}$	m(nutrients/*voedingstowwe*): $\frac{25}{100}✓ (\times 50)✓ = 12,5\text{ kg}$ $\therefore m(K) = \frac{3}{8}✓ \times 12,5$ $= 4,69\text{ kg}$	m(K): $\frac{3}{8}✓ \times (50)✓ (\times \frac{25}{100})✓ = 4,69\text{ kg}$

$$n(K) = \frac{m}{M} = \frac{4,69 \times 10^3}{39\ ✓} = 120\text{ mol}$$

$$m(KC\ell) = nM = (120)(74,5)\ ✓ = 8940\text{ g} = 8,94\text{ kg}\ ✓$$

OPTION 4/*OPSIE 4*

$\%K = \frac{3}{8}✓ \times 25\ ✓ = 9,38\%$

$m(K) = \frac{9,38}{100} \times 50\ ✓ = 4,69\text{ kg}$

$\%K \text{ in } KC\ell = \frac{39}{74,5}✓✓ \times 100 = 52,35\%$

$52,35\%\ KC\ell: 4,69\text{ kg}$

$m(100\%\ KC\ell) = \frac{4,69}{52,35} \times 100$

$= 8,96\text{ kg}\ ✓$

(6)
[14]

TOTAL/*TOTAAL*: 150

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2017

MARKING GUIDELINES/*NASIENRIGLYNE*

QUESTION 1 / *VRAAG 1*

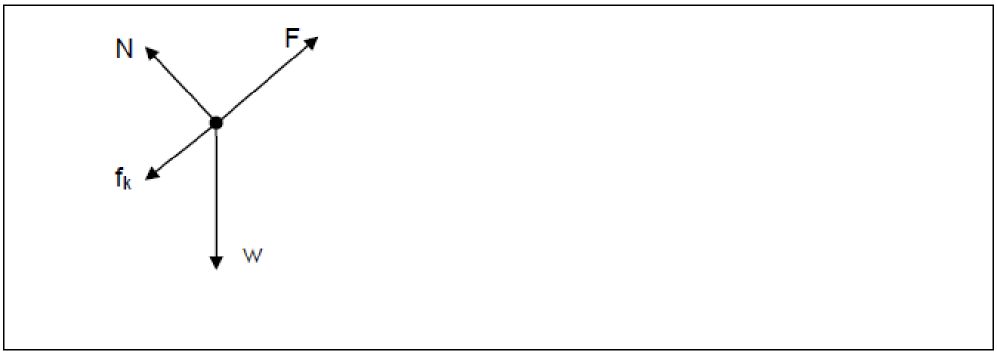
1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	A✓✓	(2)
1.4	C✓✓	(2)
1.5	B✓✓	(2)
1.6	A✓✓	(2)
1.7	D✓✓	(2)
1.8	B✓✓	(2)
1.9	C✓✓	(2)
1.10	D✓✓	(2)
		[20]

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 *F_g / F_w /gewig/mg/78,4 N/gravitasiekrag*
F	F_{app}/F_A / applied force (Accept T / tension) $F_{toegepas}$/ 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

$F_{net} = ma$ ✓ $F_{net} = 0$ $F+(-f_k) + (-F_{g\parallel}) = ma$ $F- (f_k + F_{g\parallel}) = ma$ $\underline{F - 20,37}$✓ - $\underline{(8)(9,8)\sin 30^\circ}$✓ = 0 F = 59,57 N ✓

(5)

2.1.4

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$\left.\begin{array}{l}F_{net} = ma\\(F_{g\parallel} - f_k) = ma\end{array}\right\}$ ✓ $\underline{(8)(9,8)\sin 30^\circ - 20,37}$✓ = 8a ✓ ∴magnitude/*grootte:* a = 2,35 m·s^{-2}✓	$\left.\begin{array}{l}F_{net} = ma\\(f_k - F_{g\parallel}) = ma\end{array}\right\}$ ✓ $\underline{20,37 + [-(8)(9,8)\sin 30^\circ]}$✓ = 8a ✓ ∴a = -2,35 m·s^{-2} ∴ magnitude/*grootte:* a = 2,35 m·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*
$g = \frac{GM}{r^2}$ ✓ $\overset{✓}{6} = \frac{(6,67 \times 10^{-11})M}{(700 \times 10^3)^2}$✓ M = 4,41 x 10^{22} kg ✓	$F = G\frac{m_1m_2}{r^2}$ $mg = \frac{GmM}{r^2}$ ✓ $(200)\overset{✓}{(6)} = \frac{(6,67 \times 10^{-11})(200)M}{(700 \times 10^3)^2}$✓ M = 4,41 x 10^{22} kg ✓

(4)
[21]

QUESTION 3 / *VRAAG 3*

3.1

OPTION 1/*OPSIE 1*	
Upwards positive ***Opwaarts positief:*** $v_f = v_i + a\Delta t$ ✓ $0 = (12) + (-9,8)(\Delta t)$ ✓ $\Delta t = 1,22$ s ✓	**Downwards positive** ***Afwaarts positief:*** $v_f = v_i + a\Delta t$ ✓ $0 = (-12) + (9,8)(\Delta t)$ ✓ $\Delta t = 1,22$ s ✓

OPTION 2/*OPSIE 2*	
Upwards positive ***Opwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ $0 = 12^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 7,35$ $\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓ $7,35 = 12\Delta t + ½ (-9,8)\Delta t^2$ $\Delta t = 1,22$ s ✓	**Downwards positive** ***Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (-12)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -7,35$ $\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓ $-7,35 = -12\Delta t + ½ (9,8) \Delta t^2$ $\Delta t = 1,22$ s ✓

