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PHYSICAL SCIENCES

Grade 12 | PAST PAPER BOOKLET 2019

XLEducation

PHYSICS:

Examination Guidelines: P.i – P.ii

Data & Formulae Sheets: FP-1 – FP-2

CHEMISTRY:

Examination Guidelines: C.i – C.iii

Data & Formulae Sheets: FC-1 – FC-4

Physical Science Papers - Index & Journal

Paper Description		Page #		Date each time I completed this paper	1 st Attempt Mark %	2 nd Attempt Mark %
		Paper	Memo			
PAPER 1 (PHYSICS)						
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NSC February-March	2018	P1-5 – P1-9	M1-6 – M1-9			
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PAPER 2 (CHEMISTRY)						
NSC November	2017	P2-1 – P2-4	M2-1 – M2-3			
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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: $F_{\text{net}} = \frac{\Delta p}{\Delta t}$
- 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: $F_{\text{net}}\Delta t = m\Delta v$
- 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.

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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: $W_{\text{net}} = \Delta K = K_f - K_i$
- 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: $W_{\text{nc}} = \Delta E_k + \Delta E_p$
- 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 $P_{\text{avg}} = Fv_{\text{avg}}$ 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.

$$\text{In symbols: } E = \frac{F}{q}$$

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

Electric Circuits

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

Ohm's law (Grade 11)

- State Ohm's law in words: The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
- Determine the relationship between current, voltage and resistance at constant temperature using a simple circuit.
- State the difference between ohmic conductors and non-ohmic conductors and give an example of each.

- Solve problems using $R = \frac{V}{I}$ for series and parallel circuits (maximum four resistors).

Power, energy (Grade 11)

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

Internal resistance, series and parallel networks

- Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel (maximum four resistors).
- Explain the term internal resistance.
- Solve circuit problems using $\epsilon = V_{\text{load}} + V_{\text{internal resistance}}$ Or $\epsilon = IR_{\text{ext}} + Ir$.
- 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 $I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$, $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$.

- Solve problems using $P_{\text{ave}} = I_{\text{rms}}V_{\text{rms}} = \frac{1}{2} I_{\text{max}}V_{\text{max}}$ (for a purely resistive circuit),

$$P_{\text{ave}} = I_{\text{rms}}^2 R \text{ and } P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$$

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_0 , as the minimum frequency of light needed to emit electrons from a certain metal surface.
- Define work function, W_0 : 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:
 $E = W_0 + E_{\text{max}}$, where $E = hf$ and $W_0 = hf_0$ and $E_{\text{max}} = \frac{1}{2} m(v_{\text{max}})^2$
- 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.

Conventions (e.g. signs, symbols, terminology and nomenclature)

The syllabus and question papers will conform to generally accepted international practices.

NOTE:

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

4.2 INFORMATION SHEETS – PAPER 1 (PHYSICS)**TABLE 1: PHYSICAL CONSTANTS**

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

TABLE 2: FORMULAE**MOTION**

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

FORCE

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

WORK, ENERGY AND POWER

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

WAVES, SOUND AND LIGHT

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

ELECTROSTATICS

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

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$R_s = R_1 + R_2 + \dots$	$\text{emf } (\mathcal{E}) = I(R + r)$
$Q = I\Delta t$	$W = Vq = VI\Delta t = I^2R\Delta t = \frac{V^2\Delta t}{R}$
$P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$	

ALTERNATING CURRENT

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$	$P_{\text{average}} = V_{\text{rms}} I_{\text{rms}} = I_{\text{rms}}^2 R = \frac{V_{\text{rms}}^2}{R}$
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GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2017

MARKS: 150

TIME: 3 hours

This question paper consists of 19 pages and 3 data sheets.

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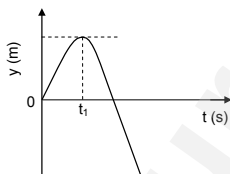
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- 1.3 A stone is projected vertically upwards from the top of a building at a speed of $v \text{ m s}^{-1}$. The position-time graph below represents the motion of the stone. Ignore the effects of air resistance.



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)

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

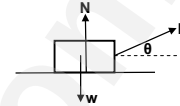
- 1.1 The acceleration due to gravity on Earth is greater than that on the moon.

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)

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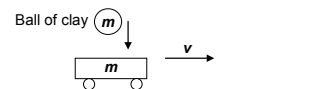
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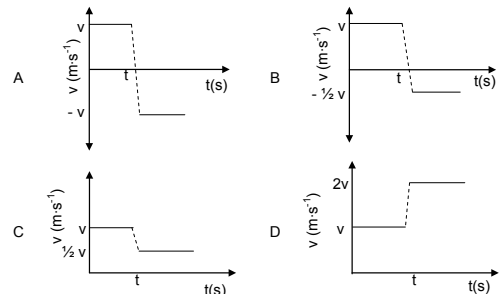
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- 1.4 A trolley of mass m is moving at constant velocity v to the right on a frictionless horizontal surface. A ball of clay, also of mass m , dropped vertically, falls onto the trolley at time t , as shown in the diagram below.



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 $2t$.

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

- A $\frac{1}{2}x$
- B x
- C $2x$
- D $4x$

(2)

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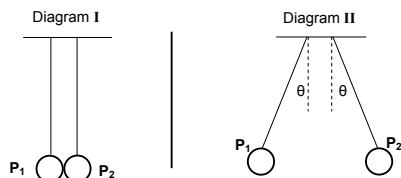
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- 1.6 The wavelengths of light emitted by a distant star appear shorter when observed from Earth. From this we can conclude that the star is ...
- A moving towards Earth and the light is blue shifted.
B moving towards Earth and the light is red shifted.
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)

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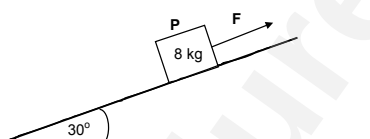
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QUESTION 2 (Start on a new page.)

- 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 $6,0 \text{ m s}^{-2}$.
- 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)

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- 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 $\frac{1}{4}P$
B $\frac{1}{2}P$
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)

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9
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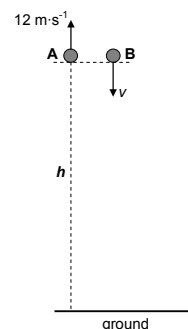
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QUESTION 3 (Start on a new page.)

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 $3v$.

- 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]

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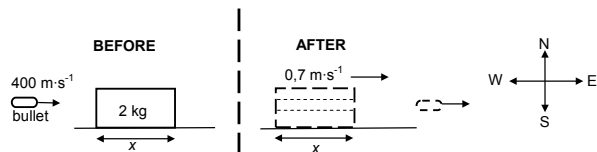
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QUESTION 4 (Start on a new page.)

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 $0,7 \text{ m s}^{-1}$ 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]

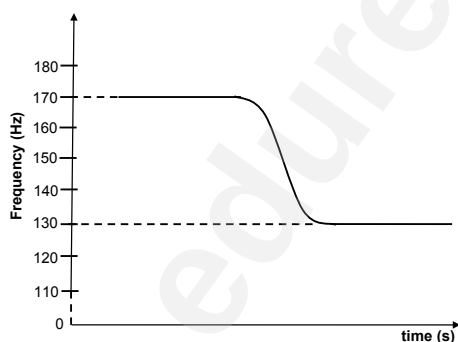
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QUESTION 6 (Start on a new page.)

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 s^{-1} . (6)
[10]

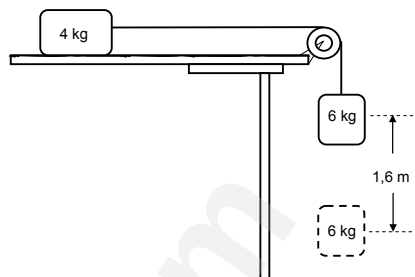
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QUESTION 5 (Start on a new page.)

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.

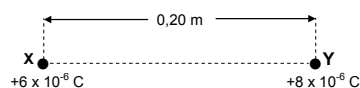
- 5.4 Use **energy principles** to calculate the speed of the 6 kg block when it falls through 1,6 m while still attached to the 4 kg block. (5)
[12]

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QUESTION 7 (Start on a new page.)

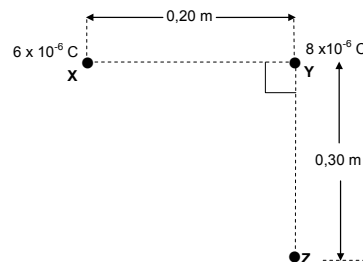
Two small spheres, **X** and **Y**, carrying charges of $+6 \times 10^{-6} \text{ C}$ and $+8 \times 10^{-6} \text{ C}$ respectively, are placed 0,20 m apart in air.



- 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)

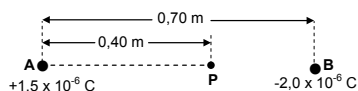
- 7.4 The magnitude of the net electrostatic force experienced by charged sphere **Y** is 15,20 N. Calculate the charge on sphere **Z**. (4)
[13]

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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 $+1,5 \times 10^{-6}$ C and sphere **B** carries a charge of $-2,0 \times 10^{-6}$ 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 $3,0 \times 10^{-9}$ C is now placed at point **P**. Calculate the magnitude of the electrostatic force experienced by this charge. (3)

[9]

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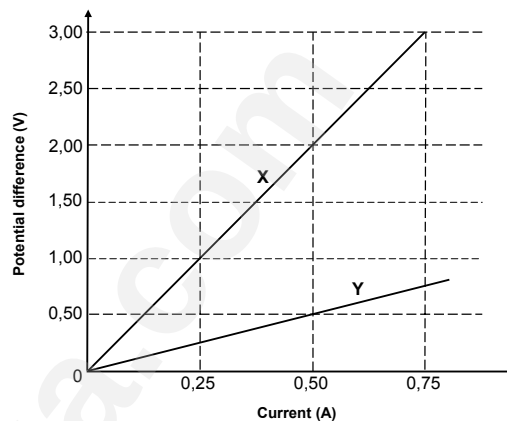
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QUESTION 9 (Start on a new page.)

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

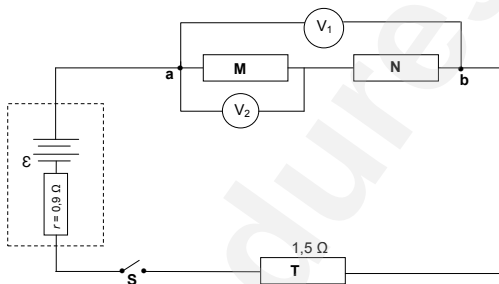


- 9.1.1 State Ohm's law in words. (2)
- 9.1.2 What physical quantity does the gradient (slope) of the V - I graph represent? (1)
- 9.1.3 Calculate the gradient (slope) of graph **X**. (2)
- 9.1.4 Determine the resistance of resistor R_1 . (4)

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



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.) (2)
- Give a reason for the answer. [18]

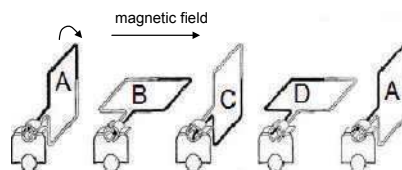
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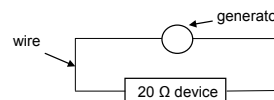
QUESTION 10 (Start on a new page.)

- 10.1 The diagram below shows different positions (**ABCD**) 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 20Ω . The wires connecting the generator to the device have a total resistance of $0,5 \Omega$. 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)

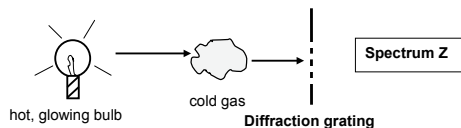
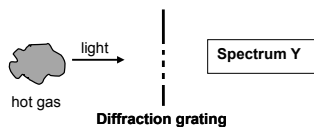
[9]

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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:

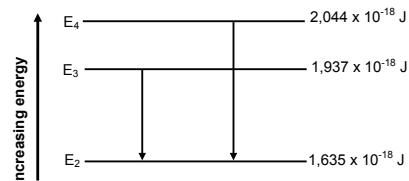
- 11.1.1 **Y** (1)
11.1.2 **Z** (1)

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- 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 E_4 to 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 threshold 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. (2)
Give a reason for the answer. [13]

TOTAL: 150

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NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2018

MARKS: 150

TIME: 3 hours

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

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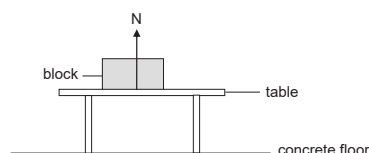
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Feb-Mar 2018

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 A constant horizontal force F is applied to a box resting on a horizontal, frictionless surface.
Which ONE of the following statements regarding force F is CORRECT?
Force F will cause the box to move with ...
A constant acceleration.
B constant velocity.
C constant kinetic energy.
D constant momentum. (2)
1.2 A block rests on a table. The table stands on a concrete floor. The normal force is represented by N , as shown in the diagram below.



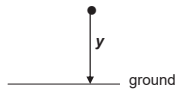
Which ONE of the following forces will form an action-reaction pair with the normal force (N)?

- A Force of the block on the Earth
B Force of the block on the table
C Force of the table surface on the block
D Force of the block on the concrete floor (2)

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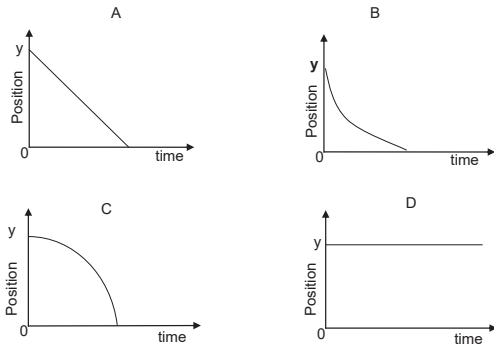
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- 1.3 A small stone is dropped from a height y above the ground. It strikes the ground after time t , as shown in the diagram below.



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

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

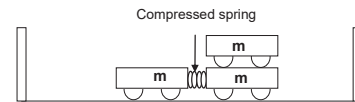


(2)

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

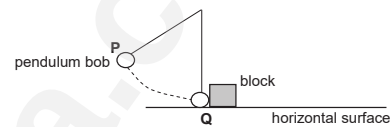


When the spring is released it falls vertically down and the single trolley moves with momentum p to the left. The magnitude of the momentum of the two trolleys moving to the right will be:

- A $2p$
B p
C $\frac{1}{2}p$
D $\frac{1}{4}p$

(2)

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



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

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

(2)

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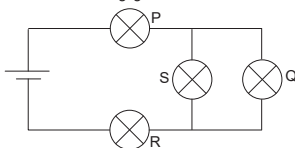
- 1.6 Which ONE of the statements below about the Doppler effect is CORRECT?
- A The Doppler effect is only applicable to sound waves.
B The Doppler effect can be used to explain the expanding universe.
C Electrons are ejected from a metal surface by means of the Doppler effect.
D A stationary listener hears a lower pitch of the sound from a siren of an approaching vehicle because of the Doppler effect.
- 1.7 The magnitude of the electrostatic force on a charge Q_1 due to another charge Q_2 is F . Both charges are now doubled without changing the distance between them.

The magnitude of the new electrostatic force on Q_1 will be:

- A $\frac{F}{2}$
B $2F$
C $4F$
D $6F$

(2)

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



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

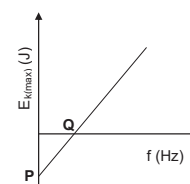
- A P burns brighter than R.
B S and Q burn brighter than P and R.
C P and R burn brighter than S and Q.
D ALL the bulbs burn with the same brightness.

(2)

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- 1.9 Which ONE of the energy conversions below takes place when a **DC** motor is in operation?
- A Kinetic to electrical
B Heat to mechanical
C Mechanical to electrical
D Electrical to mechanical
- 1.10 In an investigation on the photoelectric effect, the graph of maximum kinetic energy ($E_{k(max)}$) versus frequency (f) was obtained for a certain metal, as shown below.



The intercepts, P and Q respectively, represent ...

- A Planck's constant and threshold frequency.
B work function and threshold frequency.
C threshold frequency and work function.
D threshold frequency and Planck's constant.

(2)
[20]

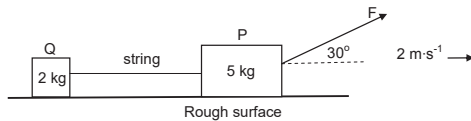
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QUESTION 2 (Start on a new page.)

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

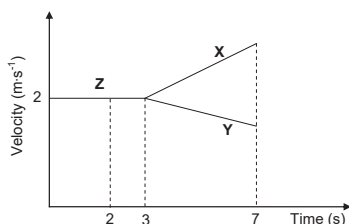
The two boxes now move to the right at a **constant speed** of 2 m s^{-1} .



- 2.1 State Newton's First Law of Motion in words. (2)
- 2.2 Draw a labelled free-body diagram for box **Q**. (4)
- Box **P** experiences a constant frictional force of 5 N and box **Q** a constant frictional force of 3 N.
- 2.3 Calculate the magnitude of force **F**. (6)

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

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



- 2.4 Write down the time at which the string breaks. (1)
- 2.5 Which portion (**X**, **Y** or **Z**) of the graph represents the motion of box **Q**, after the string breaks? Use the information in the graph to fully support the answer. (4)

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QUESTION 4 (Start on a new page.)

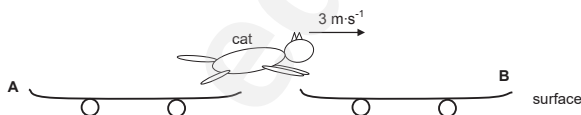
The diagram below shows two skateboards, **A** and **B**, initially at rest, with a cat standing on skateboard **A**. The skateboards are in a straight line, one in front of the other and a short distance apart. The surface is flat, frictionless and horizontal.



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

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

Refer to the diagram below.



- 4.2 Calculate the velocity of skateboard **A** just after the cat has jumped from it. (5)
- Immediately after the cat has landed, the cat and skateboard **B** move horizontally to the right at $1,28 \text{ m s}^{-1}$.
- 4.3 Calculate the magnitude of the impulse on skateboard **B** as a result of the cat's landing. (3)

[10]

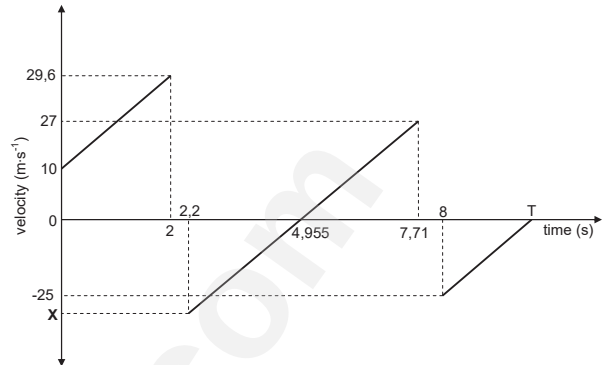
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QUESTION 3 (Start on a new page.)

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

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



- 3.1 Write down the speed with which the ball is thrown downwards. (1)
- 3.2 ALL parts of the graph have the same gradient. Give a reason for this. (2)
- 3.3 Calculate the:
- 3.3.1 Height from which the ball is thrown (3)
- 3.3.2 Time (**T**) shown on the graph (4)
- 3.4 Write down the:
- 3.4.1 Time that the ball is in contact with the ground at the first bounce (1)
- 3.4.2 Time at which the ball reaches its maximum height after the first bounce (2)
- 3.4.3 Value of **X** (1)
- 3.5 Is the collision of the ball with the ground *elastic* or *inelastic*? Give a reason for the answer using information in the graph. (2)

[16]

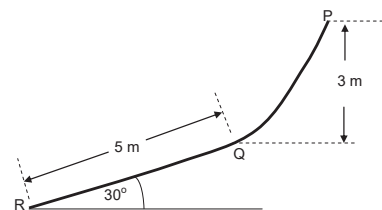
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QUESTION 5 (Start on a new page.)

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

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



- 5.1 State the law of conservation of mechanical energy in words. (2)
- 5.2 Calculate the speed of the learner at **Q**. (4)
- 5.3 Draw a labelled free-body diagram for the learner while he/she is on section **QR**. (3)
- The coefficient of kinetic friction (μ_k) between the learner and the surface of section **QR** is 0,08.
- 5.4 Calculate the magnitude of the kinetic frictional force acting on the learner when the learner is on section **QR**. (3)
- 5.5 Use energy principles to calculate the speed of the learner at point **R**. (5)

[17]

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QUESTION 6 (Start on a new page.)