OPTION 3/*OPSIE 3*	
Upwards positive ***Opwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ $0 = 12^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 7,35$ 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 ✓	**Downwards positive** ***Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (-12)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -7,35$ 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 4/*OPSIE 4*	
$(E_{mech})_A = (E_{mech})_{top}$ $(½ mv^2 + mgh)_A = (½ mv^2 + mgh)_{top}$ $\underline{½m(12)^2 + 0 = 0 + m(9,8)(h)}$ ✓ $\therefore h = \Delta y = 7,35$ m	
OR/OF $W_{net} = \Delta E_k$ $F_{net}\Delta y\cos\theta = ½ m(v_f^2 - v_i^2)$ $\underline{m(9,8)\Delta y\cos 180^\circ} = \underline{½ m(0^2 - (12)^2)}$ ✓ $\Delta y = 7,35$ 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 ✓
OR/OF $\Delta E_p + \Delta E_k = 0$ $mg(h_f - h_i) + ½ m(v_f^2 - v_i^2) = 0$ $\underline{m(9,8)(h - 0) + ½(m)(0 - 12^2) = 0}$ ✓ $\therefore h = \Delta y = 7,35$ m	

OPTION 5/*OPSIE 5*	
Upwards positive	**Downwards positive**
Opwaarts positief:	***Afwaarts positief:***
$F_{net}\Delta t = m(v_f - v_i)$ ✓	$F_{net}\Delta t = m(v_f - v_i)$ ✓
$mg\Delta t = m(v_f - v_i)$	$mg\Delta t = m(v_f - v_i)$
$(-9,8)\Delta t = (0 - 12)$ ✓	$(9,8)\Delta t = (0 - (-12))$ ✓
$\Delta t = 1,2245$ s ✓	$\Delta t = 1,2245$ s ✓

OPTION 6/*OPSIE 6*	
Upwards positive	**Downwards positive**
Opwaarts positief:	***Afwaarts positief:***
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$0 = 12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$	$0 = -12\Delta t + \frac{1}{2}(9,8)\Delta t^2$
$\Delta t = 2,4490$ s	$\Delta t = 2,4490$ s
$\Delta t = \frac{1}{2}(2,4490)$ ✓	$\Delta t = \frac{1}{2}(2,4490)$ ✓
$= 1,2245$ s ✓	$= 1,2245$ s ✓

(3)

3.2

OPTION 1/*OPSIE 1*	
Upwards positive	**Downwards positive**
Opwaarts positief:	***Afwaarts positief:***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{-3v = -v}$ ✓ + $\underline{(-9,8)(1,22)}$ ✓	$\underline{3v = v}$ ✓ + $\underline{(9,8)(1,22)}$ ✓
$v = 5,98\ m\cdot s^{-1}$ ✓ $(5,978 - 6,03\ m\cdot s^{-1})$	$v = 5,98\ m\cdot s^{-1}$ ✓ $(5,978 - 6,03\ m\cdot s^{-1})$

OPTION 2/*OPSIE 2*	
Upwards positive	**Downwards positive**
Opwaarts positief:	***Afwaarts positief:***
$F_{net}\Delta t = m(v_f - v_i)$ ✓	$F_{net}\Delta t = m(v_f - v_i)$ ✓
$mg\Delta t = m(v_f - v_i)$	$mg\Delta t = m(v_f - v_i)$
$(-9,8)(1,2245)$ ✓ $= \underline{-3v - (-v)}$ ✓	$(9,8)(1,2245)$ ✓ $= 3v - v$ ✓
$v = 6,00\ m\cdot s^{-1}$ ✓	$v = 6,00\ m\cdot s^{-1}$ ✓

(4)

3.3

OPTION 1/*OPSIE 1*	
Upwards positive	Downwards positive
Opwaarts positief:	*Afwaarts positief:*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{(-5,98)(2,44) + \frac{1}{2}(-9,8)(2,44)^2}$ ✓	$= \underline{(5,98)(2,44) + \frac{1}{2}(9,8)(2,44)^2}$ ✓
$= -43,764$	$= 43,764$
$\therefore h = 43,76$ m ✓ (43,764 – 44,08 m)	$\therefore h = 43,76$ m ✓ (43,764 – 44,08)

OPTION 2/*OPSIE 2*	
Upwards positive ***Opwaarts positief*** $v_f = v_i + a\Delta t$ $v_f = -5{,}98 + (-9{,}8)(2{,}44)$ $v_f = -29{,}892\ m\cdot s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{(-29{,}892)^2 = (-5{,}98)^2 + 2(-9{,}8)\Delta y}$ ✓ $\Delta y = -43{,}763$ m $\therefore h = 43{,}76$ m ✓ (43,764 – 44,08)	**Downwards positive** ***Afwaarts positief:*** $v_f = v_i + a\Delta t$ $v_f = 5{,}98 + 9{,}8(2{,}44)$ $= 29{,}892\ m\cdot s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{(29{,}892)^2 = (5{,}98)^2 + 2(9{,}8)\Delta y}$ ✓ $\Delta y = 43{,}76$ m $\therefore h = 43{,}76$ m ✓ (43,764 – 44,08)