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

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



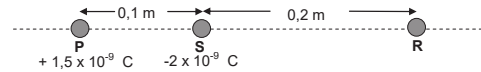
- 6.1 State the Doppler Effect in words. (2)
- 6.2 In which direction is the car moving? Choose from TOWARDS A or AWAY FROM A. Give a reason for the answer. (2)
- 6.3 Determine the speed of the police car. Take the speed of sound in air as 340 m.s^{-1} . (6)
- 6.4 Name ONE application of the Doppler effect. (1)
- [11]

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QUESTION 7 (Start on a new page.)

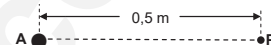
Two point charges, **P** and **S**, are placed a distance 0,1 m apart. The charge on **P** is $+1,5 \times 10^{-9} \text{ C}$ and that on **S** is $-2 \times 10^{-9} \text{ C}$. A third point charge, **R**, with an unknown positive charge, is placed 0,2 m to the right of point charge **S**, as shown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



- 7.1 State Coulomb's law in words. (2)
- 7.2 Draw a labelled force diagram showing the electrostatic forces acting on **R** due to **P** and **S**. (2)
- 7.3 Calculate the magnitude of the charge on **R**, if it experiences a net electrostatic force of $1,27 \times 10^{-6} \text{ N}$ to the left. (7)
- Take forces directed to the right as positive. [11]

QUESTION 8 (Start on a new page.)

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



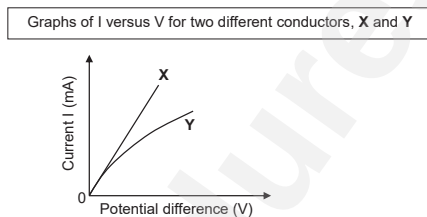
- 8.1 Draw the electric field pattern due to charged sphere **A**. Indicate the sign of the charge on the sphere in your diagram. (2)
- 8.2 Calculate the magnitude of the charge on sphere **A**. (3)
- Another charged sphere, **B**, having an excess of 10^5 electrons, is now placed at point **P**.
- 8.3 Calculate the electrostatic force experienced by sphere **B**. (6)
- [11]

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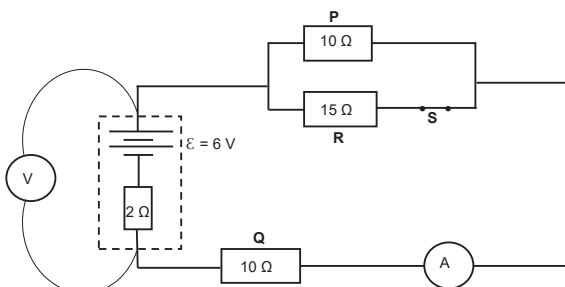
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QUESTION 9 (Start on a new page.)

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



- 9.1.1 State Ohm's law in words. (2)
- 9.1.2 Which ONE of the two conductors, **X** or **Y**, is ohmic? Refer to the graph and give a reason for the answer. (2)
- 9.2 In the diagram below, a battery with an emf of 6 V and an internal resistance of 2Ω , is connected to three resistors **P**, **Q** and **R**. A voltmeter **V** is connected across the battery. The ammeter **A** has a negligible resistance.



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

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The switch **S** is now open.

- 9.2.2 Will the ammeter reading in QUESTION 9.2.1 INCREASE, DECREASE or REMAIN THE SAME? Give a reason for the answer. (2)
- 9.2.3 How will the voltmeter reading now compare with the voltmeter reading when the switch is closed? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)
- 9.2.4 Explain the answer to QUESTION 9.2.3. (3)
- [15]

QUESTION 10 (Start on a new page.)

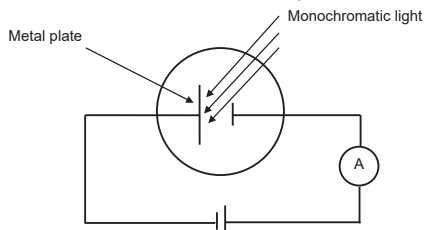
- 10.1 Learners want to build a small **DC** motor as a project. Write down THREE essential components that are needed for the building of the motor. (3)
- 10.2 An electrical device with a resistance of 11Ω is connected to an **AC** source with an rms voltage of 240 V.
- 10.2.1 Define the term *rms voltage*. (2)
- 10.2.2 Calculate the maximum (peak) current passing through the device. (4)
- [9]

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QUESTION 11 (Start on a new page.)

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



- 11.1.1 How does the energy of the photons of the incident light compare to the work function of the metal plate? Choose from GREATER THAN, LESS THAN or EQUAL TO.
Give a reason for the answer. (2)
- 11.1.2 When a change is made to the monochromatic light, the reading on the ammeter increases.
A learner makes the following statement with regard to this change:
The increase in the ammeter reading is due to an increase in the energy of the incident photons.
Give a reason why this statement is INCORRECT. (2)
- 11.1.3 What does the photoelectric effect tell us about the nature of light? (1)
- 11.2 Ultraviolet radiation is incident on the surface of sodium metal. The threshold frequency (f_0) for sodium is $5,73 \times 10^{14}$ Hz. The maximum speed of an electron emitted from the metal surface is $4,19 \times 10^5$ m·s⁻¹.
11.2.1 Define or explain the term *threshold frequency*. (2)
- Calculate the:
- 11.2.2 Work function of sodium (3)
- 11.2.3 Frequency of the incident photon (3)
- [13]**
- TOTAL: 150**

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2018

MARKS: 150

TIME: 3 hours

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

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

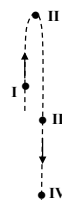
Various options are provided as possible answers to the following questions. Choose the answer and write down only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

- 1.1 The net (resultant) force acting on an object is equal to the ... of the object in the direction of the net force.
A change in momentum
B change in kinetic energy
C rate of change of momentum
D rate of change of kinetic energy (2)
- 1.2 A physical quantity that is described as a measure of the resistance of a body to a change in motion is called ...
A inertia.
B force.
C acceleration.
D weight. (2)

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- 1.3 The diagram below shows a section of the path of a stone projected vertically upwards.



At which ONE of the positions indicated on the diagram will the magnitude of the momentum of the stone be the GREATEST? Ignore air resistance.

- A I
B II
C III
D IV (2)
- 1.4 Two cars, P and Q, moving in a straight line, have the same momentum. The kinetic energy of Q is greater than the kinetic energy of P.
Which ONE of the following statements regarding the cars is CORRECT?
A Q has a smaller mass than P.
B Q has the same mass as P.
C Q is moving slower than P.
D Q is moving at the same speed as P. (2)
- 1.5 The net work done on an object to increase its speed from rest to v is W . How much net work must be done on the same object to increase its speed from v to $2v$?
A W
B $2W$
C $3W$
D $4W$ (2)

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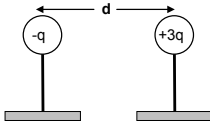
1.6 Which ONE of the following is NOT an application of the Doppler effect?

- A A light meter
- B A blood flow meter
- C Detecting the heartbeat of a foetus using ultrasound
- D Measuring the speed of an approaching car using radar

(2)

1.7 Two small identical metal spheres, on insulated stands, carry charges $-q$ and $+3q$ respectively.

When the centres of the spheres are a distance d apart, the spheres exert an electrostatic force of magnitude F on each other.



The spheres are now made to touch and are brought back to the **same positions** as before.

The magnitude of the electrostatic force which the spheres now exert on each other, in terms of F , is:

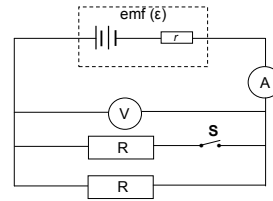
- A $\frac{4}{3}F$
- B $\frac{1}{3}F$
- C $\frac{1}{2}F$
- D $3F$

(2)

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1.8 In the circuit below the battery has an emf (ϵ) and internal resistance r . With switch S open, readings are registered on the ammeter and voltmeter.



Switch S is now closed. How do the readings on the ammeter and voltmeter change?

	AMMETER READING	VOLTMETER READING
A	Increases	Remains the same
B	Increases	Decreases
C	Decreases	Remains the same
D	Decreases	Decreases

(2)

1.9 A learner lists the following as factors that affect the magnitude of the current induced in an AC generator:

- (i) The number of turns (windings) of the coil
- (ii) The strength of the magnetic field
- (iii) The speed of rotation of the coil

Which ONE of the combinations below is CORRECT?

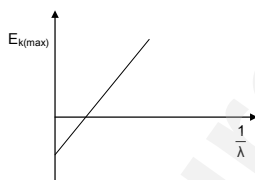
- A (i) and (ii) only
- B (i) and (iii) only
- C (ii) and (iii) only
- D (i), (ii) and (iii)

(2)

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1.10 The graph below is obtained from an experiment on the photoelectric effect.



Which ONE of the following represents the gradient of the graph?

- A hc
- B h
- C $\frac{E_{k(max)}}{\lambda}$
- D W_0

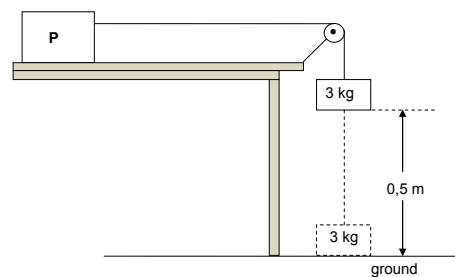
(2)
[20]

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QUESTION 2 (Start on a new page.)

Block **P**, of unknown mass, is placed on a rough horizontal surface. It is connected to a second block of mass 3 kg , by a light inextensible string passing over a light, frictionless pulley, as shown below.



Initially the system of masses is held stationary with the 3 kg block, 0.5 m above the ground. When the system is released the 3 kg block moves vertically downwards and strikes the ground after 3 s . Ignore the effects of air resistance.

2.1 Define the term *acceleration* in words.

(2)

Calculate the magnitude of the:

2.2 Acceleration of the 3 kg block using equations of motion

(3)

2.3 Tension in the string

(3)

The magnitude of the kinetic frictional force experienced by block **P** is 27 N .

2.4 Draw a labelled free-body diagram for block **P**.

(4)

2.5 Calculate the mass of block **P**.

(3)

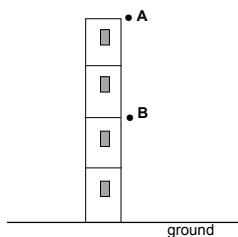
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QUESTION 3 (Start on a new page.)

In the diagram below, point **A** is at the top of a building. Point **B** is exactly halfway between the point **A** and the ground. Ignore air resistance.



- 3.1 Define the term *free fall*. (2)
- A ball of mass 0,4 kg is dropped from point **A**. It passes point **B** after 1 s.
- 3.2 Calculate the height of point **A** above the ground. (3)
- When the ball strikes the ground it is in contact with the ground for 0,2 s and then bounces vertically upwards, reaching a maximum height at point **B**.
- 3.3 Calculate the magnitude of the velocity of the ball when it strikes the ground. (3)
- 3.4 Calculate the magnitude of the average net force exerted on the ball while it is in contact with the ground. (6)

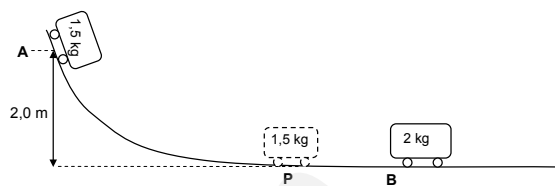
[14]

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QUESTION 4 (Start on a new page.)

A trolley of mass 1,5 kg is held stationary at point **A** at the top of a frictionless track. When the 1,5 kg trolley is released, it moves down the track. It passes point **P** at the bottom of the incline and collides with a stationary 2 kg trolley at point **B**. Refer to the diagram below. Ignore air resistance and rotational effects.



- 4.1 Use the principle of conservation of mechanical energy to calculate the speed of the 1,5 kg trolley at point **P**. (4)
- When the two trolleys collide, they stick together and continue moving with constant velocity.
- 4.2 The principle of conservation of linear momentum is given by the incomplete statement below.
In a/an ... system, the ... linear momentum is conserved.
Rewrite the complete statement and fill in the missing words or phrases. (2)
- 4.3 Calculate the speed of the combined trolleys immediately after the collision. (4)
- 4.4 Calculate the distance travelled by the combined trolleys in 3 s after the collision. (3)

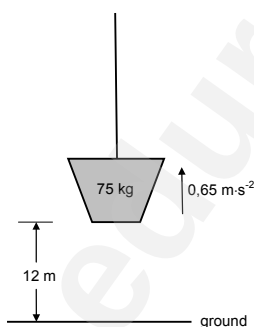
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QUESTION 5 (Start on a new page.)

A load of mass 75 kg is initially at rest on the ground. It is then pulled vertically upwards at a constant acceleration of $0,65 \text{ m}\cdot\text{s}^{-2}$ by means of a light inextensible rope. Refer to the diagram below. Ignore air resistance, rotational effects and the mass of the rope.



- 5.1 Draw a labelled free-body diagram for the load while it moves upward. (2)
- 5.2 Name the non-conservative force acting on the load. (1)
- 5.3 Calculate the work done on the load by the gravitational force when the load has reached a height of 12 m. (3)
- 5.4 State the work-energy theorem in words. (2)
- 5.5 Use the work-energy theorem to calculate the speed of the load when it is at a height of 12 m. (5)

[13]

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QUESTION 6 (Start on a new page.)

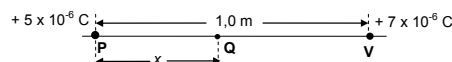
A sound source, moving at a constant speed of $240 \text{ m}\cdot\text{s}^{-1}$ towards a detector, emits sound at a constant frequency. The detector records a frequency of 5 100 Hz.

Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$.

- 6.1 State the Doppler effect. (2)
- 6.2 Calculate the wavelength of the sound emitted by the source. (7)
- Some of the sound waves are reflected from the detector towards the approaching source.
- 6.3 Will the frequency of the reflected sound wave detected by the sound source be EQUAL TO, GREATER THAN or SMALLER THAN 5 100 Hz? (1)

[10]**QUESTION 7 (Start on a new page.)**

A particle, **P**, with a charge of $+5 \times 10^{-6} \text{ C}$, is located 1,0 m along a straight line from particle **V**, with a charge of $+7 \times 10^{-6} \text{ C}$. Refer to the diagram below.



A third charged particle, **Q**, at a point x metres away from **P**, as shown above, experiences a net electrostatic force of zero newton.

- 7.1 How do the electrostatic forces experienced by **Q** due to the charges on **P** and **V** respectively, compare with each other? (2)
- 7.2 State Coulomb's law in words. (2)
- 7.3 Calculate the distance x . (5)

[9]**QUESTION 8 (Start on a new page.)**

A small metal sphere **Y** carries a charge of $+6 \times 10^{-6} \text{ C}$.

- 8.1 Draw the electric field pattern associated with sphere **Y**. (2)
- 8.2 If 8×10^{13} electrons are now transferred to sphere **Y**, calculate the electric field at a point 0,5 m from the sphere. (7)

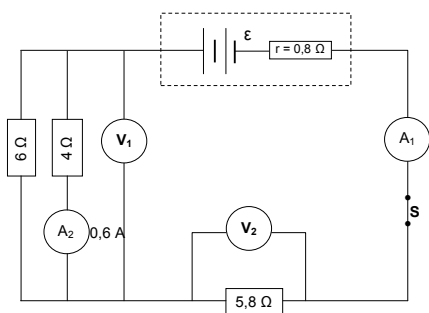
[9]

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QUESTION 9 (Start on a new page.)

- 9.1 In the circuit diagram below the battery has an unknown emf (ϵ) and an internal resistance (r) of $0,8 \Omega$.



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

The reading on ammeter A_2 is $0,6 \text{ A}$ when switch S is closed.

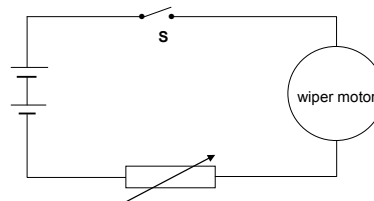
Calculate the:

- 9.1.2 Reading on voltmeter V_1 (3)
 9.1.3 Current through the 6Ω resistor (2)
 9.1.4 Reading on voltmeter V_2 (2)
 9.1.5 Emf (ϵ) of the battery (3)
 9.1.6 Energy dissipated as heat inside the battery if the current flows in the circuit for 15 s (3)

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- 9.2 A simplified circuit diagram for the windscreen wiper of a car consists of a variable resistor and a wiper motor connected to a 12 volt battery.



When switch S is closed, the potential difference across the variable resistor is $2,8 \text{ V}$ and the current passing through it is $0,7 \text{ A}$.

- 9.2.1 Calculate the resistance of the variable resistor. (2)

The resistance of the variable resistor is now decreased.

- 9.2.2 State whether the speed at which the wiper turns will INCREASE, DECREASE or REMAIN THE SAME. (3)

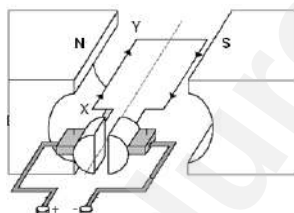
Give a reason for the answer. [20]

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QUESTION 10 (Start on a new page.)

- 10.1 The diagram below is a simplified representation of a DC motor. The current in the coil is in the direction XY.



- 10.1.1 Name the component that ensures that the coil rotates continuously in ONE DIRECTION. (1)
 10.1.2 In which direction will the coil rotate? Write down only CLOCKWISE or ANTICLOCKWISE. (2)
 10.1.3 Write down the energy conversion which takes place while the motor is working. (2)

- 10.2 An AC generator, producing a maximum voltage of 320 V , is connected to a heater of resistance 35Ω .

- 10.2.1 Write down the structural difference between an AC generator and a DC generator. (1)

Calculate the:

- 10.2.2 Root mean square (rms) value of the voltage (3)
 10.2.3 Root mean square (rms) value of the current in the heater (4) [13]

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QUESTION 11 (Start on a new page.)

A group of students investigates the relationship between the work function of different metals and the maximum kinetic energy of the ejected electrons when the metals are irradiated with light of suitable frequency.

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

During the investigation ultraviolet rays of wavelength $2 \times 10^{-8} \text{ m}$ are allowed to fall on different metal plates. The corresponding maximum kinetic energies of ejected electrons are measured.

The data obtained is displayed in the table below.

METAL PLATE USED	MAXIMUM KINETIC ENERGY ($E_{k(\max)}$) ($\times 10^{-18} \text{ J}$)
Lead	9,28
Potassium	9,58
Silver	9,19

- 11.2 Write down the dependent variable for this investigation. (1)
 11.3 Write down ONE control variable for this investigation. (1)
 11.4 Using the information in the table, and without any calculation, identify the metal with the largest work function. Explain the answer. (3)
 11.5 Use information in the table to calculate the work function of potassium. (4)
 11.6 State how an increase in the intensity of the ultraviolet light affects the maximum kinetic energy of the photoelectrons. Choose from: INCREASES, DECREASES, REMAINS THE SAME. Explain the answer. (3) [14]

TOTAL: 150

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SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

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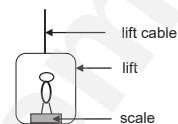
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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 Inertia is the tendency of an object to ...
- maintain its mass.
 - continue in a state of non-uniform motion.
 - remain at rest or in the state of uniform motion.
 - maintain its velocity when a non-zero net force is acting on it.

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



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

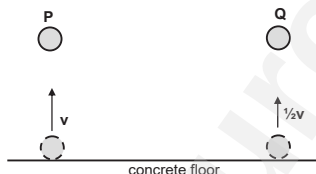
- upwards at a constant speed.
 - downwards at a constant speed.
 - upwards at an increasing speed.
 - downwards at an increasing speed.
- 1.3 An object is projected vertically upwards. Ignore air resistance. As the object rises, its velocity ...
- and acceleration are both directed upwards.
 - and acceleration are both directed downwards.
 - is directed upwards, but its acceleration is directed downwards.
 - is directed downwards, but its acceleration is directed upwards.

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- 1.4 Ball **P** and ball **Q**, of the same mass, are dropped onto a concrete floor. Both balls hit the concrete floor at the same speed, v . Ball **P** rebounds with the same vertical speed, v , but ball **Q** rebounds with speed $\frac{1}{2}v$.

Refer to the diagram below. Ignore air resistance.



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

- Kinetic energy is conserved for both balls **P** and **Q**.
 - The change in momentum of ball **P** is greater than that of ball **Q**.
 - The contact time with the floor is the same for both balls **P** and **Q**.
 - Momentum is conserved for the collision of ball **P**, but not for that of ball **Q**.
- 1.5 If the net work done on a moving object is POSITIVE, then we can conclude that the kinetic energy of the object ...
- is zero.
 - has increased.
 - has decreased.
 - has not changed.
- 1.6 The spectrum produced by a moving asteroid, as observed from Earth, indicates that the light has shifted towards the blue end of the spectrum.