OPTION 3/*OPSIE 3*	
Upwards positive ***Opwaarts positief*** $v_f = v_i + a\Delta t$ $v_f = -5{,}98 + (-9{,}8)(2{,}44)$ $v_f = -29{,}892\ m\cdot s^{-1}$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\left(\frac{-30 + (-6{,}00)}{2}\right)(2{,}4490)\right)$ ✓ $\Delta x = -44{,}082$ m h = 44,082 m ✓	**Downwards positive** ***Afwaarts positief:*** $v_f = v_i + a\Delta t$ $v_f = 5{,}98 + 9{,}8(2{,}44)$ $= 29{,}892\ m\cdot s^{-1}$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\left(\frac{30 + 6{,}00}{2}\right)(2{,}4490)\right)$ ✓ $\Delta x = 44{,}082$ m h = 44,082 m ✓

OPTION 4/*OPSIE 4*	
Upwards positive ***Opwaarts positief*** **For A/ *Vir A*** $v_f = v_i + a\Delta t$ $-12 = 12 + (-9{,}8)\Delta t$ $\Delta t = 2{,}45$ s **For B/ *Vir B*** $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= \underline{(-5{,}98)(2{,}45) + \frac{1}{2}(-9{,}8)(2{,}45)^2}$ ✓ $= -44{,}06$ m h = 44,06 m ✓	**Downwards positive** ***Afwaarts positief:*** **For A/ *Vir A*** $v_f = v_i + a\Delta t$ $12 = -12 + (9{,}8)\Delta t$ $\Delta t = 2{,}45$ s **For B/ *Vir B*** $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= \underline{(5{,}98)(2{,}45) + \frac{1}{2}(9{,}8)(2{,}45)^2}$ ✓ $= 44{,}06$ m h = 44,06 m ✓

(3)

OPTION 5/*OPSIE 5*	
Upwards positive ***Opwaarts positief*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y_A = 12\Delta t + \frac{1}{2} a\Delta t^2$ $\Delta y_B = -6\Delta t + \frac{1}{2} a\Delta t^2$ $\Delta y_A - \Delta y_B = 12\Delta t - (-6\Delta t)$ $0 - \Delta y_B = 18\Delta t$ ✓ $= 18(2{,}44)$ $= 43{,}92$ m h = 43,92 m ✓	**Downwards positive** ***Afwaarts positief:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y_A = -12\Delta t + \frac{1}{2} a\Delta t^2$ $\Delta y_B = 6\Delta t + \frac{1}{2} a\Delta t^2$ $\Delta y_A - \Delta y_B = 12\Delta t - (-6\Delta t)$ $0 - \Delta y_B = -18\Delta t$ ✓ $= -18(2{,}44)$ $= 43{,}92$ m h = 43,92 m ✓

(3)

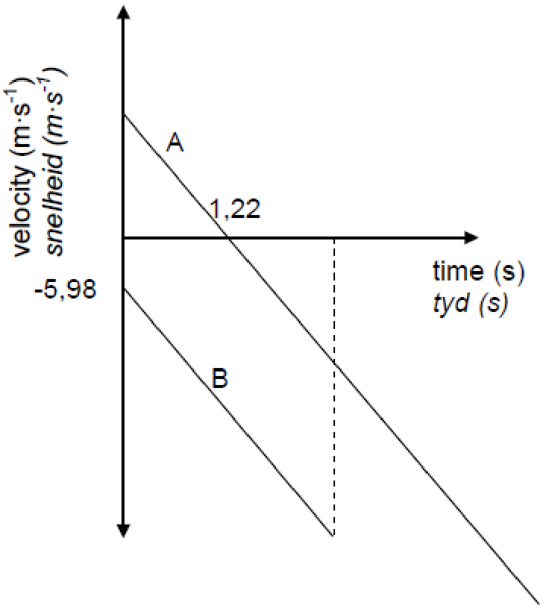
OPTION 6/*OPSIE 6*	
Upwards positive	**Downwards positive**
Opwaarts positief	***Afwaarts positief:***
$W_{net} = \Delta E_k$ ✓	$W_{net} = \Delta E_k$ ✓
$mg\Delta y\cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$	$mg\Delta y\cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$
$\underline{(-9,8)h\cos 0^o} = \underline{\frac{1}{2}(-20)^2 - \frac{1}{2}(-6)^2}$ ✓	$\underline{(9,8)h\cos 0^o} = \underline{\frac{1}{2}(20)^2 - \frac{1}{2}(6)^2}$ ✓
h = 44,082 m ✓	h = 44,082 m ✓

OPTION 7/*OPSIE 7*
$\left.\begin{array}{l}(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder} \\ mgh_i + \frac{1}{2} mv_i^2 = mgh_f + \frac{1}{2} mv_f^2\end{array}\right\}$ ✓
$\underline{(9,8)h + \frac{1}{2}(6)^2} = \underline{(9,8)(0) + \frac{1}{2}(30)^2}$ ✓
h = 44,082 m ✓

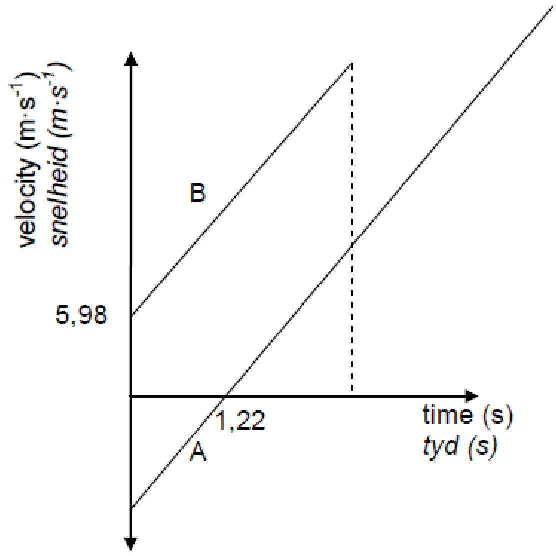
(3)