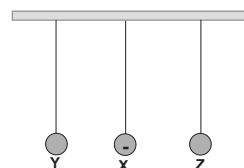
Which ONE of the following frequency combinations of the observed light and the distance between the asteroid and Earth is CORRECT?

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

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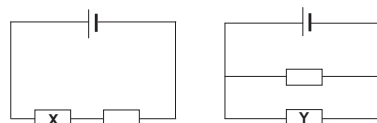
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- 1.7 Three charged spheres **X**, **Y** and **Z**, supported by insulating threads of equal length, hang from a beam, as shown in the diagram below. Sphere **X** is negatively charged. Sphere **X** attracts sphere **Y**, but repels sphere **Z**.



Which ONE of the following conclusions is CORRECT?

- Sphere **Y** is positively charged and sphere **Z** is negatively charged.
 - Sphere **Y** is positively charged and sphere **Z** is positively charged.
 - Sphere **Y** is negatively charged and sphere **Z** is negatively charged.
 - Sphere **Y** is negatively charged and sphere **Z** is positively charged.
- 1.8 In the circuit diagrams below, the cells and resistors are identical. The cells have negligible internal resistances.



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

- $\frac{1}{4}P$.
- $\frac{1}{2}P$.
- $2P$.
- $4P$.

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- 1.9 Which ONE of the following actions will NOT cause an **increase** in the induced emf in a coil if the coil is rotated in a uniform magnetic field?
- Rotating the coil faster
 - Increasing the strength of the magnetic field
 - Increasing the number of turns of the coil
 - Replacing the coil with a coil of lower resistance
- (2)
- 1.10 A learner writes the following statements about the emission spectrum of light in a notebook:
- An emission spectrum is formed when certain frequencies of electromagnetic radiation pass through a cold gas.
 - The lines in the emission spectrum of an atom have the same frequency as the corresponding lines in the atom's absorption spectrum.
 - An emission spectrum is formed when the atom makes transitions from a high-energy state to a lower energy state.
- Which ONE of the following combinations of the statements above is CORRECT?
- (i) only
 - (ii) only
 - (ii) and (iii) only
 - (i) and (iii) only
- (2) [20]

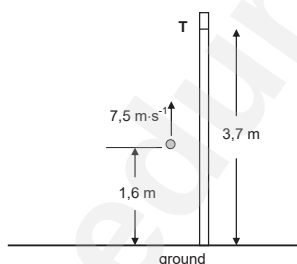
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QUESTION 3 (Start on a new page.)

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

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



- In which direction is the net force acting on the ball while it moves towards point T? Choose from: UPWARDS or DOWNWARDS. Give a reason for the answer. (2)
- Calculate the time taken by the ball to reach its highest point. (3)
- Determine, by means of a calculation, whether the ball will pass point T or not. (6)
- Draw a velocity-time graph for the motion of the ball from the instant it is thrown upwards until it reaches its highest point.

Indicate the following on the graph:

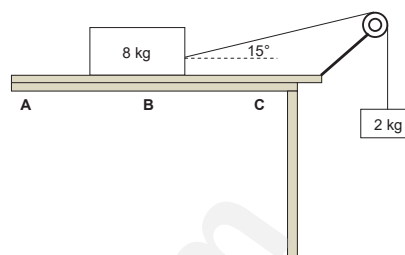
- The initial velocity and final velocity
 - Time taken to reach the highest point
- (2) [13]

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QUESTION 2 (Start on a new page.)

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



- State Newton's Second Law in words. (2)
 - Draw a labelled free-body diagram for the 8 kg block. (4)
 - When the 8 kg block reaches point B, the angle between the string and the horizontal is 15° and the acceleration of the system is $1,32 \text{ m}\cdot\text{s}^{-2}$.
 - Give a reason why the system is NOT in equilibrium. (1)
 - Use the 2 kg mass to calculate the tension in the string. (3)
 - Calculate the kinetic frictional force between the 8 kg block and the horizontal surface. (4)
 - As the 8 kg block moves from B to C, the kinetic frictional force between the 8 kg block and the horizontal surface is not constant.
 - Give a reason for this statement. (1)
- The horizontal surface on which the 8 kg block is moving, is replaced by another horizontal surface made from a different material.
- Will the kinetic frictional force, calculated in QUESTION 2.3.3 above, change? Choose from: YES or NO. Give a reason for the answer. (2) [17]

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QUESTION 4 (Start on a new page.)

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



- Define the term *momentum* in words. (2)
 - Will the girl-roller-skate combination move TO THE RIGHT or TO THE LEFT after the parcel is thrown? NAME the law in physics that can be used to explain your choice of direction. (2)
- The total mass of the roller skates is 2 kg.
- Calculate the mass of the girl. (5)
 - Calculate the magnitude of the impulse that the girl-roller-skate combination is experiencing while the parcel is being thrown. (3)
 - Without any further calculation, write down the change in momentum experienced by the parcel while it is being thrown. (2) [14]

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Nov 2018

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QUESTION 5 (Start on a new page.)

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



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

- 5.1 Define the term *non-conservative force*. (2)
 - 5.2 Is force **F** a conservative force? Choose from: YES or NO. (1)
 - 5.3 Calculate the average power generated by force **F**. (3)
- The speed of the vehicle when it reaches point B is $25 \text{ m}\cdot\text{s}^{-1}$.
- 5.4 State the work-energy theorem in words. (2)
 - 5.5 Use **energy principles** to calculate the total work done on the vehicle by the frictional forces. (5)

[13]

QUESTION 6 (Start on a new page.)

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

- 6.1 State the Doppler effect in words. (2)
- 6.2 Is the patrol car driving TOWARDS or AWAY FROM the parked vehicle? Give a reason for the answer. (2)
- 6.3 Calculate the frequency of the sound emitted by the alarm. (3)
- 6.4 The patrol car moves a distance of x metres in 10 seconds. Calculate the distance x . (6)

[13]

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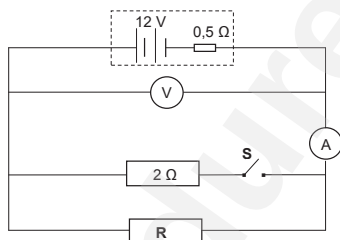
Physical Sciences/P1

12
NSC

DBE/November 2018

QUESTION 8 (Start on a new page.)

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



- 8.1 What is the meaning of the following statement?
The emf of the battery is 12 V. (2)
- The reading on the ammeter is 2 A when switch **S** is OPEN.
- 8.2 Calculate the: (3)
 - 8.2.1 Reading on the voltmeter (3)
 - 8.2.2 Resistance of resistor **R** (2)
- Switch **S** is now CLOSED.
- 8.3 How does this change affect the reading on the voltmeter? Choose from: INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (4)

[11]

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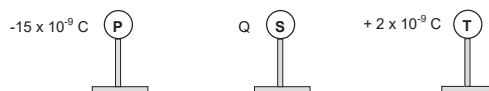
Physical Sciences/P1

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NSC

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QUESTION 7 (Start on a new page.)

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



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

- 7.1 Determine the value of charge Q . (2)
- 7.2 Draw the electric field pattern associated with the charged spheres, **S** and **T**, after they are separated and returned to their original positions. (3)

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



- 7.3 State Coulomb's law in words. (2)
- Calculate the magnitude of the:
- 7.4 Net electrostatic force acting on sphere **P** (5)
 - 7.5 Net electric field at the origin due to charges **S** and **T** (3)
 - 7.6 ONE of the charged spheres, **P** and **T**, experienced a very small increase in mass **after it was charged initially**. (3)
 - 7.6.1 Which sphere, **P** or **T**, experienced this very small increase in mass? (1)
 - 7.6.2 Calculate the increase in mass by the sphere in QUESTION 7.6.1. (3)

[19]

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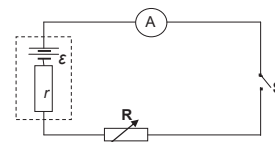
Physical Sciences/P1

13
NSC

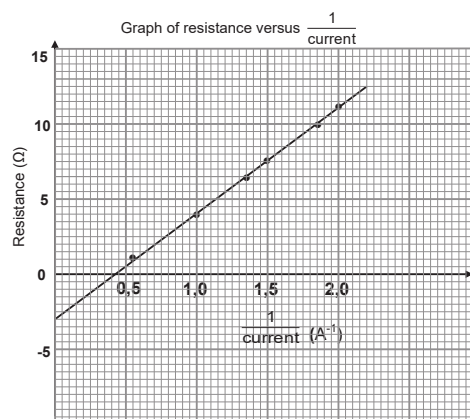
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QUESTION 9 (Start on a new page.)

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



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



- 9.1 Which variable has to be kept constant in the experiment? (1)
- 9.2 Refer to the **graph**. (2)
 - 9.2.1 Write down the value of the internal resistance of the cell. (2)
 - 9.2.2 Calculate the emf of the battery. (3)

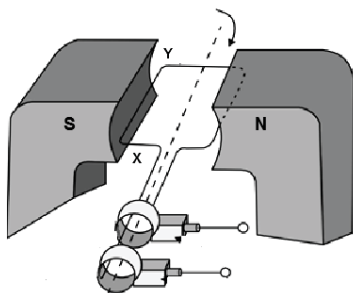
[6]

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QUESTION 10 (Start on a new page.)

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

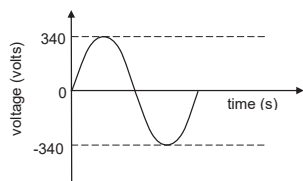


10.1.1 In which direction does the induced current flow in the coil?
Choose from: **X to Y** or **Y to X**. (1)

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

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

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



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

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

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

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

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QUESTION 11 (Start on a new page.)

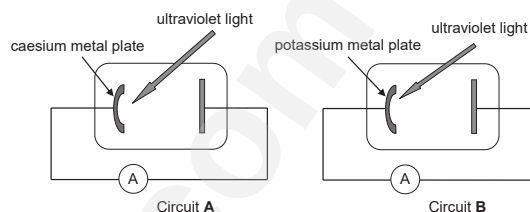
The threshold frequencies of caesium and potassium metals are given in the table below.

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

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

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

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



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

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

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

11.5 How will the maximum kinetic energy of the ejected electron, calculated in QUESTION 11.4, change when the intensity of the incident light increases? (1)

Choose from: INCREASES, DECREASES or REMAINS THE SAME. [13]

TOTAL: 150

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GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETenskappe: FISIKA (V1)**

NOVEMBER 2017

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

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Please turn over/Blaai om asseblief

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]

Nov 2017 Memo

Physical Sciences P1/Fisiese Wetenskappe V1 3
NSC/NSS – Marking Guidelines/Nasienriglyne

DBE/November 2017

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.

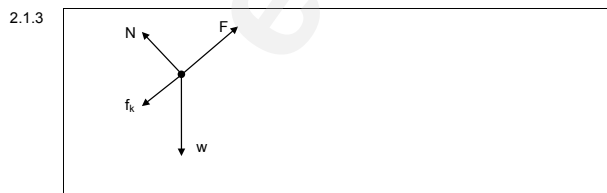
OF

'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/speed volhard tensy 'n nie-nul resulterende/netto krag daarop inwerk.

(2)



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 / (kinetics) wrywing / F_w
N	F_N / Normal (force) / Normaal (krag) / 67,9 N

(4)

Nov 2017 Memo

Physical Sciences P1/Fisiese Wetenskappe V1 4
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- 2.1.3 $F_{net} = ma$ ✓
 $F_{net} = 0$ ✓
 $F + (-f_k) + (-F_{gl}) = ma$ ✓
 $F - (f_k + F_{gl}) = ma$ ✓
 $F - 20,37 - (8)(9,8)\sin 30^\circ = 0$ ✓
 $F = 59,57 \text{ N}$ ✓

(5)

- | | OPTION 1/OPSIE 1 | OPTION 2/OPSIE 2 |
|-------|---|---|
| 2.1.4 | $F_{net} = ma$ ✓
$(F_{gl} - f_k) = ma$ ✓
$(8)(9,8)\sin 30^\circ - 20,37 = 8a$ ✓
$\therefore \text{magnitude/grootte: } a = 2,35 \text{ m}\cdot\text{s}^{-2}$ ✓ | $F_{net} = ma$ ✓
$(f_k - F_{gl}) = ma$ ✓
$20,37 - (8)(9,8)\sin 30^\circ = 8a$ ✓
$\therefore a = -2,35 \text{ m}\cdot\text{s}^{-2}$ ✓
$\therefore \text{magnitude/grootte: } a = 2,35 \text{ m}\cdot\text{s}^{-2}$ ✓ |

(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)

- | | OPTION 1/OPSIE 1 | OPTION 2/OPSIE 2 |
|-------|---|--|
| 2.2.2 | $g = \frac{GM}{r^2}$ ✓
$6 = \frac{(6,67 \times 10^{-11})M}{(700 \times 10^3)^2}$ ✓
$M = 4,41 \times 10^{22} \text{ kg}$ ✓ | $F = G \frac{m_1 m_2}{r^2}$ ✓
$mg = \frac{GmM}{r^2}$ ✓
$(200)(6) = \frac{(6,67 \times 10^{-11})(200)M}{(700 \times 10^3)^2}$ ✓
$M = 4,41 \times 10^{22} \text{ kg}$ ✓ |

(4)

[21]

QUESTION 3 / VRAAG 3

3.1

OPTION 1/OPSIE 1	
Upwards positive <i>Opwaarts positief:</i> $v_f = v_i + a\Delta t$ $0 = (12) + (-9,8)(\Delta t)$ $\Delta t = 1,22 \text{ s}$	Downwards positive <i>Afwaarts positief:</i> $v_f = v_i + a\Delta t$ $0 = (-12) + (9,8)(\Delta t)$ $\Delta t = 1,22 \text{ s}$

OPTION 2/OPSIE 2	
Upwards positive <i>Opwaarts positief:</i> $v_f^2 = v_i^2 + 2a\Delta y$ $0 = 12^2 + 2(-9,8)\Delta y$ $\Delta y = 7,35$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $7,35 = 12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $\Delta t = 1,22 \text{ s}$	Downwards positive <i>Afwaarts positief:</i> $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (-12)^2 + 2(9,8)\Delta y$ $\Delta y = -7,35$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $-7,35 = -12\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $\Delta t = 1,22 \text{ s}$

OPTION 3/OPSIE 3	
Upwards positive <i>Opwaarts positief:</i> $v_f^2 = v_i^2 + 2a\Delta y$ $0 = 12^2 + 2(-9,8)\Delta y$ $\Delta y = 7,35 \text{ m}$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $7,35 = \left(\frac{12 + 0}{2}\right)\Delta t$ $\Delta t = 1,22 \text{ s}$	Downwards positive <i>Afwaarts positief:</i> $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (-12)^2 + 2(9,8)\Delta y$ $\Delta y = -7,35 \text{ m}$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $-7,35 = \left(\frac{-12 + 0}{2}\right)\Delta t$ $\Delta t = 1,22 \text{ s}$

OPTION 4/OPSIE 4	
$(E_{\text{mech}})_A = (E_{\text{mech}})_{\text{top}}$ $\left(\frac{1}{2}mv^2 + mgh\right)_A = \left(\frac{1}{2}mv^2 + mgh\right)_{\text{top}}$ $\frac{1}{2}m(12)^2 + 0 = 0 + m(9,8)(h)$ $\therefore h = 7,35 \text{ m}$ OR/OF $W_{\text{net}} = \Delta E_k$ $F_{\text{net}}\Delta y \cos 90^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ $m(9,8)\Delta y \cos 180^\circ = \frac{1}{2}m(0^2 - (12)^2)$ $\Delta y = 7,35 \text{ m}$ OR/OF $\Delta E_p + \Delta E_k = 0$ $mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2) = 0$ $m(9,8)(h - 0) + \frac{1}{2}m(0 - 12^2) = 0$ $\therefore h = \Delta y = 7,35 \text{ m}$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $7,35 = \left(\frac{12 + 0}{2}\right)\Delta t$ $\Delta t = 1,22 \text{ s}$

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Please turn over/Blaai om asseblief

OPTION 5/OPSIE 5	
Upwards positive <i>Opwaarts positief:</i> $F_{\text{net}}\Delta t = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ $(-9,8)\Delta t = (0 - 12)$ $\Delta t = 1,2245 \text{ s}$	Downwards positive <i>Afwaarts positief:</i> $F_{\text{net}}\Delta t = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ $(9,8)\Delta t = (0 - (-12))$ $\Delta t = 1,2245 \text{ s}$

OPTION 6/OPSIE 6	
Upwards positive <i>Opwaarts positief:</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $0 = 12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $\Delta t = 2,4490 \text{ s}$ $\Delta t = \frac{1}{2}(2,4490)$ $= 1,2245 \text{ s}$	Downwards positive <i>Afwaarts positief:</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $0 = -12\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $\Delta t = 2,4490 \text{ s}$ $\Delta t = \frac{1}{2}(2,4490)$ $= 1,2245 \text{ s}$

(3)

3.2

OPTION 1/OPSIE 1	
Upwards positive <i>Opwaarts positief:</i> $v_f = v_i + a\Delta t$ $-3v = -v + (-9,8)(1,22)$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$	Downwards positive <i>Afwaarts positief:</i> $v_f = v_i + a\Delta t$ $3v = v + (9,8)(1,22)$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$ $v = 5,98 \text{ m}\cdot\text{s}^{-1}$

OPTION 2/OPSIE 2	
Upwards positive <i>Opwaarts positief:</i> $F_{\text{net}}\Delta t = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ $(-9,8)(1,2245) = -3v - (-v)$ $v = 6,00 \text{ m}\cdot\text{s}^{-1}$	Downwards positive <i>Afwaarts positief:</i> $F_{\text{net}}\Delta t = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ $(9,8)(1,2245) = 3v - v$ $v = 6,00 \text{ m}\cdot\text{s}^{-1}$

(4)

3.3

OPTION 1/OPSIE 1	
Upwards positive <i>Opwaarts positief:</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \frac{(-5,98)(2,44) + \frac{1}{2}(-9,8)(2,44)^2}{2}$ $= -43,764$ $\therefore h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$	Downwards positive <i>Afwaarts positief:</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \frac{(5,98)(2,44) + \frac{1}{2}(9,8)(2,44)^2}{2}$ $= 43,764$ $\therefore h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$

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OPTION 2/OPSIE 2	
Upwards positive <i>Opwaarts positief:</i> $v_f = v_i + a\Delta t$ $v_f = -5,98 + (-9,8)(2,44)$ $v_f = -29,892 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $(-29,892)^2 = (-5,98)^2 + 2(-9,8)\Delta y$ $\Delta y = -43,763 \text{ m}$ $\therefore h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$	Downwards positive <i>Afwaarts positief:</i> $v_f = v_i + a\Delta t$ $v_f = 5,98 + 9,8(2,44)$ $v_f = 29,892 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $(29,892)^2 = (5,98)^2 + 2(9,8)\Delta y$ $\Delta y = 43,76 \text{ m}$ $\therefore h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$ $h = 43,76 \text{ m}$

OPTION 3/OPSIE 3	
Upwards positive <i>Opwaarts positief:</i> $v_f = v_i + a\Delta t$ $v_f = -5,98 + (-9,8)(2,44)$ $v_f = -29,892 \text{ m}\cdot\text{s}^{-1}$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $= \left(\frac{(-30) + (-6,00)}{2}\right)(2,4490)$ $\Delta x = -44,082 \text{ m}$ $h = 44,082 \text{ m}$	Downwards positive <i>Afwaarts positief:</i> $v_f = v_i + a\Delta t$ $v_f = 5,98 + 9,8(2,44)$ $v_f = 29,892 \text{ m}\cdot\text{s}^{-1}$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $= \left(\frac{(30) + (6,00)}{2}\right)(2,4490)$ $\Delta x = 44,082 \text{ m}$ $h = 44,082 \text{ m}$

OPTION 4/OPSIE 4	
Upwards positive <i>Opwaarts positief:</i> For A/ Vir A $v_f = v_i + a\Delta t$ $-12 = 12 + (-9,8)\Delta t$ $\Delta t = 2,45 \text{ s}$ For B/ Vir B $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \frac{(-5,98)(2,45) + \frac{1}{2}(-9,8)(2,45)^2}{2}$ $= -44,06 \text{ m}$ $h = 44,06 \text{ m}$	Downwards positive <i>Afwaarts positief:</i> For A/ Vir A $v_f = v_i + a\Delta t$ $12 = -12 + (9,8)\Delta t$ $\Delta t = 2,45 \text{ s}$ For B/ Vir B $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \frac{(5,98)(2,45) + \frac{1}{2}(9,8)(2,45)^2}{2}$ $= 44,06 \text{ m}$ $h = 44,06 \text{ m}$

(3)

OPTION 5/OPSIE 5	
Upwards positive <i>Opwaarts positief:</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_A = 12\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_B = -6\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_A - \Delta y_B = 12\Delta t - (-6\Delta t)$ $0 - \Delta y_B = 18\Delta t$ $= 18(2,44)$ $= 43,92 \text{ m}$ $h = 43,92 \text{ m}$	Downwards positive <i>Afwaarts positief:</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_A = -12\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_B = 6\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_A - \Delta y_B = -12\Delta t - (6\Delta t)$ $0 - \Delta y_B = -18\Delta t$ $= -18(2,44)$ $= 43,92 \text{ m}$ $h = 43,92 \text{ m}$

(3)

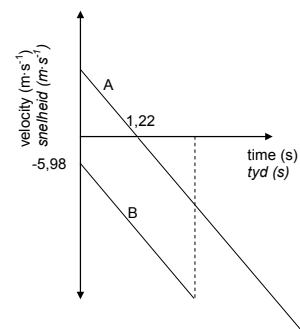
OPTION 6/OPSIE 6	
Upwards positive <i>Opwaarts positief:</i> $W_{\text{net}} = \Delta E_k$ $mg\Delta y \cos 90^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ $(-9,8)h \cos 0^\circ = \frac{1}{2}(-20)^2 - \frac{1}{2}(-6)^2$ $h = 44,082 \text{ m}$	Downwards positive <i>Afwaarts positief:</i> $W_{\text{net}} = \Delta E_k$ $mg\Delta y \cos 90^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ $(9,8)h \cos 0^\circ = \frac{1}{2}(20)^2 - \frac{1}{2}(6)^2$ $h = 44,082 \text{ m}$

OPTION 7/OPSIE 7	
$(E_p + E_k)_{\text{top/bottom}} = (E_p + E_k)_{\text{bottom/top}}$ $mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$ $(9,8)h + \frac{1}{2}(6)^2 = (9,8)(0) + \frac{1}{2}(30)^2$ $h = 44,082 \text{ m}$	

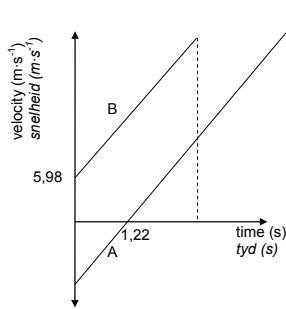
(3)

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 liniere 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 liniere momentum voor die botsing gelyk aan die totale momentum na die botsing.

(2)

- 4.2 $\Sigma p_i = \Sigma p_f$ ✓

$$m_B v_{Bi} + m_b v_{Bi} = m_B v_{Bf} + m_b v_{Bf}$$

$$\Delta p_{bullet} = -\Delta p_{block}$$

$$(0,015)(400) + 0 = (0,015)v_{Bf} + \frac{2(0,7)}{1}$$

$$v_{Bf} = 306,67 \text{ (306,666) m} \cdot \text{s}^{-1} \checkmark$$

(4)

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4.3

OPTION 1/OPSIE 1

$$F_{net} \Delta t = \Delta p$$

$$\Delta p = m v_f - m v_i \checkmark$$

For bullet / Vir koeël

$$\Delta p = (0,015)(306,666 - 400) \checkmark$$

$$= -1,4 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$$

$$F_{net}(0,002) = -1,4$$

$$F_{net} = -700 \text{ N}$$

For block / Vir blok

$$\Delta p = (2)(0,7 - 0) \checkmark$$

$$= 1,4 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$$

$$F_{net}(0,002) = 1,4$$

$$F_{net} = 700 \text{ N}$$

$$W_{net} = \Delta E_k$$

$$F_{net} \Delta x \cos \theta = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$(700) \Delta x \cos 180^\circ \checkmark = \frac{1}{2} (0,015)(306,67^2 - 400^2) \checkmark$$

$$\Delta x = 0,71 \text{ m} \checkmark$$

$$F_{net} = ma$$

$$-700 = (0,015)a$$

$$\text{OR/OF}$$

$$F_{net} = ma$$

$$700 = (0,015)a$$

$$a = -46\,666,67$$

$$\text{or/of } 46\,665 \text{ m} \cdot \text{s}^{-2}$$

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$= (400)(0,002) \checkmark + \frac{1}{2} (-46\,666,67)(0,002)^2 \checkmark$$

$$= 0,71 \text{ m (0,70667) m} \checkmark$$

$$\text{OR/OF}$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$(306,67)^2 \checkmark = (400)^2 + 2(-46\,666,67)\Delta x \checkmark$$

$$\Delta x = 0,71 \text{ m (0,70667) m} \checkmark$$

OPTION 2/OPSIE 2

$$v_f = v_i + a\Delta t \checkmark$$

$$306,666 = 400 + a(0,002) \checkmark$$

$$a = -46\,667 \text{ m} \cdot \text{s}^{-2}$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$(306,666)^2 \checkmark = 400^2 + 2(-46\,667)\Delta x \checkmark$$

$$\Delta x = 0,71 \text{ m (0,706) m} \checkmark$$

OPTION 3/OPSIE 3

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \left(\frac{400 + 306,666}{2} \right) (0,002) \checkmark$$

$$= 0,71 \text{ m (0,707) m} \checkmark$$

5.4

OPTION 1/OPSIE 1

$$W_{net} = \Delta E_k / \Delta K \checkmark = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$W_{net} = F_{net} \Delta x \cos \theta$$

$$W_{net} = W_f + W_g + W_N$$

$$= \mu_k N \Delta x \cos \theta + W_g + W_N$$

$$W_{net} = \frac{(0,4)(4)(9,8)(1,6) \cos 180^\circ}{1} \checkmark + 94,08 + 0$$

$$= 68,992 \text{ J}$$

$$W_{net} = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$68,992 \checkmark = \frac{1}{2} (4)(v_f^2 - 0) + \frac{1}{2} (6)(v_i^2 - 0) \checkmark$$

$$v_f = 3,71 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 2/OPSIE 2

$$W_{nc} = \Delta E_p + \Delta E_k \checkmark$$

$$f \Delta x \cos \theta = (m_1 g h_i - m_1 g h_f) + (\frac{1}{2} m_1 v_f^2 - \frac{1}{2} m_1 v_i^2) + (\frac{1}{2} m_2 v_f^2 - \frac{1}{2} m_2 v_i^2)$$

$$(0,4)(4)(9,8)(1,6) \cos 180^\circ \checkmark = [0 - (6)(9,8)(1,6)] \checkmark + (\frac{1}{2} (6) v_f^2 + \frac{1}{2} (4) v_i^2 - 0) \checkmark$$

$$68,992 = 5 v_f^2$$

$$v_f = 3,71 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 3/OPSIE 3

$$f_k = \mu_k N = (0,4)(4)(9,8) = 15,68 \text{ N}$$

$$T - f_k = ma$$

$$W - T = ma$$

$$T - 15,68 = 4a \dots (i)$$

$$(6)(9,8) - T = 6a \dots (ii)$$

$$\therefore a = 4,312 \text{ m} \cdot \text{s}^{-2}$$

$$\therefore T = 32,928 \text{ N}$$

$$F_{net} = ma$$

$$= (6)(4,312)$$

$$= 25,872$$

$$W_{net} = F_{net} \Delta x \cos \theta$$

$$= (25,872)(1,6) \cos 0^\circ \checkmark$$

$$= 41,3952 \text{ J}$$

$$W_{net} = \Delta E_k \checkmark$$

$$41,3952 = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$41,3952 = \frac{1}{2} (6)(v_f^2 - 0) \checkmark$$

$$v_f = 3,7146 \text{ m} \cdot \text{s}^{-1} \checkmark$$

Above calculations can be done with 4 kg or 10 kg / Bostaande berekeninge kan met 4 kg of 10 kg gedoen word

4 kg block

$$W_{net} = \Delta E_k / \Delta K \checkmark$$

$$W_f + W_T = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$f \Delta x \cos 180^\circ + T \Delta x \cos 0^\circ = \frac{1}{2} (4)(v_f^2 - 0)$$

$$(15,68)(1,6)(-1) \checkmark + (32,928)(1,6)(1) \checkmark = 2 v_f^2$$

$$v_f = 3,72 \text{ m} \cdot \text{s}^{-1} \checkmark$$

6 kg block

$$W_{net} = \Delta E_k / \Delta K \checkmark$$

$$W_w + W_T = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$f \Delta x \cos 0^\circ + T \Delta x \cos 180^\circ = \frac{1}{2} (6)(v_f^2 - 0)$$

$$(6)(9,8)(1,6)(1) \checkmark + (32,928)(1,6)(-1) \checkmark = 3 v_f^2$$

$$v_f = 3,72 \text{ m} \cdot \text{s}^{-1} \checkmark$$

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 / 58,8 N / gravitational force / F _{earth} on block F_a / F_w / gewig / mg / 58,8 N / gravitasiekrag / F _{aarde} op blok	
T	Tension / spanning	

5.3

$$W_w = w \Delta x \cos \theta \checkmark$$

$$= mg \Delta x \cos \theta$$

$$= (6)(9,8)(1,6) \cos 0^\circ \checkmark$$

$$\therefore W = 94,08 \text{ J} \checkmark$$

$$W_w = -\Delta E_p \checkmark$$

$$= -mg(h_f - h_i)$$

$$= - (6)(9,8)(0 - 1,6) \checkmark$$

$$= 94,08 \text{ J} \checkmark$$

(3)

OPTION 4/OPSIE 4

$$W_{\text{net}} = \Delta E_k \quad \checkmark$$

For the 4 kg mass / Vir die 4 kg massa

$$T(1,6)\cos 0^\circ + [(0,4)(9,8)(4)](1,6)\cos 180^\circ = \frac{1}{2}(4)v^2 - 0$$

For the 6 kg mass/Vir die 6 kg massa

$$(6)(9,8)(1,6)\cos 0^\circ + T(1,6)\cos 180^\circ = \frac{1}{2}(6)(v^2 - 0)$$

Adding the two equations / Optel van twee vergelykings

$$68,992 = \frac{1}{2}(4)v^2 + \frac{1}{2}(6)v^2 \quad \checkmark$$

$$5v^2 = 68,992$$

$$v = 3,71 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

OPTION 5/OPSIE 5

$$W_{\text{net}} = \Delta E_k \quad \checkmark$$

$$F_{\text{net}} \Delta x \cos \theta = \frac{1}{2} m(v_f^2 - v_i^2)$$

$$(F_g - f) \Delta x \cos \theta = \frac{1}{2} m(v_f^2 - v_i^2)$$

$$[(6)(9,8) - (0,4)(4)(9,8)] \checkmark (1,6) \cos 0^\circ = \frac{1}{2}(10)(v_f^2 - 0) \quad \checkmark$$

$$v_f = 3,71 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

(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.

6.2.1 170 Hz ✓

6.2.2 130 Hz ✓

- 6.3 **POSITIVE MARKING FROM QUESTIONS 6.2.1 and 6.2.2/ POSITIEWE NASIEN VANAF VRAAG 6.2.1 en 6.2.2**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark$$

$$170 = \frac{(340 + 0)}{(340 - v_s)} f_s \quad \checkmark$$

$$130 = \frac{(340 - 0)}{340 + v_s} f_s \quad \checkmark$$

$$v_s = 45,33 \text{ m}\cdot\text{s}^{-1} \quad \checkmark (45,33 - 45,45 \text{ m}\cdot\text{s}^{-1})$$

(6)
[10]

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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 elektrostatische krag uitgeoefen deur een puntlading op 'n ander puntlading is direk eweredig aan die produk van die (groottes van die) ladinge 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 puntladinge is direk eweredig aan die produk van die ladinge en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

(2)

- 7.2

OPTION 1/ OPSIE 1

$$F = k \frac{Q_1 Q_2}{r^2} \quad \checkmark$$

$$= \frac{(9 \times 10^9)(6 \times 10^{-6})(8 \times 10^{-6})}{(0,2)^2} \quad \checkmark$$

$$= 10,8 \text{ N} \quad \checkmark$$

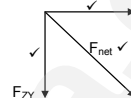
OPTION 2/ OPSIE 2

$$E = \frac{kQ}{r^2} = \frac{(9 \times 10^9)(8 \times 10^{-6})}{(0,2)^2} = 1,8 \times 10^4 \text{ N}\cdot\text{C}^{-1}$$

$$F = Eq = (1,8 \times 10^4)(6 \times 10^{-6}) = 10,8 \text{ N} \quad \checkmark$$

(4)

- 7.3



(3)

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- 7.4

OPTION 1/OPSIE 1

$$F_{\text{net}}^2 = F_{XY}^2 + F_{ZY}^2$$

$$15,20^2 = 10,8^2 + F_{ZY}^2$$

$$F_{ZY} = 10,696 \text{ N}$$

$$F_{ZY} = k \frac{Q_2 Q_Y}{r^2}$$

$$10,696 \checkmark = 9 \times 10^9 \times \frac{8 \times 10^{-6} \times Q_Z}{(0,30)^2} \quad \checkmark$$

$$Q_Z = 1,34 \times 10^{-6} \text{ C} \quad \checkmark$$

OPTION 2/OPSIE 2

$$\cos \theta = \frac{10,8}{15,2}$$

$$\theta = 44,72^\circ$$

$$\sin 44,72 = \frac{F_{ZY}}{15,2} \quad \text{OR/OF} \quad \tan 44,72 = \frac{F_{ZY}}{F_{XY}} \quad \checkmark$$

$$F_{ZY} = 10,696 \text{ N}$$

$$F_{ZY} = k \frac{Q_2 Q_Y}{r^2}$$

$$10,696 \checkmark = 9 \times 10^9 \times \frac{8 \times 10^{-6} \times Q_Z}{(0,30)^2} \quad \checkmark$$

$$Q_Z = 1,34 \times 10^{-6} \text{ C} \quad \checkmark$$

(4)
[13]**QUESTION 8 / VRAAG 8**

- 8.1 Electric field at a point is the force per unit positive charge placed at that point. ✓
Elektriese veld by 'n punt is die krag per eenheids positiewe lading geplaas by daardie punt.

(2)

- 8.2

$$E = \frac{kQ}{r^2} \quad \checkmark$$

$$E_{\text{net}} = (E_A + E_B)$$

$$= 9 \times 10^9 \frac{(15 \times 10^{-6})}{(0,4)^2} + 9 \times 10^9 \frac{(2,0 \times 10^{-6})}{(0,3)^2} \quad \checkmark$$

$$= 2,84 \times 10^5 \text{ N}\cdot\text{C}^{-1} \quad \checkmark$$

(4)

- 8.3

OPTION 1/OPSIE 1

$$F_E = qE \quad \checkmark$$

$$= (3,0 \times 10^{-9})(2,84 \times 10^5) \quad \checkmark$$

$$= 8,52 \times 10^{-4} \text{ N} \quad \checkmark$$

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OPTION 2/OPSIE 2

$$F = \frac{kQ_1 Q_2}{r^2} \quad \checkmark$$

$$F_{\text{net}} = (F_A + F_B)$$

$$= \left(\frac{(9 \times 10^9)(3 \times 10^{-6})(15 \times 10^{-6})}{(0,4)^2} + \frac{(9 \times 10^9)(3 \times 10^{-6})(2,0 \times 10^{-6})}{(0,3)^2} \right) \quad \checkmark$$

$$= 8,53 \times 10^{-4} \text{ N} \quad \checkmark$$

(3)
[9]**QUESTION 9 / VRAAG 9**

- 9.1.1 The potential difference (voltage) across a conductor is directly proportional to the current in the conductor at constant temperature. ✓
Die potensiaalverskil (spanning) oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.

OR/OF

The current in a conductor is directly proportional to the potential difference (voltage) across the conductor if temperature is constant. ✓

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil (spanning) oor die geleier indien die temperatuur konstant is.

(2)

- 9.1.2

(Equivalent) resistance/ (Ekwivalente) weerstand ✓

(1)

- 9.1.3

$$\text{Gradient/Helling} = \frac{\Delta V}{\Delta I}$$

$$= \frac{2-0}{0,5-0} = 4 \text{ (}\Omega\text{)} \quad \checkmark$$

(2)

- 9.1.4

OPTION 1/OPSIE 1In series $R_1 + R_2 = 4 \Omega$ ✓(1)In parallel $\frac{R_1 R_2}{R_1 + R_2} = 1 \Omega$ ✓(2)

$$R_1 R_2 = 4 \Omega$$

$$\therefore R_1 = R_2 = 2 \Omega \quad \checkmark$$

OPTION 2/OPSIE 2

For graph X/Vir grafiek X:

$$R_1 + R_2 = 4 \text{(1) } \checkmark$$

For graph Y/Vir grafiek Y

$$\frac{1}{R_{\text{eff}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\left\{ \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = \left(\frac{1}{1} \right) \right\} \quad \checkmark \text{(2)}$$

$$R_2 - 4R_1 + 4 = 0$$

$$R_1 = 2 \Omega \quad \checkmark$$

(4)

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9.2.1
$$I = \frac{V}{R}$$

$$= \frac{5}{(R_M + R_N)}$$

$$= \frac{5}{(6)}$$

$$= 0,83 \text{ A} \checkmark$$

(3)

9.2.2 **OPTION 1/OPSIE 1**
 $\mathcal{E} = I(R + r) \checkmark$
 $= 0,83[(6 + 1,5) \checkmark + 0,9 \checkmark]$
 $= 6,997 \text{ V}$
 $= 7,00 \text{ V} \checkmark \quad (6,972 - 7,00 \text{ V})$

OPTION 2/OPSIE 2
 $\mathcal{E} = (V_s + V_{II} + V_I) \checkmark / V_{\text{extreks}} + V_{\text{int}}$
 $= [5 + (0,833 \times 1,5) \checkmark + (0,9 \times 0,833)] \checkmark$
 $= 6,999 \text{ V}$
 $= 7,00 \text{ V} \checkmark \quad (6,972 - 7,00 \text{ V})$

9.2.3 The resistance R_N will be $3 \Omega \checkmark$
 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 3Ω 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]

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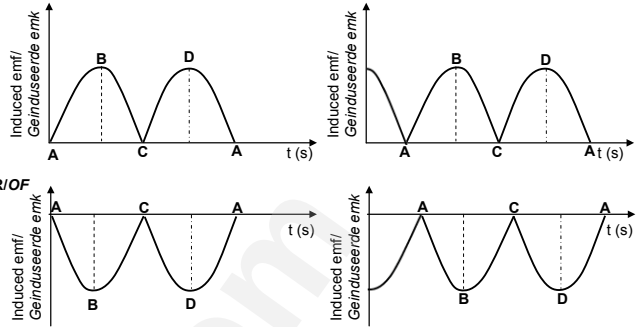
QUESTION 10 / VRAAG 10

10.1

10.1.1 Mechanical to electrical / Meganies na elektrisies ✓

(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 $20,5 \Omega \checkmark$

(1)

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10.2.2 **OPTION 1/OPSIE 1**

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{R} \checkmark$$

$$= \frac{25}{20,5} \checkmark$$

$$= 1,22 \text{ (1,2195) A}$$

$P_{\text{ave}} = I_{\text{rms}}^2 R$
 $= (1,22)^2 (0,5)$
 $= 0,74 \text{ W}$

$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark$
 $P_{\text{ave}} = \frac{(25)^2}{20,5} \checkmark$
 $P_{\text{ave}} = 30,49 \text{ W}$

Actual energy delivered per second(power) / Energie aan toestel gelever per sekonde (drywing)
 $= (30,49 - 0,74)$
 $= 29,75 \text{ W} \checkmark$

OR/OF
 $V_{\text{rms/vgk device/toestel}} = \frac{20}{20,5} \times 25 = 24,39 \text{ V}$
 $P_{\text{ave}} = \frac{V_{\text{rms}} I_{\text{rms}}}{20,5} \checkmark$
 $= \frac{(24,39)(1,22)}{20,5} \checkmark$
 $= 29,76 \text{ W} \checkmark$

$W = I_{\text{rms}}^2 R \Delta t$
 $= (1,22)^2 (0,5)(1)$
 $= 0,74 \text{ J}$

$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark$
 $P_{\text{ave}} = \frac{(25)^2}{20,5} \checkmark$
 $P_{\text{ave}} = 30,49 \text{ W}$

Actual energy delivered per second(power) / Energie aan toestel gelever per sekonde (drywing)
 $= (30,49 - 0,74)$
 $= 29,75 \text{ W} \checkmark$

OPTION 2/OPSIE 2

$$V_{\text{rms/vgk device/toestel}} = \frac{20}{20,5} \times 25 = 24,39 \text{ V}$$

$$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark = \frac{(24,39)^2}{20,5} \checkmark = 29,74 \text{ W} \checkmark$$

(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 $E_2 = E_4 - E_2$
 $E_4 - E_2 = (2,044 \times 10^{-18} - 1,635 \times 10^{-18}) \checkmark = 4,09 \times 10^{-19} \text{ J}$

$E = hf$
 $4,09 \times 10^{-19} = (6,63 \times 10^{-34})f \checkmark$
 $f = 6,17 \times 10^{14} \text{ Hz} \checkmark$

(4)

11.2.3 $E = W_0 + E_{k(\text{max})}$
 $hf = hf_0 + E_{k(\text{max})}$
 $hf = hf_0 + \frac{1}{2} m v_{\text{max}}^2$
 $E = W_0 + \frac{1}{2} m v_{\text{max}}^2$
 $4,09 \times 10^{-19} \checkmark = (6,63 \times 10^{-34}) \checkmark (4,4 \times 10^{14}) \checkmark + E_{k(\text{max})}$
 $E_{k(\text{max})} = 1,17 \times 10^{-19} \text{ J} \checkmark$

OR/OF
 $E_{k(\text{max})} = E_{\text{light/lig}} - W_0$
 $= hf_{\text{light/lig}} - hf_0 \checkmark$
 $= (6,63 \times 10^{-34}) \checkmark (6,17 \times 10^{14}) \checkmark - (6,63 \times 10^{-34}) \checkmark (4,4 \times 10^{14}) \checkmark$
 $= 1,17 \times 10^{-19} \text{ J} \checkmark$

(4)

11.2.4

No✓ / Nee

The threshold frequency is greater than the frequency of the photon. ✓
 Die drumpelfrekwensie is groter as die frekwensie van die foton

OR/OF

The frequency of the photon is less than the threshold frequency ✓
 Die frekwensie van die foton is minder as die drumpelfrekwensie

OR/OF

Energy of the photon is less than the work function of the metal ✓
 Energie van foton is minder as die van die arbeidsfunksie van die metaal

(2)

[13]

TOTAL/TOTAAL: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT

GRADE/GRAAD 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

FEBRUARY/MARCH/FEBRUARIE/MAART 2018

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

These marking guidelines consist of 13 pages.
Hierdie nasienriglyne bestaan uit 13 bladsye.