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 linière 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 linière 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

<u>OPTION 1/*OPSIE 1*</u>

$F_{net}\Delta t = \Delta p$
$\Delta p = mv_f - mv_i$ ✓

For bullet / *Vir koeël*

$\Delta p = (0,015)(306,666 - 400)$ ✓
$= -1,4\ kg\cdot m\cdot s^{-1}$
$F_{net}(0,002) = -1,4$
$F_{net} = -700\ N$

For block / *Vir blok*

$\Delta p = (2)(0,7 - 0)$ ✓
$= 1,4\ kg\cdot m\cdot s^{-1}$
$F_{net}(0,002) = 1,4$
$F_{net} = 700\ N$

$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$
$(700)\Delta x\cos 180^\circ$ ✓ $= \frac{1}{2}(0,015)(306,67^2 - 400^2)$ ✓
$\Delta x = 0,71\ m$ ✓

$F_{net} = ma$
$-700 = (0,015)a$
OR/*OF*
$F_{net} = ma$
$700 = (0,015)a$

$a = -46\ 666,67$
or/*of* $46\ 665\ m\cdot s^{-2}$

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (400)(0,002)$ ✓ $+ \frac{1}{2}(-46\ 666,67)(0,002)^2$ ✓
$= 0,71\ m\ (0,70667)\ m$ ✓

OR/OF
$v_f^2 = v_i^2 + 2a\Delta x$
$(306,67)^2$ ✓ $= (400)^2 + 2(-46\ 666,67)\Delta x$ ✓
$\Delta x = 0,71\ m\ (0,70667\ m)$ ✓

<u>OPTION 2/*OPSIE 2*</u>

$v_f = v_i + a\Delta t$ ✓
$306,666 = 400 + a(0,002)$ ✓
$a = -46\ 667\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$
$(306,666)^2$ ✓ $= 400^2 + 2(-4667)\Delta x$ ✓
$\Delta x = 0,71\ m\ (0,706\ m)$ ✓

<u>OPTION 3/*OPSIE 3*</u>

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \left(\frac{400 + 306,666}{2}\right)(0,002)$ ✓✓✓

$= 0,71\ m\ (0,707)\ m$ ✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K/\Delta E_k$ ✓

$F_{net}\Delta x\cos\theta = ma\Delta x\cos\theta = \Delta K/\Delta E_k$

$v_f = v_i + a\Delta t$

$306{,}666 = 400 + a\,(0{,}002)$ ✓

$a = -46\ 667\ m\cdot s^{-2}$

$W_{net} = \Delta K/\Delta E_k$

$F_{net}\Delta x\cos\theta = ma\Delta x\cos\theta = \Delta K/\Delta E_k$

$(0{,}015)(46\ 667)\Delta x\cos180^{\circ}$ ✓ $= \frac{1}{2}(0{,}015)(306{,}666^2 - 400^2)$ ✓

$\Delta x = 0{,}71\ m\ (0{,}707)$ ✓

OR/*OF*

$W_{nc} = \Delta E_p + \Delta E_k$

$(0{,}015)(46\ 667)\Delta x\cos180^{\circ}$ ✓ $= \frac{1}{2}(0{,}015)(306{,}666^2 - 400^2)$ ✓

$\Delta x = 0{,}71\ m\ (0{,}707)$ ✓ (5)

[11]

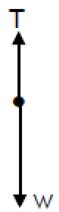
QUESTION 5/*VRAAG 5*

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 / $F_{\text{earth on block}}$ *F_g / F_w / gewig / mg /58,8 N/ gravitasiekrag / $F_{\text{aarde op blok}}$*
T	F_T/ Tension/ *spanning*

5.3

$W_w = w\Delta x\cos\theta$ ✓ $= mg\Delta x\cos\theta$ $= (6)(9{,}8)(1{,}6)\cos0^{\circ}$ ✓ $\therefore W = 94{,}08\ J$ ✓	$W_w = -\Delta E_P$ ✓ $= -mg(h_f - h_i)$ $= -(6)(9{,}8)(0 - 1{,}6)$ ✓ $= 94{,}08\ J$ ✓

(3)

5.4

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_K$ /ΔK✓ $= \frac{1}{2}m(v_f^{\ 2} - v_i^{\ 2})$
$W_{net} = F_{net}\Delta x\cos\theta$
$W_{net} = W_f + W_g + W_N$
$= \mu_k N\Delta x\cos\theta + W_g + W_N$

$W_{net} = \underline{(0,4)(4)(9,8)(1,6)\cos 180^o}$ ✓ $+ 94,08 + 0$
$= 68,992$ J
$W_{net} = \frac{1}{2}m(v_f^{\ 2} - v_i^{\ 2})$
$\underline{68,992}$✓ $= \underline{\frac{1}{2}(4)(v_f^{\ 2} - 0) + \frac{1}{2}(6)(v_f^2 - 0)}$✓
$v_f = 3,71\ m\cdot s^{-1}$✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$f\Delta x\cos\theta = (m_1gh_f - m_1gh_i) + (\frac{1}{2}m_1v_f^2 - \frac{1}{2}m_1v_i^2) + (\frac{1}{2}m_2v_f^2 - \frac{1}{2}m_2v_i^2)$
$\underline{(0,4)(4)(9,8)\ (1,6)\ \cos 180^o}$ ✓ $= [0 - (6)(9,8)(1,6)]$✓ $+ (\frac{1}{2}(6)v_f^2 + \frac{1}{2}(4)v_f^2 - 0)$✓
$68,992 = 5v_f^2$
$v_f = 3,71\ m\cdot s^{-1}$✓