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QUESTION 1/VRAAG 1

- | | | |
|------|-----|-----|
| 1.1 | A✓✓ | (2) |
| 1.2 | B✓✓ | (2) |
| 1.3 | C✓✓ | (2) |
| 1.4 | B✓✓ | (2) |
| 1.5 | A✓✓ | (2) |
| 1.6 | B✓✓ | (2) |
| 1.7 | C✓✓ | (2) |
| 1.8 | C✓✓ | (2) |
| 1.9 | D✓✓ | (2) |
| 1.10 | B✓✓ | (2) |
- [20]

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QUESTION 2/VRAAG 2

- 2.1. A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force acts on it. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid in 'n reguitlyn volhard tensy 'n nie-nul resulterende/netto krag daarop inwerk. (2)

2.2

Accepted labels/Aanvaarde benoemings	
W	F_g / F_w weight / mg / gravitation force F_g / F_w / gewig / mg / gravitasiekrag
T	F_t / tension F_s / spanning
f_k	(Kinetic) Friction / F_f / 4 N / f / wrywing / F_w
N	F_{Normal} / Normal / F_N



(4)

Notes/Aantekeninge

- Mark awarded for label and arrow/Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s)/Enige ander addisionele krag(te) Max/Maks $\frac{3}{4}$
- If force(s) do not make contact with body/Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{3}{4}$

2.3 Object Q/Voorwerp Q

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ F_{\text{net}} &= 0 \\ T + (f_k) &= ma \\ T - 3 &= 0 \checkmark \\ T &= 3 \text{ N} \end{aligned} \right\} \checkmark$$

Object P/Voorwerp P

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ F_{\text{hor}} - (f_k + T) &= ma \checkmark \\ (F \cos 30^\circ) - 5 - 3 &= 0 \checkmark \\ F &= 9,24 \text{ N} \checkmark (9,238 \text{ N}) \end{aligned} \right\}$$

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- 2.4 3 s✓ (1)
- 2.5 Y✓
Graph Y represents the motion of Q after the string breaks.
The graph Y shows a decreasing velocity ✓ with a negative acceleration. ✓
This is because the net force (friction) acting on Q is in the opposite direction to its motion. ✓ (accept: only frictional force acts on Q).
Grafiek Y verteenwoordig die beweging van Q na die toujie breek
Die versnelling is negatief vir grafiek Y en toon 'n afnemende snelheid
Dit is omdat wrywing op Q inwerk (4)

[17]

QUESTION 3/VRAAG 3

- 3.1 10 m·s⁻¹✓ (1)
- 3.2 The gradient represents the acceleration due to gravity (g) which is constant for free fall. ✓
Die helling verteenwoordig die versnelling as gevolg van gravitasie (g) wat konstant vir vry-val is.
[The graphs represent free fall/Die grafieke verteenwoordig vryval] (1)

- 3.3.1 POSITIVE MARKING FROM QUESTION 3.1
POSITIEWE NASIEN VANAF VRAAG 3.1
- | OPTION 1/OPSIE 1 | |
|---|---|
| $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$
$= (10)(2) + \frac{1}{2} (9,8)(2^2) \checkmark$
$= 39,6 \text{ m}$
Height/Hoogte = 39,6 m ✓ | $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$
$= (-10)(2) + \frac{1}{2} (-9,8)(2^2) \checkmark$
$= -39,6 \text{ m}$
Height/Hoogte = 39,6 m ✓ |
| OPTION 2/OPSIE 2 | |
| $\Delta x = \frac{(v_i + v_f)}{2} \Delta t \checkmark$
$\Delta x = \left(\frac{10 + 29,6}{2} \right) (2) \checkmark$
$\Delta x = 39,6 \text{ m} \checkmark$ | $v_f^2 = v_i^2 + 2a\Delta x \checkmark$
$(29,6)^2 = (10)^2 + 2(9,8)\Delta x \checkmark$
$\Delta x = 39,6 \text{ m} \checkmark$ |
| OPTION 4/OPSIE 4 | |
| Height = Area under the graph
Hoogte = Area onder die grafiek
= Area of van □ + Area of van △
$= (10)(2) + \left(\frac{1}{2} \right) (2)(19,6) \checkmark$
$= 39,6 \text{ m} \checkmark$ | Any one/Enige een✓ |
| OPTION 5/OPSIE 5 | |
| Height = Area of trapezium
$= \frac{1}{2} (10 + 29,6) \times 2 \checkmark = 39,6 \text{ m} \checkmark$ | Hoogte = Area van trapesium ✓ |
- (3)

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3.3.2	OPTION 1/OPSIE 1 $v_i = v_f + a\Delta t$ $0 = -25 + (9,8)(\Delta t) \checkmark$ $\Delta t = 2,55 \text{ s}$ $\text{Total time T/Totale tyd} = 8 + 2,55 \checkmark$ $= 10,55 \text{ s}$	OPTION 2/OPSIE 2 $v_i = v_f + a\Delta t$ $0 = 25 + (-9,8)(\Delta t) \checkmark$ $\Delta t = 2,55 \text{ s}$ $\text{Total time T/Totale tyd} = 8 + 2,55 \checkmark$ $= 10,55 \text{ s}$
	OPTION 3/OPSIE 3 $v_f^2 = v_i^2 + 2a\Delta x$ $\Delta x = 31,89 \text{ m}$ $\Delta x = \frac{(v_i + v_f)}{2} \Delta t$ $31,89 = \left(\frac{25 + 0}{2}\right) \Delta t \checkmark$ $\Delta t = 2,55 \text{ s}$ $\text{Total time T/Totale tyd} = 8 + 2,55 \checkmark$ $= 10,55 \text{ s}$	OPTION 4/OPSIE 4 $E_{Mi} = E_{Mf}$ $W_{nc} = 0$ $W_{net} = \Delta E_K$ $W_{con} = \Delta E_K$ $\Delta E_K + \Delta E_P = 0$ $E_{Ki} + E_{Pi} = E_{Kf} + E_{Pf}$ $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$ $\frac{1}{2}(25)^2 + 0 = 0 + 9,8h_f$ $\Delta x = 31,89 \text{ m}$ $\Delta x = \frac{(v_i + v_f)}{2} \Delta t$ $31,89 = \left(\frac{25 + 0}{2}\right) \Delta t \checkmark$ $\Delta t = 2,55 \text{ s}$ $\text{Total time T/Totale tyd} = 8 + 2,55 \checkmark$ $= 10,55 \text{ s}$
	OPTION 5/OPSIE 5 Slope of graph = 9,8 $\checkmark$ $= \frac{0 - (-25)}{T - 8} \checkmark \checkmark$ Total time T/Totale tyd = 10,55 s $\checkmark$	If values of v_i and v_f are swapped around, and a negative time is obtained, give 1 mark for formula and 1 mark for adding calculated time to 8 s, (max 2/4).

- 3.4.1 0,2 s $\checkmark$ (1)
- 3.4.2 4,955 s $\checkmark$ (2)
- 3.4.3 -27 (m s⁻¹) $\checkmark$ [Must include the negative/Moet negatief insluit] (1)

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- 3.5 Inelastic/Onelasties $\checkmark$
The speeds at which it strikes and leaves the ground are not the same/The kinetic energies will not be the same $\checkmark$
Die spoed waarmee dit die grond tref en die grond verlaat is nie dieselfde nie./Die kinetiese energieë sal nie dieselfde wees nie (2)
- QUESTION 4/VRAAG 4**
- 4.1 The total linear momentum of a closed (isolated) system remains constant (is conserved). $\checkmark \checkmark$
Die totale lineêre momentum in 'n geslote sisteem bly konstant (bly behoue)
- OR/OF**
In an isolated system, the total linear momentum before collision is equal to the total linear momentum after collision $\checkmark \checkmark$
In 'n geïsoleerde sisteem is die totale lineêre momentum voor botsing gelyk aan die totale lineêre momentum na botsing.
(If key words isolated and total missing -1 mark for each.) (2)
- 4.2 $\Sigma p_i = \Sigma p_f$
 $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ } Any one/Enige een $\checkmark$
For the system cat-skate board A/Vir die sisteem kat-skaatsplank
 $(3,5)(0) + (2,6)(0) \checkmark = (3,5)v_{\text{skateboard/skaatsplank}} + (2,6)(3) \checkmark$
 $v_{\text{skateboard/skaatsplank}} = 2,23 \text{ m s}^{-1} \checkmark$ to the left/na links $\checkmark$
- ACCEPT/AANVAAR** $v = -2,23 \text{ m s}^{-1} \checkmark \checkmark$ (5)
- 4.3 $F_{\text{net}} \Delta t = \Delta p = mv_f - mv_i \checkmark$
 $= (3,5)(1,28 - 0) \checkmark$
 $= 4,48 \text{ N s } (4,48 \text{ kg ms}^{-1}) \checkmark$
- OR/OF**
 $F_{\text{net}} \Delta t = \Delta p = mv_f - mv_i \checkmark$
 $= (2,6)(1,28 - 3) \checkmark$
 $= -4,48 \text{ N s } (4,48 \text{ kg ms}^{-1})$
 $\therefore \Delta p = 4,48 \text{ N s} \checkmark$ (3)

[10]

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QUESTION 5/VRAAG 5

- 5.1 The total mechanical energy/sum of kinetic and gravitational potential energy in a closed/isolated system is constant (conserved). $\checkmark \checkmark$
Die totale meganiese energie/some van kinetiese en gravitasionele potensiele energie in 'n geslote sisteem bly behoue.
(If key words isolated and total missing -1 mark for each.) (2)
- 5.2 $E_{\text{MECH P}} = E_{\text{MECH Q}}$
 $(E_P + E_K)_P = (E_P + E_K)_Q$
 $W_{\text{net}} = \Delta E_K$
 $W_{\text{con}} = \Delta E_K$
 $\Delta E_K + \Delta E_P = 0$
 $(mgh + \frac{1}{2}mv^2)_P = (mgh + \frac{1}{2}mv^2)_Q$
 $50(9,8)(3) + 0 \checkmark = 0 + \frac{1}{2}(50)v^2 \checkmark$
 $v = 7,67 \text{ m s}^{-1} \checkmark (7,668 \text{ m s}^{-1})$

5.3	Accepted labels/Aanvaarde benoemings	
w	F_g / F_w / weight / mg / gravitašionale krag	$\checkmark$
N	F_N	$\checkmark$
f_k	F_f / friction / f	$\checkmark$

**Notes/Aantekeninge**

- Mark awarded for label and arrow/Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s)/Enige ander addisionele krag(te) Max/Maks $\frac{2}{3}$
- If force(s) do not make contact with body/Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{2}{3}$

- 5.4 $f_k = \mu_k N$
 $= \mu_k (mg \cos \theta)$ } $\checkmark$ Any one/Enige een
 $= 0,08 (50 \times 9,8) \cos 30^\circ \checkmark$
 $= 33,95 (33,948) \text{ N} \checkmark$ (3)

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NOTE/LET WEL:

IN ALL THE OPTIONS FOR QUESTION 5.5 BELOW, ACCEPT THE SUBSTITUTION: IN AL DIE OPSIES VIR VRAAG 5.5 HIERONDER, AANVAAR DIE VERVANGING
5 cos 60° IN PLACE OF/IN PLAAS VAN 5 sin 30°

- 5.5 **OPTION 1/OPSIE 1**
POSITIVE MARKING FROM QUESTION 5.4/POSITIEWE NASIEN VANAF VRAAG 5.4
 $W = F_{\text{net}} \Delta x \cos \theta$
 $W_{\text{net}} = W_f + W_w + W_N$
 $W_{\text{net}} = W_f + (-\Delta E_P) + W_N$
 $W_{\text{net}} = f_k \Delta x \cos 180^\circ + mgsin \theta \Delta x \cos 0 + 0$
 $W_{\text{net}} = \Delta E_K / \Delta K$
 $W_{\text{net}} = [33,948(5)(-1)] \checkmark + [(50)(9,8)(5) \sin 30^\circ + 0] \checkmark$
 $= 1055,26 (1055,259)$
 $1055,259 = \frac{1}{2}(50)(v_f^2 - 7,668^2) \checkmark$
 $v_f = 10,05 \text{ m s}^{-1} \checkmark$
- OPTION 2/OPSIE 2**
POSITIVE MARKING FROM QUESTION 5.2/POSITIEWE NASIEN VANAF VRAAG 5.3
 $W_{\text{nc}} = \Delta E_P + \Delta E_K$
 $f_k \Delta x \cos \theta = (mgh_i - mgh_f) + (\frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2)$ } 1 mark for any of the two/1 punt vir enige van die twee
 $\mu mg \Delta x \cos 180^\circ = [0 - (mg \Delta x \sin 30^\circ)] + \frac{1}{2}m(v_i^2 - v_f^2)$
 $[33,948(5)(-1)] \checkmark = [0 - 50(9,8)(5) \sin 30^\circ] \checkmark + \frac{1}{2}(50)(v_i^2 - 7,668^2) \checkmark$
 $v_i = 10,05 \text{ m s}^{-1} \checkmark$

OPTION 3/OPSIE 3

POSITIVE MARKING FROM QUESTION 5.2 AND 5.4/POSITIEWE NASIEN VANAF VRAAG 5.2 EN 5.4
 $W_{\text{nc}} = \Delta E_P + \Delta E_K$
 $f_k \Delta x \cos \theta = (mgh_i - mgh_f) + (\frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2)$ } 1 mark for any of the two/1 punt vir enige van die twee
 $(33,95)(5) \cos 180^\circ = [(50)(9,8)(0 - 5 \sin 30^\circ)] \checkmark + \frac{1}{2}(50)(v_i^2 - 7,668^2) \checkmark$
 $v_i = 10,05 \text{ m s}^{-1} \checkmark$

(5)

[17]

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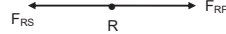
QUESTION 6/VRAAG 6

- 6.1 An (apparent) change in the observed frequency (pitch). (wavelength) ✓ as a result of the relative motion between a source and an observer ✓ (listener).
'n (Waarskynlike) verandering in die waargenome frekwensie (toonhoogte) (golflengte) as gevolg van die relatiewe beweging tussen bron en waarnemer (luisteraar) (2)
- 6.2 Towards A./Na A ✓
Recorded frequency higher./Aangetekende frekwensie is hoër ✓ (2)
- 6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓
FOR A/VIR A
 $690 = \frac{340}{340 - v_s} f_s$ (1)
- FOR B/VIR B:**
 $610 = \frac{340}{340 + v_s} f_s$ (2)
- $\frac{690}{610} = \frac{340 + v_s}{340 - v_s}$
 $1,131 (340 - v_s) = 340 + v_s$
 $v_s = 20,90 \text{ m.s}^{-1}$ ✓ (20.90 to 20.92 m.s⁻¹) (6)
- 6.4 **ANY ONE/ENIGE EEN**
Doppler flow meter/Doppler-vloeimeter ✓
Measuring foetal heartbeat/Meet van fetale hartslag
Measure speed of blood flow
Ultra sound/Ultraklank
Sonar
Radar (for speeding/vir jaag) (1)
[11]

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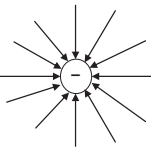
QUESTION 7/VRAAG 7

- 7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product (of the magnitudes) of the charges and inversely proportional to the square of the distance between them. ✓ ✓
Die grootte van die elektrostatiese krag uitgeoefen deur een puntlading op 'n ander puntlading is direk eweredig aan die produk (van die groottes) van die ladinge en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle (2)
- 7.2  (2)
- NOTE/LET WEL:**
One mark for each force, correctly shown./Een punt vir elke krag korrek getoon. (2)
- 7.3 Taking right as positive/Neem regs as positief
 $F = k \frac{Q_1 Q_2}{r^2}$ ✓
 $F_{\text{net R}} = F_{\text{PR}} + F_{\text{SR}}$
 $F_{\text{net}} = k \frac{Q_1 Q_2}{r^2} + k \frac{Q_1 Q_2}{r^2}$
 $-1,27 \times 10^{-8} = \left\{ \frac{(9 \times 10^9)(1,5 \times 10^{-9})(Q)}{(0,3)^2} - \frac{(9 \times 10^9)(2 \times 10^{-9})(Q)}{(0,2)^2} \right\}$
 $-1,27 \times 10^{-8} = 150Q - 450Q$ (for subtraction/vir aftrekking)
 $Q = 4,23 \times 10^{-9} \text{ C}$ ✓
Accept answers where left is taken as positive. (7)
[11]

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QUESTION 8/VRAAG 8

- 8.1  (2)
- Shape (radial)/Vorm (radiaal) ✓
Polarity (sign) of A/Polariteit (Teken) van A ✓
Do not penalize for incorrect direction/Moet nie penaliseer vir verkeerde rigting nie
- 8.2 $E = \frac{kQ}{r^2}$ ✓
 $3 \times 10^7 = \frac{(9 \times 10^9)(Q)}{(0,5)^2}$
 $Q = 8,33 \times 10^{-4} \text{ C}$ ✓ (3)
- 8.3 $Q = ne$ ✓
 $= (10^5)(1,6 \times 10^{-19})$ ✓
 $= 1,6 \times 10^{-14} \text{ C}$
 $E = \frac{F}{Q}$ ✓
 $3 \times 10^7 = \frac{F}{1,6 \times 10^{-14}}$ ✓
 $F = 4,8 \times 10^{-7} \text{ N}$ Right/Regs ✓ (6)
[11]
- (Positive marking from 8.2 for this option)
 $F = k \frac{Q_1 Q_2}{r^2}$ ✓
 $F = (9 \times 10^9) \frac{(8,33 \times 10^{-4})(1,6 \times 10^{-14})}{(0,5)^2}$ ✓
 $= 4,8 \times 10^{-7} \text{ N}$ Right/Regs ✓

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QUESTION 9/VRAAG 9

- 9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓ ✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur. (2)
- OR/OF**
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature. ✓ ✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor die geleier by konstante temperatuur (2)
- 9.1.2 Graph X./Grafiek X ✓
Graph X is a straight line (passing through the origin) therefore potential difference is directly proportional to current. ✓
/Grafiek X is lineêr (2)
- 9.2.1 $\frac{1}{R_{\text{eff}}} = \frac{1}{R_{10}} + \frac{1}{R_{15}}$
 $\frac{1}{R_{\text{eff}}} = \frac{1}{10} + \frac{1}{15}$ ✓
 $R_{\text{eff}} = 6 \Omega$
 $\therefore R = (10 + 6 + 2)$ ✓ (for the addition/vir optelling)
 $= 18 \Omega$
 $R = \frac{V}{I}$ ✓
 $I = \frac{6}{18}$ ✓
 $= 0,33 \text{ A}$ ✓ (5)
- 9.2.2 Decrease. ✓
The total resistance of the circuit increases ✓.
Afneem
Die totale weerstand van die stroombaan neem toe. (2)
- 9.2.3 Increase/Neem toe ✓ (1)

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- 9.2.4 The total resistance in the external circuit increases./Die totale weerstand in die eksterne stroombaan neem toe ✓
Current decreases/Stroom neem af ✓
"Lost" volts decreases/"Verlore" volts neem af ✓

OR/OF

The total resistance in the external circuit increases./Die totale weerstand in die eksterne stroombaan neem toe ✓
V ∝ R ✓ for constant/vir konstante ✓
Therefore V increases./Dus neem V toe

QUESTION 10/VRAAG 10**10.1 ANY THREE/ENIGE DRIE**

- I. Permanent magnets/Permanente magnete
- II. coils (armature)/spoel
- III. commutator/kommutator
- IV. brushes/borsels
- V. power supply/battery/kragbron

- 10.2.1 The rms voltage of AC is the potential difference which dissipates the same amount of energy as the equivalent DC potential difference. ✓✓
Die wgk spanning/potensiaalverskil van WS is die potensiaalverskil wat dieselfde aantal energie verkais as GS.
Accept formula for V_{rms} as 1 mark.