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

$F_{net} = ma$
$= (6)(4,312)$
$= 25,872$

$W_{net} = F_{net}\Delta x\cos\theta$
$= (25,872)(1,6)\cos 0^o$✓
$= 41,3952$ J

$W_{net} = \Delta E_k$✓
$41,3952 = \frac{1}{2}m(v_f^2 - v_i^2$
$\underline{41,3952 = \frac{1}{2}(6)(v_f^2 - 0)}$✓
$v_f = 3,7146\ m\cdot s^{-1}$✓

Above calculations can be done with 4 kg or 10 kg / *Bostaande berekeninge kan met 4 kg of 10 kg gedoen word*

<u>4 kg block</u>
$W_{net} = \Delta E_K$ /ΔK✓
$W_f + W_T = \frac{1}{2}m(v_f^2 - v_i^2)$

$f\Delta x\cos 180^o + T\Delta x\cos 0^o = \frac{1}{2}(4)(v_f^2 - 0)$
$(15,68)(1,6)(-1)$✓ $+ (32,928)(1,6)(1)$✓ $= 2v_f^2$
$v_f = 3,72\ m\cdot s^{-1}$✓

<u>6 kg block</u>
$W_{net} = \Delta E_K$ /Δ K✓
$W_w + W_T = \frac{1}{2}m(v_f^2 - v_i^2)$

$mg\Delta x\cos 0^o + T\Delta x\cos 180^o = \frac{1}{2}(6)(v_f^2 - 0)$
$(6)(9,8)(1,6)(1)$✓ $+ (32,928)(1,6)(-1)$✓ $= 3v_f^2$
$v_f = 3,72\ m\cdot s^{-1}$✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_K / \Delta K$ ✓

For the 4 kg mass / *Vir die 4 kg massa*

$T(1,6)\cos 0^\circ + [(0,4)(9,8)(4)](1,6)\cos 180^\circ$ ✓ $= ½(4)v^2 – 0)$

For the 6 kg mass/*Vir die 6 kg massa*

$(6)(9,8)(1,6)]\cos 0^\circ + T(1,6)\cos 180^\circ$ ✓ $= ½(6)(v^2 – 0)$

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*

$W_{net} = \Delta E_k$ ✓

$F_{net}\ \Delta x \cos\theta = ½\ m(v_f^2 – v_i^2)$

$(F_g – f)\Delta x \cos\theta = ½m(v_f^2 – v_i^2)$

$[(6)(9,8) – (0,4)(4)(9,8)]$ ✓ $(1,6)\cos 0^\circ$ ✓ $= ½(10)(v_f^2 - 0)$ ✓

$v_f = 3,71 m.s^{-1}$ ✓ (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

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark$$

$$170 = \frac{(340+0)}{(340 - v_s)} \times f_s \quad \text{------------} \quad (1)$$

$$130 = \frac{(340-0)}{340 + v_s} \times f_s \quad \text{------------} \quad (2)$$

$v_s = 45,33\ m \cdot s^{-1}$ ✓ $(45,33 – 45,45\ m \cdot s^{-1})$ (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*

$$F = k\frac{Q_1Q_2}{r^2} \checkmark$$

$$= \frac{(9\times10^9)(6\times10^{-6})(8\times10^{-6})}{(0,2)^2} \checkmark\checkmark$$

$$= 10,8\ \text{N} \checkmark$$

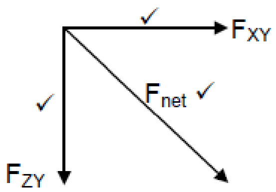
OPTION 2/ *OPSIE 2*

$$E = \frac{kQ}{r^2} = \frac{(9\times10^9)(8\times10^{-6})}{(0,2)^2 \checkmark} = 1,8 \times 10^4\ \text{N·C}^{-1}$$

$$F = Eq = (1,8 \times 10^4)(6 \times 10^{-6}) \checkmark = 10,8\ \text{N} \checkmark$$

(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

$F_{ZY} = k\dfrac{Q_ZQ_Y}{r^2}$

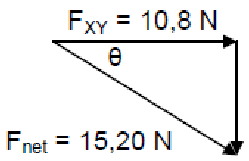
$10{,}696 ✓ = 9 \times 10^9 \times \dfrac{8 \times 10^{-6} \times Q_Z}{(0{,}30)^2}$ ✓

$Q_Z = 1{,}34 \times 10^{-5}$ C ✓

OPTION 2 /*OPSIE 2*

$\cos\theta = \dfrac{10{,}8}{15{,}2}$

$\theta = 44{,}72^{\circ}$



$\sin 44{,}72 = \dfrac{F_{ZY}}{15{,}2}$ ✓ **OR/*OF*** $\tan 44{,}72 = \dfrac{F_{ZY}}{F_{XY}}$

F_{ZY} = 10,696 N

$F_{ZY} = k\dfrac{Q_ZQ_Y}{r^2}$

$10{,}696 ✓ = 9 \times 10^9 \times \dfrac{8 \times 10^{-6} \times Q_Z}{(0{,}30)^2}$ ✓

$Q_Z = 1{,}34 \times 10^{-5}$ C ✓ (4)

[13]

QUESTION 8 / *VRAAG 8*

8.1 Electric field at a point is the force per <u>unit</u> <u>positive</u> charge placed at that point. ✓✓
Elektriese veld by 'n punt is die krag per <u>eenheids</u> <u>positiewe</u> lading geplaas by daardie punt. (2)

8.2

$E = \dfrac{kQ}{r^2}$ ✓

$E_{net} = (E_A + E_B)$

$= 9 \times 10^9 \dfrac{(1{,}5 \times 10^{-6})}{(0{,}4)^2}$ ✓ $+ 9 \times 10^9 \dfrac{(2{,}0 \times 10^{-6})}{(0{,}3)^2}$ ✓

$= 2{,}84 \times 10^5\ N \cdot C^{-1}$ ✓ (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 ✓

<u>OPTION 2/*OPSIE 2*</u>

$F = \dfrac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = (F_A + F_B)$

$= \left(\dfrac{(9\times10^9)(3\times10^{-6})(1,5\times10^{-6})}{(0,4)^2} + \dfrac{(9\times10^9)(3\times10^{-6})(2,0\times10^{-6})}{(0,3)^2}\right)$ ✓

$= 8,53 \times 10^{-4}$ N ✓ (3)

[9]

QUESTION 9 / *VRAAG 9*

9.1.1 The potential difference (voltage) across a conductor is <u>directly</u> proportional to the current in the conductor at <u>constant temperature</u>. ✓✓
Die potensiaalverskil (spanning) oor 'n geleier is <u>direk</u> eweredig aan die stroom in die geleier by <u>konstante temperatuur</u>.
OR/*OF*
The current in a conductor is <u>directly</u> proportional to the potential difference (voltage) across the conductor if <u>temperature is constant</u>✓✓
Die stroom in 'n geleier is <u>direk</u> eweredig aan die potensiaalverskil (spanning) oor die geleier indien die <u>temperatuur konstant</u> is. (2)

9.1.2 (Equivalent) resistance/ (*Ekwivalente) weerstand*✓ (1)

9.1.3

Gradient/*Helling* $= \dfrac{\Delta V}{\Delta I}$

$= \dfrac{2-0}{0,5-0}$ ✓ $= 4\ (\Omega)$✓ (2)

9.1.4 **<u>OPTION 1/*OPSIE 1*</u>**

In series $R_1 + R_2 = 4\ \Omega$ ✓............(1)

In parallel $\dfrac{R_1R_2}{R_1+R_2} = 1\ \Omega$ ✓✓..........(2)

$R_1R_2 = 4\ \Omega$

$\therefore R_1 = R_2 = 2\ \Omega$ ✓

<u>OPTION 2/*OPSIE 2*</u>

For graph X/*Vir grafiek X*:

$R_1 + R_2 = 4$.................(1) ✓

For graph Y/*Vir grafiek Y*

$\dfrac{1}{R_{//}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

$\left\{\left(\dfrac{1}{R_1} + \dfrac{1}{R_2}\right) = \left(\dfrac{1}{1}\right)\right\}$ ✓ ✓ ....(2)

$R_1^2 - 4R_1 + 4 = 0$

$R_1 = 2\ \Omega$✓ (4)

9.2.1

$$I = \frac{V}{R}$$

$$= \frac{5}{(R_M + R_N)}$$

$$= \frac{5}{(6)}\ \checkmark$$

$$= 0{,}83\ A\checkmark$$

(3)

9.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\varepsilon = I(R + r)$ ✓ $= 0{,}83[(6 + 1{,}5)$ ✓ $+ 0{,}9$✓$]$ $= 6{,}997$ V $= 7(,00)$ V✓ (6,972 – 7,00 V)	$\varepsilon = (V_s + V_{//} + V_r)$✓ / $V_{ext/eks} + V_{int}$ $= [5 + (0{,}833 \times 1{,}5)$ ✓ $+ (0{,}9 \times 0{,}833)]$ ✓ $= 6{,}999$ V $= 7(,00)$ 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)

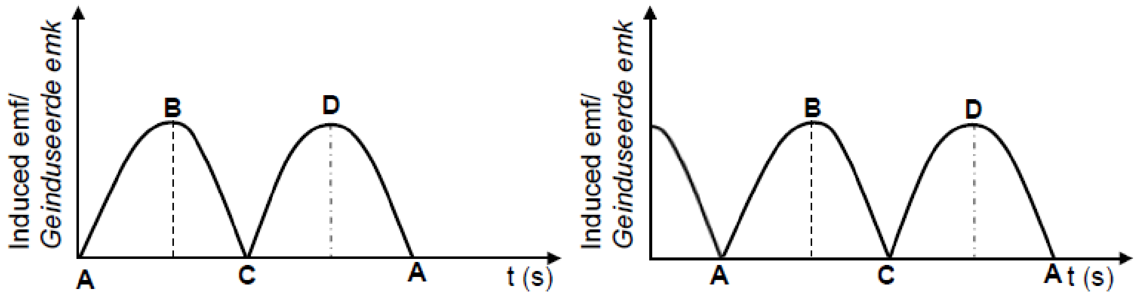
[18]