10.2.2 OPTION 1/OPSIE 1

$$V_{rms} = I_{rms} R$$

$$I_{rms} = \frac{V_{rms}}{R}$$

$$I_{rms} = \frac{240}{11}$$

$$I_{rms} = 21,82 \text{ A}$$

$$I_{max} = \frac{I_{rms}}{\frac{1}{\sqrt{2}}}$$

$$I_{max} = (21,82) \sqrt{2} \checkmark$$

$$I_{max} = 30,86 \text{ A} \checkmark$$

OPTION 3/OPSIE 3

$$P_{ave} = \frac{V_{rms}^2}{R}$$

$$P_{ave} = \frac{(240)^2}{11}$$

$$P_{ave} = 5236,36 \text{ W}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$21,82 = \frac{I_{max}}{\sqrt{2}}$$

$$I_{max} = 30,86 \text{ A} \checkmark$$

OPTION 2/OPSIE 2

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_{max} = (240) \sqrt{2} \checkmark$$

$$V_{max} = 339,41$$

$$V_{max} = I_{max} R$$

$$\frac{339,41}{11}$$

$$I_{max} = 30,86 \text{ A} \checkmark$$

$$P_{ave} = I_{rms} V_{rms}$$

$$5236,36 = I_{rms} \cdot 240$$

$$I_{rms} = 21,82 \text{ A}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$21,82 = \frac{I_{max}}{\sqrt{2}}$$

$$I_{max} = 30,86 \text{ A} \checkmark$$

$$P_{ave} = \frac{I_{max}^2 R}{2}$$

$$5236,36 = \frac{I_{max}^2 (240)}{2}$$

$$I_{max} = 30,86 \text{ A} \checkmark$$

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QUESTION 11/VRAAG 11**11.1.1 Greater than/Groter as ✓**

Electrons are ejected from the metal plate./Elektrone word vrygestel vanaf die metaalplaat ✓ Accept: a current is registered on the ammeter. (2)

- 11.1.2 Increase in intensity means that (for the same frequency) the number of photons per second increases (ammeter reading increases) ✓ but the energy of the photons stays the same ✓ (Therefore the statement is incorrect).

OR
An increase in the energy of the photons only increases the kinetic energy of the photoelectrons and not the number of photoelectrons, thus the ammeter reading will not change.

Toename in intensiteit beteken dat (vir dieselfde frekwensie) die aantal fotone neem toe (ammeterlesing neem toe) maar die energie van die fotone bly dieselfde. (Dus is die stelling verkeerd) (2)

11.1.3 Light has a particle nature/Lig het 'n deeltjienatuur

Accept light energy is quantized/Aanvaar ligenergie is gekwantiseer ✓ (1)

- 11.2.1 The minimum frequency needed for the emission of electrons (from a metal surface).
Die minimum energie benodig vir die vrystelling van elektrone (vanaf die metaaloppervlak) (2)

11.2.2 $W_0 = hf_0$ ✓

$$= (6,63 \times 10^{-34}) (5,73 \times 10^{14}) \checkmark$$

$$= 3,8 \times 10^{-19} \text{ J} \checkmark [3,799 \times 10^{-19} \text{ J}]$$

11.2.3 POSITIVE MARKING FROM QUESTION 11.2.2**POSITIEWE NASIE VANAF VRAAG 11.2.2****OPTION 1/OPSIE 1**

$$E = W_0 + E_{k(\max)}$$

$$hf = hf_0 + E_{k(\max)}$$

$$hf = hf_0 + \frac{1}{2} mv^2$$

$$E = W_0 + \frac{1}{2} mv^2$$

$$(6,63 \times 10^{-34}) f = 3,8 \times 10^{-19} + [\frac{1}{2} (9,11 \times 10^{-31}) (4,19 \times 10^5)^2] \checkmark$$

$$f = 6,94 \times 10^{14} \text{ Hz} \checkmark [7 \times 10^{14} \text{ Hz}]$$

OPTION 2/OPSIE 2

$$E = W_0 + E_{k(\max)}$$

$$hf = hf_0 + E_{k(\max)}$$

$$hf = hf_0 + \frac{1}{2} mv^2$$

$$E = W_0 + \frac{1}{2} mv^2$$

$$E = 3,8 \times 10^{-19} + [\frac{1}{2} (9,11 \times 10^{-31}) (4,19 \times 10^5)^2] \checkmark$$

$$hf = 4,599 \times 10^{-19}$$

$$(6,63 \times 10^{-34}) f = 4,599 \times 10^{-19}$$

$$f = 6,94 \times 10^{14} \text{ Hz} \checkmark [7 \times 10^{14} \text{ Hz}]$$

TOTAL/TOTAAL: 150

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**basic education**

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

2018**MARKING GUIDELINES/NASIENRIGLYNE****MARKS/PUNTE: 150**

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

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Please turn over/Blaai om asseblief

QUESTION 1/VRAAG 1

- 1.1 C ✓✓ (2)
- 1.2 A ✓✓ (2)
- 1.3 D ✓✓ (2)
- 1.4 A ✓✓ (2)
- 1.5 C ✓✓ (2)
- 1.6 A ✓✓ (2)
- 1.7 B ✓✓ (2)
- 1.8 B ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 A ✓✓ (2)

[20]

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QUESTION 2/VRAAG 2

- 2.1 The rate of change of velocity. ✓✓
Die tempo van verandering van snelheid.

Accept/Aanvaar

Change in velocity per unit time
Verandering in snelheid per eenheidstyd

(2)

NOTE:/LET WEL

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.

2.2 **OPTION 1/OPSIE 1**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$0,5 = (0)(3) + \frac{1}{2} (a)(3^2) \checkmark$$

$$a = 0,11 \text{ m} \cdot \text{s}^{-2} \checkmark$$

(3)

OPTION 2/OPSIE 2

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$0,5 = \left(\frac{0 + v_f}{2} \right) (3) \checkmark$$

$$v_f = 0,333 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$v_f = v_i + a \Delta t$$

$$0,33 = 0 + a(3) \checkmark$$

$$a = 0,11 \text{ m} \cdot \text{s}^{-2} \checkmark$$

(3)

OPTION 3/OPSIE 3

$$v_f = v_i + a \Delta t$$

$$= 0 + 3a$$

$$v_f = 3a \dots \dots \dots (i)$$

$$v_f^2 = v_i^2 + 2a \Delta y$$

$$= 0^2 + 2a(0,5)$$

$$v_f = \sqrt{a} \dots \dots \dots (ii)$$

$$9a^2 = a \checkmark$$

$$\therefore a = 0,11 \text{ m} \cdot \text{s}^{-2} \checkmark$$

(3)

2.3 **POSITIVE MARKING FROM 2.2 / POSITIEWE NASIEN VANAF 2.2****OPTION 1/OPSIE 1**

For the 3 kg mass/vir die 3 kg massa:

$$F_{\text{net}} = ma$$

$$(mg - T)/(mg + T) = ma \checkmark$$

$$(3)(9,8) - T = (3)(0,11) \checkmark$$

$$T = 29,07 \text{ N} \checkmark$$

(3)

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OPTION 2/OPSIE 2

For the 3 kg mass/vir die 3 kg massa:

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$0,5 = \left(\frac{0 + v_f}{2} \right) (3) \checkmark$$

$$v_f = 0,333 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OR/OF**POSITIVE MARKING FROM 2.2/POSITIEWE NASIEN VANAF 2.2**

$$v_f = v_i + a \Delta t$$

$$= 0 + (0,11)(3) \checkmark$$

$$= 0,33 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$W_{\text{net}} = \Delta E_k \checkmark$$

$$W_w + W_T = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$mg \Delta x \cos \theta + T \Delta x \cos \theta = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$(3)(9,8)(0,5) \cos 0^\circ + T(0,5) \cos 180^\circ = \frac{1}{2} (3)(0,33^2 - 0^2) \checkmark$$

$$14,7 - 0,5T = -0,16$$

$$T = 29,72 \text{ N} \checkmark$$

(3)

OPTION 3/OPSIE 3

$$W_{\text{nc}} = \Delta E_k + \Delta E_p \checkmark$$

$$T \Delta x \cos 180^\circ = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 + mgh_f - mgh_i$$

$$T(0,5) \cos 180^\circ = \frac{1}{2} (3)(0^2 - 0,33^2) + (3)(9,8)(0) - (3)(9,8)(0,5) \checkmark$$

$$T = 29,72 \text{ N} \checkmark$$

(3)

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2.4

ACCEPT/AANVAAR

Accepted labels/Aanvaarde benoemings	
w	F_g / F_w / weight / mg / gravitational force F_g / F_w / gewig / mg / gravitasiekrag
f	Friction/ F_f / f_k / 27 N/ wrywing / F_w
N	Normal (force) / F_{normal} / F_N / F_{normal}
T	F_{tension} / F_{spanning}

Notes/Aantekeninge

- Mark awarded for label and arrow / Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale. / Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s) / Enige ander addisionele krag(te) Maxi/Maks $\frac{3}{4}$
- If force(s) do not make contact with body / Indien krag(te) nie met die voorwerp kontak maak nie: Maxi/Maks: $\frac{3}{4}$

(4)

2.5 **POSITIVE MARKING FROM 2.2 AND 2.3/POSITIEWE NASIEN VANAF 2.2 EN 2.3**

For/ Vir P

$$F_{\text{net}} = ma \checkmark$$

$$T - f = ma \checkmark$$

$$29,07 - 27 = m(0,11) \checkmark$$

$$m = 18,82 \text{ kg} \checkmark \text{ (Range: } 18,60 - 18,82)$$

OR/OF

For/ Vir P

$$F_{\text{net}} = ma \checkmark$$

$$T - f = ma \checkmark$$

$$29,72 - 27 = m(0,11) \checkmark$$

$$m = 24,73 \text{ kg} \checkmark$$

(3)

[15]

QUESTION 3/VRAAG 3

- 3.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gravitasie/gewig/gravitasiekrag.

OR/OFMotion in which the only force considered is gravitational. ✓✓Beweging waar die enigste krag wat in ag geneem word, gravitasie is.

(2)

NOTE:/LET WEL

If ONLY is omitted minus 1 mark.

Indien SLEGS uitgelaat is, trek 1 punt af.

3.2

OPTION 1/OPSIE 1**UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= (0)(1) + \frac{1}{2} (-9,8)(1^2) \checkmark$$

$$= -4,9 \text{ m}$$

$$\text{Height/hoogte} = 2\Delta y$$

$$= (2)(4,9)$$

$$= 9,8 \text{ m} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= (0)(1) + \frac{1}{2} (9,8)(1^2) \checkmark$$

$$= 4,9 \text{ m}$$

$$\text{Height/hoogte} = 2\Delta y$$

$$= (2)(4,9)$$

$$= 9,8 \text{ m} \checkmark$$

OPTION 2/OPSIE 2**UPWARD POSITIVE/OPWAARTS POSITIEF**

$$v_f = v_i + a \Delta t$$

$$= 0 + (-9,8)(1) \checkmark$$

$$= -9,8 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \left(\frac{0 + (-9,8)}{2} \right) (1) \checkmark$$

$$= -4,9 \text{ m}$$

$$\text{Height/hoogte} = (2)(4,9)$$

$$= 9,8 \text{ m} \checkmark$$

DOWNWARD POSITIVE/AFWAARTS POSITIEF

$$v_f = v_i + a \Delta t$$

$$= 0 + (9,8)(1) \checkmark$$

$$= 9,8 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \left(\frac{0 + (9,8)}{2} \right) (1) \checkmark$$

$$= 4,9 \text{ m}$$

$$\text{Height/hoogte} = (2)(4,9)$$

$$= 9,8 \text{ m} \checkmark$$

OPTION 3/OPSIE 3	OPTION 4/OPSIE 4
UPWARD POSITIVE/OPWAARTS POSITIEF $v_f = v_i + a\Delta t$ $= 0 + (-9,8)(1)$ $= -9,8 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $(-9,8)^2 = 0 + (2)(-9,8)\Delta y$ $\Delta y = -4,9 \text{ m}$ Height/hoogte = $2\Delta y$ $= (2)(-4,9)$ Height/hoogte = $9,8 \text{ m}$ ✓	DOWNWARD POSITIVE/AFWAARTS POSITIEF $v_f = v_i + a\Delta t$ $= 0 + (9,8)(1)$ $= 9,8 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $(9,8)^2 = 0 + (2)(9,8)\Delta y$ $\Delta y = 4,9 \text{ m}$ Height/hoogte = $2\Delta y$ $= (2)(4,9)$ Height/hoogte = $9,8 \text{ m}$ ✓

OPTION 5/OPSIE 5	OPTION 6/OPSIE 6
UPWARD POSITIVE/OPWAARTS POSITIEF $v_f = v_i + a\Delta t$ $= 0 + (-9,8)(1)$ $v_f = -9,8 \text{ m}\cdot\text{s}^{-1}$ $W_{\text{net}} = \Delta K$ $mg\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(9,8)(\frac{1}{2}h) \cos 0^\circ = \frac{1}{2}(9,8^2 - 0)$ $h = 9,8 \text{ m}$ ✓	DOWNWARD POSITIVE/AFWAARTS POSITIEF $v_f = v_i + a\Delta t$ $= 0 + 9,8(1)$ $v_f = 9,8 \text{ m}\cdot\text{s}^{-1}$ $W_{\text{net}} = \Delta K + \Delta U$ $0 = (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) + (mg\frac{1}{2}h - mgh)$ $(9,8)(\frac{1}{2}h) = (\frac{1}{2}(9,8^2 - 0) - 9,8h)$ $h = 9,8 \text{ m}$ ✓

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OPTION 1/OPSIE 1 UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $= 0 + (2)(-9,8)(-9,8)$ $v_f = 13,86 \text{ m}\cdot\text{s}^{-1}$ ✓ DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $= 0 + (2)(9,8)(9,8)$ $v_f = 13,86 \text{ m}\cdot\text{s}^{-1}$ ✓ OR/OF FROM POINT B/ VANAF PUNT B UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $= (-9,8)^2 + (2)(-9,8)(-4,9)$ $v_f = -13,86 \text{ m}\cdot\text{s}^{-1}$ Magnitude = $13,86 \text{ m}\cdot\text{s}^{-1}$ ✓ DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $= (9,8)^2 + (2)(9,8)(4,9)$ $v_f = 13,86 \text{ m}\cdot\text{s}^{-1}$ ✓	(3)
---	-----

OPTION 2/OPSIE 2

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$-9,8 = 0 + \frac{1}{2}(-9,8)\Delta t^2$$

$$\Delta t = 1,41 \text{ s}$$

1 mark for either of the two/
1 punt vir enige van die twee

$$v_f = v_i + a\Delta t$$

$$= 0 + (-9,8)(1,41)$$

$$= -13,82 \text{ m}\cdot\text{s}^{-1}$$

$$\text{Magnitude} = 13,82 \text{ m}\cdot\text{s}^{-1}$$
 ✓

(3)

OPTION 1/OPSIE 1 POSITIVE MARKING FROM 3.3/POSITIEWE NASIEN VANAF 3.3 UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $0 = v_i^2 + (2)(-9,8)(4,9)$ $v_i = 9,8 \text{ m}\cdot\text{s}^{-1}$ $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ $F_{\text{net}}(0,2) = 0,4[9,8 - (-13,86)]$ $F_{\text{net}} = 47,32 \text{ N}$ ✓	1 mark for any 1 punt vir enige een
--	--

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UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $0 = v_i^2 + (2)(9,8)(-4,9)$ $v_i = -9,8 \text{ m}\cdot\text{s}^{-1}$ $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ $F_{\text{net}}(0,2) = 0,4[-9,8 - (-13,86)]$ $F_{\text{net}} = -47,32 \text{ N}$ $F_{\text{net}} = 47,32 \text{ N}$ ✓	1 mark for any 1 punt vir enige een If calculation of $9,8 \text{ m}\cdot\text{s}^{-1}$ is not shown and it is substituted correctly award 1 mark/Indien berekening van $9,8 \text{ m}\cdot\text{s}^{-1}$ nie getoon is nie en dit is korrek vervang ken 1 punt toe
OPTION 2/OPSIE 2 POSITIVE MARKING FROM 3.3/ POSITIEWE NASIEN VANAF 3.3 $E_{\text{mech top/bo}} = E_{\text{mech ground/meg grond}}$ $(E_p + E_k)_{\text{top}} = (E_p + E_k)_{\text{bottom/onder}}$ $(mgh + \frac{1}{2}mv^2)_{\text{top/bo}} = (mgh + \frac{1}{2}mv^2)_{\text{bottom/onder}}$ $(0,4)(9,8)(4,9) + 0 = \frac{1}{2}(0,4)v_f^2$ $v_f = 9,8 \text{ m}\cdot\text{s}^{-1}$ $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ $F_{\text{net}}(0,2) = 0,4[9,8 - (-13,86)]$ $F_{\text{net}} = 47,32 \text{ N}$ ✓	1 mark for any 1 punt vir enige een If calculation of $9,8 \text{ m}\cdot\text{s}^{-1}$ is not shown and it is substituted correctly award 1 mark/Indien berekening van $9,8 \text{ m}\cdot\text{s}^{-1}$ nie getoon is nie en dit is korrek vervang ken 1 punt toe

(6)

[14]

OPTION 3/OPSIE 3 POSITIVE MARKING FROM 3.3/ POSITIEWE NASIEN VANAF 3.3 $v_f = v_i + a\Delta t$ $9,8 = -13,86 + a(0,2)$ $a = 118,3 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ $= (0,4)(118,3)$ $= 47,32 \text{ N}$ ✓	(6)
--	-----

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QUESTION 4/VRAAG 4

4.1 $E_{\text{mech top/meg bo}} = E_{\text{mech bottom/meg onder}}$ $(E_p + E_k)_{\text{top/bo}} = (E_p + E_k)_{\text{bottom/onder}}$ $(mgh + \frac{1}{2}mv^2)_{\text{top/bo}} = (mgh + \frac{1}{2}mv^2)_{\text{bottom/onder}}$ $(1,5)(9,8)(2) + 0 = 0 + \frac{1}{2}(1,5)v_f^2$ $v_f = 6,26 \text{ m}\cdot\text{s}^{-1}$ ✓	1 mark for any 1 punt vir enige een
4.2 In a/an closed/isolated system, the total linear momentum is conserved. In 'n geïsoleerde/geslote sisteem bly die totale liniêre momentum behoue.	(2)
4.3 POSITIVE MARKING FROM 4.1/POSITIEWE NASIEN VANAF 4.1 $\Sigma p_i = \Sigma p_f$ $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$ $(1,5)(6,26) + 0 = (1,5 + 2)v_f$ $v_f = 2,68 \text{ m}\cdot\text{s}^{-1}$ ✓	1 mark for any 1 punt vir enige een
4.4 POSITIVE MARKING FROM 4.3/POSITIEWE NASIEN VANAF 4.3 OPTION 1/OPSIE 1 $\Delta x = v_f\Delta t$ $= (2,68)(3)$ $= 8,04 \text{ m}$ ✓ OPTION 2/OPSIE 2 $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $= \left(\frac{(2,68 + 6,26)}{2}\right)(3)$ $= 8,04 \text{ m}$ ✓ OPTION 3/OPSIE 3 $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= (2,68)(3) + \frac{1}{2}(0)(3)^2$ $= 8,04 \text{ m}$ ✓ (Range 8,04 – 8,05)	(2) [13]

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QUESTION 5/VRAAG 5

5.1



Accepted labels/Aanvaarde benoemings	
W	$F_g/F_w/\text{weight}/\text{mg}/\text{gravitational force}/19,6 \text{ N}$ $F_g/F_w/\text{gewicht}/\text{mg}/\text{gravitasiekrag}/19,6 \text{ N}$
T	Tension/ F_t / F_K / Spanning

Notes/Aantekeninge:

- Mark awarded for label and arrow/Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s)/Enige ander addisionele krag(te) Max/Maks $\frac{1}{2}$
- If force(s) do not make contact with body/Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{1}{2}$

(2)

5.2 Tension✓/Spanning

Accept/AanvaarF applied / F_{toegepas}

(1)

5.3

$$W = F \Delta x \cos \theta$$

$$W_w = mg \Delta x \cos \theta$$

$$= 75(9,8)(12) \cos 180^\circ$$

$$= -8\,820 \text{ J}$$

OR/OF

$$W_w = -\Delta E_p$$

$$= -(mgh - 0)$$

$$= -(75)(9,8)(12)$$

$$= -8\,820 \text{ J}$$

(3)

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5.4 The work done on an object by a net force is equal to the change in the object's kinetic energy. ✓✓
Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/OF

The net work done on an object is equal to the change in the object's kinetic energy. ✓✓
Die netto arbeid verrig op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

NOTE: ILET WEL

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.