QUESTION 10 / *VRAAG10*

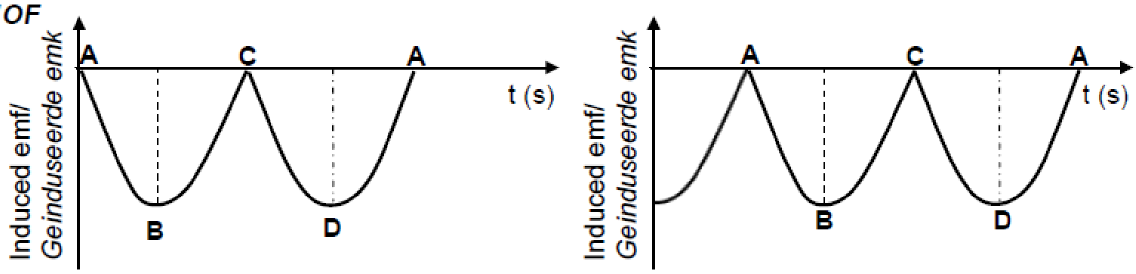
10.1

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

$P_{ave} = I_{rms}^2 R$ $= (1,22)^2(0,5)$ $= 0,74$ W $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $P_{ave} = \frac{(25)^2}{20,5}$ ✓ $P_{ave} = 30,49$ W Actual energy delivered per second(power) / *Energie aan toestel gelewer per sekonde (drywing)* $= (30,49 - 0,74)$ $= 29,75$ W✓	$P_{ave} = I_{rms}^2 R$✓ $= (1,22)^2(20)$ ✓ $= 29,77$ W✓ **OR/OF** $V_{rms/wgk\ device/toestel} = \frac{20}{20,5}$✓ $\times 25 = 24,39$ V $P_{ave} = V_{rms} I_{rms}$ ✓ $= (24,39)(1,22)$ $= 29,76$ W ✓	$W = I^2_{rms} R\Delta t$ $= (1,22)^2\ (0,5)(1)$ $= 0,74$ J $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $P_{ave} = \frac{(25)^2}{20,5}$ ✓ $P_{ave} = 30,49$ W Actual energy delivered per second(power) / *Energie aan toestel gelewer per sekonde (drywing)* $= (30,49 - 0,74)$ $= 29,75$ 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

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$
$hf = hf_0 + \frac{1}{2} m v^2_{max}$
$E = W_0 + \frac{1}{2} m v^2_{max}$

✓ Any one/*Enige een*

$4{,}09 \times 10^{-19}$ ✓ $= \underline{(6{,}63 \times 10^{-34})(4{,}4 \times 10^{14})}$ ✓ $+ E_{k(max)}$

$E_{k(max)} = 1{,}17 \times 10^{-19}$ J ✓

OR/OF

$E_{k(max)} = E_{light/lig} - W_o$
$= hf_{light/lig} - hf_o$

✓ Any one/*Enige een*

$= \underline{(6{,}63 \times 10^{-34})(6{,}17 \times 10^{14})}$ ✓ $- \underline{(6{,}63 \times 10^{-34})(4{,}4 \times 10^{14})}$ ✓
$= 1{,}17 \times 10^{-19}$ 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

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2017

MARKING GUIDELINES/*NASIENRIGLYNE*

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

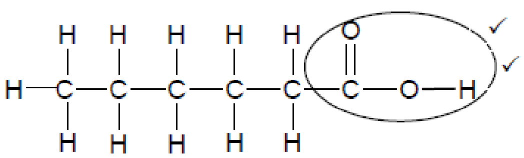
2.1

2.1.1 Esters ✓ (1)

2.1.2 Ethyl ✓ butanoate ✓/*Etielbutanoaat* (2)

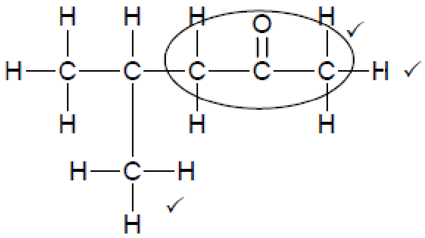
2.1.3 Butanoic acid/*Butanoësuur* ✓ (1)

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)

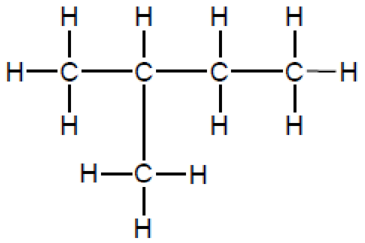
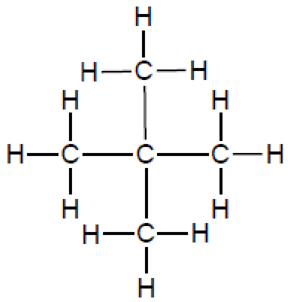
3.3.2 Q ✓
It is the temperature where the graph intercepts the dotted line. ✓
Dit is die temperatuur waar die grafiek die stippellyn sny.

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

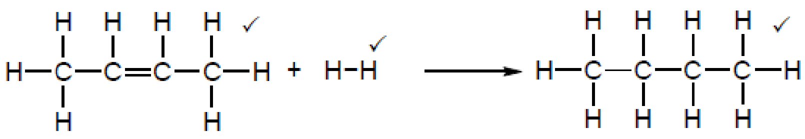
4.3.1 Substitution/Hydrolysis ✓
Substitusie/Hidrolise (1)

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-✓<u>bromobutane</u> ✓/*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. *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

<table>
<tr><td rowspan="2">

OPTION 1/*OPSIE 1*

Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t}$

$15 = \frac{\Delta V}{30 - 0}$ ✓

$V(H_2)_{produced/berei} = 450\ cm^3$

$n(H_2)_{produced/berei} = \frac{V}{V_m}$

$= \frac{450}{24\ 000}$ ✓

$= 0{,}0188\ mol$

$n(Zn) = n(H_2) = 0{,}0188\ mol$ ✓

$n(Zn)_{used/gebruik} = \frac{m}{M}$

$\therefore 0{,}0188 = \frac{m}{65}$ ✓

$\therefore m(Zn) = 1{,}22\ g$ ✓

</td><td>

OPTION 2/*OPSIE 2*

Ave rate/*Gem. tempo* = $\frac{15}{24\ 000}$ ✓

$= 6{,}25 \times 10^{-4}\ mol \cdot s^{-1}$

$V(H_2)_{produced/berei} = 6{,}25 \times 30$ ✓

$= 0{,}0188\ mol$

$n(Zn) = n(H_2) = 0{,}0188\ mol$ ✓

$n(Zn)_{used} = \frac{m}{M}$

$0{,}0188 = \frac{m}{65}$ ✓

$\therefore m(Zn) = 1{,}22\ g$ ✓

</td></tr>
<tr><td>

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 ✓

</td></tr>
</table>

(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*

$n = \frac{m}{M}$

$= \frac{1,12}{28}$ ✓

= 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*

$n = \frac{m}{M}$

$= \frac{1,2}{28}$ ✓

$= 0,04$ 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*

$n(COBr_2)_{eq/ewewig} = cV$

$= 2,11 \times 10^{-3} \times 2$ ✓

$= 4,22 \times 10^{-3}$ mol

$n(COBr_2)_{initial/begin}$

$= 0,04 + 4,22 \times 10^{-3}$ ✓

$= 0,044$ mol

% decomposed $= \frac{0,04 ✓}{0,044 ✓} \times 100$

$= 90,46\%$ ✓

Range/*Gebied*: 90,46 – 90,9%

OPTION 2/*OPSIE 2*

$n(COBr_2)_{eq/ewewig} = cV$

$= 2,11 \times 10^{-3} \times 2$ ✓

$= 4,22 \times 10^{-3}$ mol

$n(COBr_2)_{initial/begin}$

$= 0,04 + 4,22 \times 10^{-3}$ ✓

$= 0,044$ mol

$m(COBr_2)_{initial/begin} = nM$

$= 0,044 \times 188$

$= 8,27$ g

$m(COBr_2)_{reacted/reageer} = 0,04 \times 188$

$= 7,52$ g

% decomposed/*ontbind* $= \frac{7,52 ✓}{8,27} \times 100$

$= 90,9\%$ ✓ (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***
$pH = -\log[H_3O^+]$ ✓ 6 ✓ $= -\log[H_3O^+]$ $[H_3O^+] = 1 \times 10^{-6}\ mol \cdot dm^{-3}$ $[H_3O^+][OH^-] = 10^{-14}$ ✓ $[OH^-] = 1 \times 10^{-8}\ mol \cdot dm^{-3}$ ✓	$pH + pOH = 14$ ✓ 6 ✓ $+ pOH = 14$ $pOH = -\log[OH^-]$ ✓ $8 = -\log[OH^-]$ $[OH^-] = 1 \times 10^{-8}\ mol \cdot dm^{-3}$ ✓

(4)

7.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(Na_2CO_3) = \frac{m}{M}$ ✓ $= \frac{0,29}{106}$ ✓ $= 2,74 \times 10^{-3}$ mol $n(HC\ell) = 2n(Na_2CO_3)$ ✓ $= 5,47 \times 10^{-3}$ mol $c(HC\ell)_{dilute/verdun} = \frac{n}{V}$ $= \frac{5,47\times10^{-3}}{0,05}$ ✓ $= 0,1094\ mol \cdot dm^{-3}$ $cV(HC\ell)_{dilute/verdun} = cV(HC\ell)_{conc/gekons}$ $0,1094 \times 500$ ✓ $= (HC\ell)_{conc/gekons} \times 5$ ✓ $\therefore c(HC\ell)_{conc/gekons} = 10,94\ mol \cdot dm^{-3}$ ✓	$n(Na_2CO_3) = \frac{m}{M}$ ✓ $= \frac{0,29}{106}$ ✓ $= 2,74 \times 10^{-3}$ mol $n(HC\ell) = 2n(Na_2CO_3)$ ✓ $= 5,47 \times 10^{-3}$ mol In 50 cm^3: $n(HC\ell) = 5,47 \times 10^{-3}$ mol In 500 cm^3: $n(HC\ell) = \frac{500✓}{50}(5,47 \times 10^{-3})$ ✓ $= 0,547$ mol $c(HC\ell)_{conc/gekons} = 0,547 \times \frac{1000}{5 ✓}$ $= 10,94\ mol \cdot dm^{-3}$ ✓

(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* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓   = +0,80 ✓- (- 1,66) ✓   = 2,46 V ✓
OPTION 2/*OPSIE 2*   ✓ $Ag^+(aq) + e^- \rightarrow Ag(s)$ 0,80 V ✓ $A\ell(s) \rightarrow A\ell^{3+}(aq) + 3e^-$ 1,66 V ✓ $3Ag^+(aq) + A\ell(s) \rightarrow 3Ag(s) + A\ell^{3+}(aq)$ 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 $NH_3 + HNO_3$ ✓ $\rightarrow NH_4NO_3$ ✓ Bal. ✓ (3)

10.2

10.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
N : P : K 10 : 5 : 15 m(fertiliser/*kunsmis*) = $\frac{30}{100}$ x 15 = 4,5 kg m(P) = $\frac{5}{30}$ x 4,5 ✓ = 0,75 kg ✓	m(fertiliser/*kunsmis*) = $\frac{5}{100}$ x 15 ✓ = 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

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