5.5 **POSITIVE MARKING FROM 5.3/POSITIEWE NASIEN VANAF 5.3****OPTION 1/OPSIE 1**

$$W_{\text{net}} = \Delta K$$

$$F_{\text{net}} \Delta x \cos \theta = (\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2)$$

$$(75)(0,65)(12) \cos 0^\circ = \frac{1}{2}(75)(v_f^2 - 0)$$

$$v_f = 3,95 \text{ m}\cdot\text{s}^{-1} \quad (3,949 \text{ m}\cdot\text{s}^{-1})$$

1 mark for any of these
1 punt vir enige van hierdie

POSITIVE MARKING FROM 5.2/ POSITIEWE NASIEN VANAF 5.2**OPTION 2/OPSIE 2**

$$W_{\text{net}} = \Delta K$$

$$W_{\text{net}} = \Delta K + \Delta U$$

$$W_T + W_g = \Delta K$$

$$T - mg = ma$$

$$T - 75(9,8) = 75(0,65)$$

$$T = 783,75 \text{ N}$$

$$W_T = 783,75(12) \cos 0^\circ$$

$$= 9405 \text{ J}$$

$$9405 - (8820) = \frac{1}{2}(75)(v_f^2 - 0)$$

$$v_f = 3,95 \text{ m}\cdot\text{s}^{-1} \quad (3,949 \text{ m}\cdot\text{s}^{-1})$$

$$W_{\text{net}} = (\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2) + (mgh_f - mgh_i)$$

$$9405 = (\frac{1}{2}(75)v_f^2 - 0) + (75)(9,8)(12 - 0)$$

$$v_f = 3,95 \text{ m}\cdot\text{s}^{-1}$$

(5)
[13]

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)

NOTE: ILET WEL

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.

6.2

OPTION 1/OPSIE 1

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$$

OR/OF

$$f_L = \frac{v}{v - v_s} f_s$$

$$(5100) = \frac{340}{(340 - 240)} f_s$$

$$f_s = 1\,500 \text{ Hz}$$

$$v = f \lambda$$

$$340 = (1\,500) \lambda$$

$$\lambda = 0,23 \text{ m}$$

(7)

OPTION 2/OPSIE 2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$$

OR/OF

$$f_L = \frac{v}{v - v_s} \left(\frac{v}{\lambda_s} \right)$$

$$(5100) = \left(\frac{340}{340 - 240} \right) \left(\frac{340}{\lambda_s} \right)$$

$$\lambda = 0,23 \text{ m}$$

(7)

6.3 Greater than ✓/Groter as

(1)

[10]

QUESTION 7/VRAAG 7

7.1 The two forces must be equal in magnitude ✓ but in opposite directions ✓ /Die twee kragte moet gelyke groottes hê maar in teenoorgestelde rigtings werk.

OR/OF

The force experienced by Q due to P, must be equal in magnitude ✓ but opposite in direction to the force experienced by Q due to V. ✓ /Die krag wat Q agv P ondervind moet gelyk in grootte maar teenoorgesteld in rigting wees met die krag wat Q agv V ondervind

(2)

7.2

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) ladinge 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 puntladinge is direk eweredig aan die produk van die ladinge en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle

(2)

NOTE: ILET WEL

If mass is mentioned instead of charges. $\frac{0}{2}$

Indien massa in plaas van ladinge genoem word. $\frac{0}{2}$

NOTE: ILET WEL

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.

7.3

OPTION 1/OPSIE 1

$$F = k \frac{Q_1 Q_2}{r^2} \checkmark$$

$$F_{PQ} = \frac{(9 \times 10^9)(Q)(5 \times 10^{-6})}{(x)^2} \checkmark$$

$$= \frac{45 \times 10^3 Q}{x^2}$$

$$F_{VQ} = \frac{(9 \times 10^9)(Q)(7 \times 10^{-6})}{(1-x)^2} \checkmark$$

$$= \frac{63 \times 10^3 Q}{(1-x)^2}$$

$$(F_{\text{net}} = F_{PQ} - F_{VQ} = 0)$$

$$\frac{45 \times 10^3 Q}{x^2} = \frac{63 \times 10^3 Q}{(1-x)^2} \checkmark \text{ (equating two equations)}$$

$$6,708(1-x) = 7,937x$$

$$x = 0,458 \text{ m}$$

$$x \text{ is } 0,46 \text{ m} \checkmark \text{ (away from P/weg van P)}$$

(5)

OPTION 2/OPSIE 2

$$E = \frac{kQ_p}{r^2} \checkmark$$

$$E_{\text{net}} = \frac{kQ_p}{r^2} - \frac{kQ_v}{r^2}$$

$$(E_{\text{net}} = E_p - E_v = 0)$$

$$0 = \frac{(9 \times 10^9)(5 \times 10^{-6})}{x^2} \checkmark - \frac{(9 \times 10^9)(7 \times 10^{-6})}{(1-x)^2} \checkmark$$

$$\frac{(9 \times 10^9)(5 \times 10^{-6})}{x^2} = \frac{(9 \times 10^9)(7 \times 10^{-6})}{(1-x)^2} \checkmark \text{ (equating two equations)}$$

$$\therefore x = 0,46 \text{ m} \checkmark \text{ (away from P/weg van P)}$$

(5)

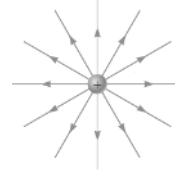
[9]

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QUESTION 8/VRAAG 8

8.1



Criteria for sketch/Kriteria vir skets	Marks/Punte
Lines are directed away from the charge / Lyne is weg vanaf die lading	✓
Lines are radial, start on sphere and do not cross. / Lyne is radiaal, begin op die sfeer en kruis nie	✓

(2)

8.2

$$Q = ne \checkmark$$

$$= (8 \times 10^{13})(-1,6 \times 10^{-19}) \checkmark \text{ or/of } (8 \times 10^{13})(1,6 \times 10^{-19})$$

$$= -12,8 \times 10^{-6}$$

$$\text{Net charge on the sphere} = (+6 \times 10^{-6}) + (-12,8 \times 10^{-6}) \checkmark$$

$$Q_{\text{net}} = -6,8 \times 10^{-6} \text{ C}$$

$$E = \frac{kQ}{r^2} \checkmark$$

$$E = \frac{(9 \times 10^9)(6,8 \times 10^{-6})}{(0,5)^2} \checkmark$$

$$= 2,45 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark \text{ towards sphere / na die sfeer}$$

(7)

[9]

QUESTION 9/VRAAG 9

9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.

OR/OF

The ratio of potential difference across a conductor to the current in the conductor is constant, provided the temperature remains constant.
Die verhouding van potensiaalverskil oor die geleier tot stroom in die geleier is konstant indien die temperatuur konstant bly.

(2)

NOTE/LET WEL

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.

9.1.2

$$V_1 = IR \checkmark$$

$$= (0,6)(4) \checkmark$$

$$= 2,4 \text{ V} \checkmark$$

(3)

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9.1.3

POSITIVE MARKING FROM 9.1.2/POSITIEWE NASIEN VANAF 9.1.2

$$I_{60} = \frac{V}{R}$$

$$= \frac{2,4}{6} \checkmark$$

$$= 0,4 \text{ A} \checkmark$$

OR/OF

$$\frac{6}{10}(I) = 0,6 \checkmark$$

$$I = 1 \text{ A}$$

$$I_{60} = 0,4 \text{ A} \checkmark$$

OR/OF

$$V_{40} = V_{60}$$

$$I_{40}R_1 = I_{60}R_2$$

$$\frac{(0,6)(4)}{I_{60}} = \frac{6}{1} \checkmark$$

$$I_{60} = 0,4 \text{ A} \checkmark$$

(2)

9.1.4

POSITIVE MARKING FROM 9.1.3/POSITIEWE NASIEN VANAF 9.1.3

$$V_2 = IR$$

$$= (0,4 + 0,6)(5,8) \checkmark$$

$$= 5,8 \text{ V} \checkmark$$

(2)

9.1.5

POSITIVE MARKING FROM 9.1.4 AND 9.1.2/POSITIEWE NASIEN VANAF 9.1.4 EN 9.1.2**OPTION 1/OPSIE 1**

$$V_{\text{ext}} = (5,8 + 2,4) \checkmark$$

$$= 8,2 \text{ V}$$

$$V_{\text{int}} = Ir$$

$$= (1)(0,8) \checkmark$$

$$= 0,8 \text{ V}$$

$$\text{Emf} = 0,8 + 8,2 = 9 \text{ V} \checkmark$$

OPTION 2/OPSIE 2

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{6} + \frac{1}{4}$$

$$= \frac{5}{12}$$

$$R_p = 2,4 \Omega$$

$$R_{\text{ext}} = (2,4 + 5,8) \checkmark$$

$$= 8,2 \Omega$$

$$\text{Emf} = I(R + r)$$

$$= 1(8,2 + 0,8) \checkmark$$

$$= 9 \text{ V} \checkmark$$

$$R_{\text{eff}} = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{(6)(4)}{(6+4)}$$

$$= 2,4 \Omega$$

(3)

9.1.6

POSITIVE MARKING FROM 9.1.5 AND 9.1.3/POSITIEWE NASIEN VANAF 9.1.5 EN 9.1.3

$$W = V I \Delta t \checkmark$$

$$= (0,8)(1)(15) \checkmark$$

$$= 12 \text{ J} \checkmark$$

$$W = I^2 R \Delta t \checkmark$$

$$= (1)^2 (0,8)(15) \checkmark$$

$$= 12 \text{ J} \checkmark$$

$$W = \frac{V^2 \Delta t}{R} \checkmark$$

$$= \frac{0,8^2 (15)}{0,8} \checkmark$$

$$= 12 \text{ J} \checkmark$$

(3)

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9.2.1

$$R = \frac{V}{I}$$

$$= \frac{2,8}{0,7} \checkmark$$

$$= 4 \Omega \checkmark$$

(2)

9.2.2

Increases ✓/Neem toe

Total resistance decreases, ✓ current/power increases ✓, motor turns faster/
Totale weerstand neem af, stroom/drywing neem toe, motor draai vinniger

(3)

[20]

QUESTION 10/VRAAG 10

10.1

10.1.1 Split ring / commutator ✓/Spleetring/ kommutator

(1)

10.1.2

Anticlockwise ✓✓/Antikloksgewys

(2)

10.1.3

Electrical energy ✓ to mechanical (kinetic) energy ✓
Elektriese energie na meganiese (kinetiese) energie

(2)

10.2

10.2.1 DC generator: split ring/commutator and AC generator has slip rings ✓
GS-generator spleetring/kommutator en WS-generator sleepinge**OR/OF**

AC generator: slip ring and DC generator has split rings ✓
WS-generator sleepinge en GS-generator spleetring

(1)

10.2.2

$$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$$

$$= \frac{320}{\sqrt{2}} \checkmark$$

$$= 226,27 \text{ V} \checkmark$$

(3)

10.2.3

OPTION 2/OPSIE 12

$$I_{\text{max}} = \frac{V_{\text{max}}}{R}$$

$$= \frac{320}{35} \checkmark$$

$$= 9,14 \text{ A}$$

$$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \checkmark$$

$$= \frac{9,14}{\sqrt{2}} \checkmark$$

$$= 6,46 \text{ A} \checkmark$$

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POSITIVE MARKING FROM 10.2.2/ POSITIEWE NASIEN VANAF 10.2.2.2.**OPTION 2/OPSIE 2**

$$P_{\text{average}} = \frac{V_{\text{rms}}^2}{R}$$

$$= \frac{226,27^2}{35} \checkmark$$

$$= 1462,80 \text{ W}$$

$$P_{\text{average}} = V_{\text{rms}} I_{\text{rms}} \checkmark$$

$$1462,80 = (226,27) I_{\text{rms}} \checkmark$$

$$I_{\text{rms}} = 6,46 \text{ A} \checkmark$$

$$P_{\text{average}} = I_{\text{rms}}^2 R \checkmark$$

$$1462,80 = I_{\text{rms}}^2 (35) \checkmark$$

$$I_{\text{rms}} = 6,46 \text{ A} \checkmark$$

(4)

POSITIVE MARKING FROM 10.2.2/ POSITIEWE NASIEN VANAF 10.2.2.2**OPTION 1/OPSIE 1**

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{R} \checkmark = \frac{226,27}{35} \checkmark = 6,46 \text{ A} \checkmark$$

(4)

[13]

QUESTION 11/VRAAG 11

- 11.1 Work function (of a metal) is the minimum energy needed to eject an electron from the metal/surface.
Werksfunksie (van 'n metaal) is die minimum energie benodig om 'n elektron vanaf die metaal/oppervlak vry te stel.

(2)

NOTE:/LET WEL

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.

- 11.2 (Maximum) kinetic energy of the ejected electrons ✓
(Maksimum) kinetiese energie van die vrygestelde elektrone.

(1)

- 11.3 Wavelength/Frequency (of light) ✓
Golfte/te/frekwensie (van lig)

(1)

- 11.4 Silver ✓/Silwer

According to Photoelectric equation, $hf = W_0 + \frac{1}{2}mv^2$
(For a given constant frequency), as the work function increases the kinetic energy decreases. ✓ Silver has the smallest kinetic energy ✓ and hence the highest work function.
Volgens die fotoelektriese vergelyking $hf = W_0 + \frac{1}{2}mv^2$:
(Vir 'n gegewe konstante frekwensie) as die werksfunksie verhoog, verlaag die kinetiese energie. Silwer het die kleinste kinetiese energie en dus die hoogste werksfunksie.

(3)

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TOTAL/TOTAAL: 150**basic education**Department:
Basic Education
REPUBLIC OF SOUTH AFRICA**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT****GRADE/GRAAD 12****PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)****NOVEMBER 2018****MARKING GUIDELINES/NASIENRIGLYNE****MARKS/PUNTE: 150**

These marking guidelines consist of 29 pages.
Hierdie nasien riglyne bestaan uit 29 bladsye.

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QUESTION 1/VRAAG 1

- 1.1 C /D ✓✓ (2)
- 1.2 C ✓✓ (2)
- 1.3 C ✓✓ (2)
- 1.4 B ✓✓ (2)
- 1.5 B ✓✓ (2)
- 1.6 A ✓✓ (2)
- 1.7 A ✓✓ (2)
- 1.8 D ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 C ✓✓ (2)

[20]

QUESTION 2/VRAAG 2

- 2.1 When a (non-zero) resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓✓

Wanneer 'n (nie-nul) resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die (netto) krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/OF

The (non-zero) resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. ✓✓ (2 or 0)

Die (nie-nul) netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum.

ACCEPT/AANVAAR

Acceleration is directly proportional to the net force and inversely proportional to the mass of the object.

Versnelling direk eweredig is aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

NOTE/LET WEL

If any of the underlined key words in the correct context is omitted deduct 1 mark.

Indien enige van die onderstreepte sleutel woorde in die korrekte konteks uitgelaat is, trek 1 punt af.

(2)

2.2

**Notes/Aantekeninge**

- Mark is awarded for label and arrow
Punt word toegeken vir byskrif en pyltjie
- Do not penalise for length of arrows
Moenie vir die lengte van die pyltjies penaliseer nie.
- If T is not shown but T_x and T_y are shown, give 1 mark for both
Indien T nie aangetoon is nie maar T_x en T_y is getoon. Ken 1 punt toe vir beide.
- If force(s) do not make contact with body/Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{3}{4}$
- Deduct 1 mark for any additional force /Trek 1 punt af vir enige addisionele krag

(4)

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	Accept the following symbols /Aanvaar die volgende simbole.
N	F_N ; Normal; Normal force /Normaal; Normaalkrag ✓
f	F_f ; f_k ; frictional force/wrywingskrag/kinetic frictional force/ kinetiese wrywingskrag ✓
W	F_g ; mg; Weight; $F_{\text{Earth on block}}$; F_W / Gewicht; Gravitational force / Gravitasiëskrag/ 78,4 N ✓
T	Tension/Spinning; F_T ; F_A ; F /16,96 N ✓

- 2.3.1 The 2/8 kg block /system is accelerating/Die 2/8 kg blok / sisteem is besig om te versnel ✓

OR/OF

The acceleration is not zero / $a \neq 0$ ($\text{m}\cdot\text{s}^{-2}$) / $a = 1,32 \text{ m}\cdot\text{s}^{-2}$ / Die versnelling is nie nul nie ✓

OR/OF

Velocity is /increasing/changing/not constant/Snelheid neem toe/ verander/is nie konstant nie ✓

OR/OF

F_{net} is not equal to zero / F_{net} is nie gelyk aan nul nie / $F_{\text{net}} \neq 0$ (N) ✓

OR/OF

The acceleration is changing / Die versnelling verander ✓

Accept/Aanvaar

An unbalanced force is acting on it / 'n Ongebalanseerde krag werk in op die liggaam ✓

(1)

- 2.3.2 For 2 kg/Vir die 2 kg massa

$$\begin{aligned} F_{\text{net}} &= ma \\ mg - T &= ma \\ (2)(9,8) - T &= 2(1,32) \\ T &= 16,96 \text{ N} \end{aligned}$$

1 mark for any
1 punt vir

$$\begin{aligned} F_{\text{net}} &= ma \\ mg + T &= ma \\ (2)(-9,8) + T &= 2(-1,32) \\ T &= 16,96 \text{ N} \end{aligned}$$

(3)

- 2.3.3 POSITIVE MARKING FROM 2.3.2/POSITIEWE NASIEN VANAF 2.3.2

$$\begin{aligned} F_{\text{net}} &= ma \\ T \cos 15^\circ - f &= ma \end{aligned}$$

$$\begin{aligned} T_x &= T \cos 15^\circ \\ &= 16,96 \cos 15^\circ \\ &= 16,38 \text{ N (16,382 N)} \end{aligned}$$

$$16,382 - f = (8)(1,32) \quad \checkmark$$

$$f = 5,82 \text{ N (to the left/na links)} \quad \checkmark$$

OR/OF

$$\begin{aligned} F_{\text{net}} &= ma \\ T \cos 15^\circ + f &= ma \end{aligned}$$

$$\begin{aligned} T_x &= T \cos 15^\circ \\ &= 16,96 \cos 15^\circ \\ &= 16,38 \text{ N (16,382 N)} \end{aligned}$$

$$\begin{aligned} -16,382 + f &= (8)(-1,32) \quad \checkmark \\ f &= 5,82 \text{ N (to the left/na links)} \quad \checkmark \end{aligned}$$

(4)

- 2.4 ANY ONE/ENIGE EEN

Normal force changes/decreases ✓/Normaalkrag verander/neem af
The angle (between string and horizontal) changes/increases. /Die hoek (tussen die tou/tjie en die horisontaal) verander/neem toe

The vertical component of the tension changes/increases/Die vertikale komponent van die spanning verander / neem toe.

(1)

- 2.5

Yes ✓/Ja

The frictional force (coefficient of friction) depends on the nature of the surfaces in contact. ✓

Die wrywingskrag (wrywingskoeffisiënt) is afhanklik van die aard van die oppervlaktes in kontak met mekaar.

ACCEPT/AANVAAR

The nature of the surface changes / μ_k changes

Die aard van die oppervlakte verander / μ_k verander

(2)

[17]

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QUESTION 3/VRAAG 3

- 3.1 Downwards/Afwaarts ✓

The only force acting on the object is the gravitational force/weight which acts downwards. ✓/Die enigste krag wat op die voorwerp inwerk is die gravitasiekrag/gewig wat afwaarts inwerk.

ACCEPT/AANVAAR:

The only force acting is gravitational/weight. ✓/Die enigste krag wat inwerk is gravitasie/gewig

OR/OF

Gravitational force/weight acts downwards. ✓/Gravitasiëskrag/gewig werk afwaarts

OR/OF

The ball is in free-fall / Die bal in vry-val ✓

OR/OF

(Gravitational) acceleration is downwards/(Gravitasiëne) versnelling is afwaarts

(2)

- 3.2

OPTION 1/OPSIE 1

Upward positive/Opwaarts positief

$$\begin{aligned} v_f &= v_i + a\Delta t \quad \checkmark \\ 0 &= 7,5 + (-9,8)\Delta t \quad \checkmark \\ \Delta t &= 0,77 \text{ s} \quad \checkmark \end{aligned}$$

Downward positive/Afwaarts positief

$$\begin{aligned} v_f &= v_i + a\Delta t \quad \checkmark \\ 0 &= -7,5 + (9,8)\Delta t \quad \checkmark \\ \Delta t &= 0,77 \text{ s} \quad \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

Upward positive

Opwaarts positief

At highest point v_f is zero

By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (7,5)^2 + (2)(-9,8)\Delta y$$

$$\Delta y = 2,87 \text{ (2,869) m}$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$$

$$2,87 = \frac{7,5 + 0}{2} \Delta t \quad \checkmark$$

$$\Delta t = 0,77 \text{ s} \quad \checkmark$$

OPTION 2/OPSIE 2

Downward positive

Afwaarts positief

At highest point v_f is zero

By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (-7,5)^2 + (2)(9,8)\Delta y$$

$$\Delta y = -2,87 \text{ (-2,869) m}$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$$

$$-2,87 = \frac{-7,5 + 0}{2} \Delta t \quad \checkmark$$

$$\Delta t = 0,77 \text{ s} \quad \checkmark$$

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OPTION 3/OPSIE 3 Upward positive Opwaarts positief $F_{net}\Delta t = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ ✓ $(-9,8)\Delta t = 0 - 7,5$ ✓ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s})$ ✓	OPTION 3/OPSIE 3 Downward positive Afwaarts positief $F_{net}\Delta t = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ ✓ $(9,8)\Delta t = 0 - (-7,5)$ ✓ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s})$ ✓
---	---

OPTION 4/OPSIE 4 Upward positive Opwaarts positief (Top to Bottom / Bo na onder) $v_f = v_i + a\Delta t$ ✓ $-7,5 = 0 + (-9,8)\Delta t$ ✓ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s})$ ✓	OPTION 4/OPSIE 4 Downward positive Afwaarts positief (Top to Bottom / Bo na onder) $v_f = v_i + \Delta t$ ✓ $7,5 = 0 + (9,8)\Delta t$ ✓ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s})$ ✓
---	--

OPTION 5/OPSIE 5 Upward positive Opwaarts positief (Top to Bottom / Bo na onder) $v_f^2 = v_i^2 + 2a\Delta y$ $(7,5)^2 = (0)^2 + 2(-9,8)\Delta y$ $\Delta y = -2,87 \text{ m}$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-2,87 = (0)\Delta t + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓ $\Delta t = 0,765 \text{ s}$ ✓	OPTION 5/OPSIE 5 Downward positive Afwaarts positief (Top to Bottom / Bo na onder) $v_f^2 = v_i^2 + 2a\Delta y$ $(7,5)^2 = (0)^2 + 2(9,8)\Delta y$ $\Delta y = 2,87 \text{ m}$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $2,87 = (0)\Delta t + \frac{1}{2}(9,8)(\Delta t)^2$ ✓ $\Delta t = 0,765 \text{ s}$ ✓
---	---

(3)

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NOTES for marking QUESTION 3.3 AANTEKENINGE vir merk van VRAAG 3.3	
Formula mark/Formule punt	✓
Substitution mark /Vervangingspunt	✓✓
Mark for height/distance / Punt vir hoogte/afstand	✓
Mark for comparison/Punt vir vergelyking	✓
Mark for conclusion/Punt vir gevolgtrekking	✓

3.3

OPTION 1/OPSIE 1 Upward positive/Opwaarts positief At highest point v_f is zero/By hoogste punt is v_f nul $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (7,5)^2 + (2)(-9,8)\Delta y$ ✓ $\Delta y = 2,87 (2,869) \text{ m}$ ✓ This is higher than height needed to reach point T (2,1 m) ✓ <u>therefore the ball will pass point T.</u> ✓ Dit is hoër as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.
Downward positive/Afwaarts positief At highest point v_f is zero/By hoogste punt is v_f nul $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (-7,5)^2 + (2)(9,8)\Delta y$ ✓ $\Delta y = -2,87 (-2,869) \text{ m}$ ✓ This is higher than height needed to reach point T (2,1 m) ✓ <u>therefore the ball will pass the target.</u> ✓ Dit is hoër as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

OPTION 2/OPSIE 2 (POSITIVE MARKING FROM 3.2) Upward positive/Opwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (7,5)(0,77) + \frac{1}{2}(-9,8)(0,77)^2$ ✓ $\Delta y = 2,87 \text{ m } (2,86 \text{ m})$ ✓ This is higher than height needed to reach point T (2,1 m) ✓ <u>therefore the ball will pass point T.</u> ✓ Dit is hoër as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.
Downward positive/Afwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (-7,5)(0,77) + \frac{1}{2}(9,8)(0,77)^2$ ✓ $\Delta y = -2,87 \text{ m } (2,869 \text{ m})$ ✓ This is higher than the height needed to reach point T (2,1 m) ✓ <u>therefore the ball will pass point T.</u> ✓ Dit is hoër as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

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OPTION 3/OPSIE 3 $(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$ $(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$ $(mgh + \frac{1}{2}mv^2)_{Top/Bo} = (mgh + \frac{1}{2}mv^2)_{Bottom/Onder}$ $(9,8)(h) + 0 = 0 + \frac{1}{2}(7,5)^2 \checkmark$ $h = 2,87 \text{ m } (2,869 \text{ m}) \checkmark$	1 mark for any 1 punt vir enige
---	------------------------------------

This is higher than height needed to pass the target (2,1 m) ✓ therefore the ball will pass the target. ✓
 Dit is hoër as die hoogte benodig om punt T (2,1 m) verby te gaan dus sal die bal punt T verbygaan.

OPTION 4/OPSIE 4 $W_{net} = \Delta E_K$ $mg\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓ $(9,8)\Delta x \cos 180^\circ = 0 - \frac{1}{2}(7,5)^2$ ✓ $\Delta x = 2,87 \text{ m } (2,869 \text{ m})$ ✓ This is higher than point height needed to pass point T (2,1 m) ✓ <u>therefore the ball will pass point T.</u> ✓ Dit is hoër as die hoogte benodig om punt T (2,1 m) verby te gaan dus sal die bal punt T verbygaan.
--

OPTION 5/OPSIE 5 Upward positive/Opwaarts positief If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$. At highest point v_f is zero Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = [(7,5)^2 + (2)(-9,8)(y_f - 1,6)]$ ✓ $y_f = 4,47 (4,469) \text{ m}$ ✓ Yes ✓✓ OR/OF This point (4,47m) is higher than point T ✓✓ (or even the required height of 2,1 m) therefore the ball will pass point T. Ja ✓✓ Dit is hoër as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan. Downward positive/Afwaarts positief If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$. At highest point v_f is zero Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = [(-7,5)^2 + (2)(9,8)(y_f - (-1,6))]$ ✓ $y_f = -4,47 (-4,469) \text{ m}$ ✓ height is/hoogte is 4,47 m. This point (4,47 m) is higher than point T ✓✓ (or even the required height of 2,1 m) <u>therefore the ball will pass point T.</u> ✓ Hierdie punt (4,47 m) is hoër as punt T (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt T verbygaan.
--

OPTION 6/OPSIE 6 (POSITIVE MARKING FROM 3.2) Upward positive/Opwaarts positief If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$. At highest point v_f is zero Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $(y_f - 1,6) = (7,5)(0,77) + \frac{1}{2}(-9,8)(0,77)^2$ ✓ $y_f = 4,47 \text{ m } (4,469 \text{ m})$ ✓ This point (4,47m) is higher than point T ✓✓ (or even the required height of 2,1 m) <u>therefore the ball will pass point T.</u> ✓ Hierdie punt (4,47 m) is hoër as punt T (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt T verbygaan. Downward positive/Afwaarts positief If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$. At highest point v_f is zero Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $(y_f - (-1,6)) = (-7,5)(0,765) + \frac{1}{2}(9,8)(0,765)^2$ ✓ $y_f = -4,47 \text{ m } (-4,469 \text{ m})$ ✓ This point (4,47m) is higher than point T ✓✓ (or even the required height of (2,1m) <u>therefore the ball will pass point T.</u> ✓ Hierdie punt (4,47 m) is hoër as punt T (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt T verbygaan.
--

OPTION 7/OPSIE 7 (POSITIVE MARKING FROM 3.2) Upward positive/Opwaarts positief $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{0 + 7,5}{2}\right)(0,77)$ ✓✓ $= 2,89 \text{ m}$ ✓ This is higher than height needed to pass the target (2,1 m) ✓ <u>therefore the ball will pass the target.</u> ✓ Dit is hoër as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.	OPTION 7/OPSIE 7 (POSITIVE MARKING FROM 3.2) Downward positive/Afwaarts positief $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{0 - 7,5}{2}\right)(0,77)$ ✓✓ $= -2,89 \text{ m}$ ✓ Height/Hoogte is 2,89m This is higher than height needed to pass the target (2,1 m) ✓ <u>therefore the ball will pass the target.</u> ✓ Dit is hoër as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.
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OPTION 8/OPSIE 8**Upward positive/Opwaarts positief**At highest point v_i is zero/By hoogste punt is v_i nul

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$0 \checkmark = v_i^2 - (2)(9,8)(2,1) \checkmark$$

$$v_i = 6,42 \text{ m}\cdot\text{s}^{-1} \checkmark$$

This is the actual velocity needed to reach the target.

The given velocity is greater than the actual velocity needed. ✓

The ball will pass the target. ✓

Dit is die werklike snelheid benodig om die teiken te bereik

Die gegewe snelheid is groter as die werklike snelheid benodig

Die bal sal die teiken verbygaan.

Downward positive/Afwaarts positiefAt highest point v_i is zero

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$0 \checkmark = v_i^2 + (2)(9,8)(-2,1) \checkmark$$

$$v_i = 6,42 \text{ m}\cdot\text{s}^{-1} \checkmark$$

This is the actual velocity needed to pass the target.

The given velocity is greater than the actual velocity needed. ✓

The ball will reach the target. ✓

Dit is die werklike snelheid benodig om die teiken te verby te gaan.

Die gegewe snelheid is groter as die werklike snelheid benodig

Die bal sal die teiken verbygaan.

OPTION 9/OPSIE 9

$$W_{nc} = \Delta E_p + \Delta E_k \checkmark$$

$$0 = mgh_i - mgh_f + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark$$

$$0 \checkmark = (9,8)h_i - (9,8)(1,6) + \frac{1}{2}(0)^2 - \frac{1}{2}(7,5)^2 \checkmark$$

$$0 = (9,8)h_i - 43,805 \checkmark$$

$$\therefore h_i = 4,47 \text{ m} \checkmark$$

The ball will pass point T ✓✓

Die bal sal punt T verbygaan.

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OPTION 10/OPSIE 10**POSITIVE MARKING FROM 3.2 / POSITIEWE NASIEN VANAF 3.2****Upward positive/Opwaarts positief**

$$\Delta t(\text{max. height/maks. hoogte}) = 0,77 \text{ s}$$

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$2,1 \checkmark = (7,5)\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\therefore \Delta t = 0,36 \text{ s} \checkmark$$

∴ Δt (max height/maks. hoogte, 0,77 s) > Δt (to pass point T/ om T verby te gaan, 0,36 s) ✓

∴ The ball passed point T ✓

Die bal het punt T verbygegaan.

Downward positive/Afwaarts positief

$$\Delta t(\text{max height}) = 0,77 \text{ s}$$

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$2,1 \checkmark = (7,5)\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\therefore \Delta t = 0,36 \text{ s} \checkmark$$

∴ Δt (max height, 0,77 s) > Δt (to reach point T, 0,36 s) ✓

∴ The ball passed point T ✓

Die bal het punt T verbygegaan

OPTION 11/OPSIE 11**Upward positive/Opwaarts positief**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$(3,7 - 1,6) \checkmark = 7,5\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = 0,375 \text{ s} \checkmark$$

The time to pass point T is less than time to reach maximum height ✓. Ball will pass point T. ✓

Die tyd om punt T verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt T verbygaan

Downward positive/Afwaarts positief

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$(3,7 - 1,6) \checkmark = -7,5\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 0,375 \text{ s} \checkmark$$

The time to reach point T is less than time to reach maximum height ✓. Ball will pass point T. ✓

Die tyd om punt T verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt T verbygaan

OPTION 12/OPSIE 12**Upward positive/Opwaarts positief**

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (7,5)^2 + 2(-9,8)(2,1) \checkmark$$

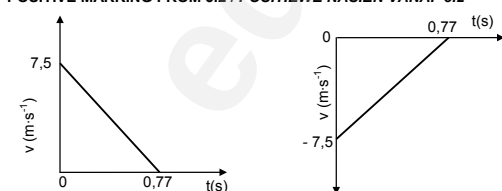
$$v_f = 3,88 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Velocity at T is $3,88 \text{ m}\cdot\text{s}^{-1}$ therefore the ball still moving towards its maximum height ✓✓Snelheid by T is $3,88 \text{ m}\cdot\text{s}^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte**Downward positive/Afwaarts positief**

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (-7,5)^2 + 2(9,8)(-2,1) \checkmark$$

$$v_f = -3,88 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Velocity at T is $-3,88 \text{ m}\cdot\text{s}^{-1}$ therefore the ball is still moving towards its maximum height ✓✓Snelheid by T is $-3,88 \text{ m}\cdot\text{s}^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte**3.4 POSITIVE MARKING FROM 3.2 / POSITIEWE NASIEN VANAF 3.2****Notes/Notas:**

Initial velocity and time for final velocity shown

Beginsnelheid en tyd vir finale snelheid aangedui. ✓

Correct straight line (including orientation) drawn

Korrekte reguitlyn (insluitend oriëntasie) geteken. ✓

(6)

(2)

[13]

QUESTION 4/VRAAG 4

- 4.1 Momentum is the product of the mass of an object and its velocity ✓✓
Momentum is die produk van die massa van 'n voorwerp en sy snelheid.
[NOTE/LET WEL: 2 orlof 0]

(2)

- 4.2 To the left/Na links ✓
Newton's third law/Newton se derde wet ✓

ACCEPT/AANVAAR:

Principle of conservation of linear momentum / law of action-reaction

Beginsel van behoud van lineêre momentum/wet van aksie-reaksie

Newton's third law and Newton's second law/Newton se derde wet en

Newton se tweede wet

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NOTE: For QUESTION 4.3 and 4.4 motion to the right has been taken as positive. Candidates may use the opposite direction.
LET WEL: Vir VRAAG 4.3 en 4.4 word beweging na regs as positief geneem.
Kandidate mag die teenoorgestelde rigting gebruik.

4.3

OPTION 1/OPSIE 1

$$\sum p_i = \sum p_f \checkmark$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f} \checkmark$$

$$\text{mass of girl is } m / \text{massa van meisie is } m \checkmark$$

$$\frac{1}{2}(m + 2)(0) + \frac{1}{2}(8)(0) = \frac{1}{2}(m + 2)(-0,6) + \frac{1}{2}(8)(4) \checkmark$$

$$m = 51,33 \text{ kg} \checkmark$$

OPTION 2/OPSIE 2

$$\sum p_i = \sum p_f \checkmark$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f} \checkmark$$

$$0 = m_1v_{1f} + m_2v_{2f} \checkmark$$

$$0 \checkmark = (8)(4) + m_2(-0,6) \checkmark$$

$$\therefore m_2 = 53,33 \text{ kg} \checkmark$$

$$\therefore m_{\text{girl}} = 53,33 - 2 \checkmark$$

$$\therefore m_{\text{girl}} = 51,33 \text{ kg} \checkmark$$

OPTION 3/OPSIE 3

$$\Delta p_{\text{girl}} = -\Delta p_{\text{parcel}} \checkmark$$

$$m(v_f - v_i) = -m(v_i - v_i) \checkmark$$

$$(m + 2)(-0,6 - 0) \checkmark = -8(4 - 0) \checkmark$$

$$m = 51,33 \text{ kg} \checkmark$$

Allocate mark if 0 is substituted on left hand side/Ken punt toe indien 0 aan linkerkant vervang is.

NOTE: Penalise only once for the incorrect sign of the 0,6.
LET WEL: Penaliseer slegs eenmaal die die inkorrekte teken van 0,6

(5)

4.4

POSITIVE MARKING FROM 4.3/POSITIEWE NASIEN VANAF 4.3

$$\text{Impulse} = \Delta p = m(v_f - v_i) \checkmark$$

$$= (51,33 + 2)(-0,6 - 0) \checkmark$$

$$= -32 \text{ N}\cdot\text{s} / \text{kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$$

Magnitude of impulse/Grootte van die impuls is $32 \text{ N}\cdot\text{s} / 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ ✓**OR/OF**

$$\text{Impulse} = \Delta p_{\text{parcel/pakket}} = m(v_f - v_i) \checkmark$$

$$\Delta p = (8)(4 - 0) \checkmark = 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$$

$$\therefore \Delta p_{\text{girl/meisie}} = 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$$

(3)

4.5

POSITIVE MARKING FROM 4.4/POSITIEWE NASIEN VANAF 4.4 $32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} / \text{N}\cdot\text{s}$ ✓ to the right/opposite direction /na regs/teenoorgestelde rigting ✓

(2)

[14]

QUESTION 5/VRAAG 5

- 5.1 A force is non-conservative if the work it does on an object which is moving between two points depends on the path taken. ✓✓
 'n Krag is nie-konserwatief indien die arbeid wat dit verrig op 'n voorwerp wat tussen twee punte beweeg van die pad afhang. ✓✓
OR/OF
 A force is non-conservative if the work it does on an object depends on the path taken. ✓✓
 'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhang van die pad wat dit neem. ✓✓

OR/OF

A force is non-conservative if the work it does in moving an object around a closed path is non-zero. ✓✓
 'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg nie-nul is. ✓✓

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If the word work is omitted 0 marks
 Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien die woord arbeid uitgelaat is 0 punte.

- 5.2 No/Nee ✓

5.3 **OPTION 1/ OPSIE 1**

$$P = \frac{W}{\Delta t} \checkmark$$

$$= \frac{4,8 \times 10^6}{(90)} \checkmark$$

$$= 53\,333,33 \text{ W}$$

$$= 5,33 \times 10^4 \text{ W (53,33 kW)} \checkmark$$

OPTION 2/OPSIE 2

$$\Delta x = \left(\frac{v_f + v_i}{2} \right) \Delta t$$

$$= \left(\frac{0 + 25}{2} \right) (90)$$

$$= 1\,125 \text{ m}$$

$$W_F = F \Delta x \cos \theta$$

$$4,80 \times 10^6 = F (1\,125) \cos 0^\circ$$

$$F = 4\,266,667 \text{ N}$$

$$P_{\text{ave}} = F v_{\text{ave}} \checkmark$$

$$= (4\,266,667)(12,5) \checkmark$$

$$= 53\,333,33 \text{ W} \checkmark$$

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- 5.4 The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓
 Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie. ✓✓

OR/OF

The work done on an object by a net force ✓ is equal to the change in the object's kinetic energy. ✓✓
 Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. ✓✓

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
 Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

5.5 **OPTION 1/OPSIE 1**

$$W_{\text{net}} = \Delta K \checkmark$$

$$W_w + W_f + W_F = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$m g \Delta x \cos \theta + W_f + W_F = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$(1\,500)(9,8)(200 \cos 180^\circ) \checkmark + W_f + 4,8 \times 10^6 \checkmark = \frac{1}{2} (1\,500)(25^2 - 0) \checkmark$$

$$-2\,940\,000 + W_f + 4,8 \times 10^6 = 468\,750$$

$$W_f = -1\,391\,250 \text{ J}$$

$$= -1,39 \times 10^6 \text{ J} \checkmark$$

OR/OF

$$W_{\text{net}} = \Delta K \checkmark$$

$$W_w + W_f + W_F = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$-\Delta E_p + W_f + W_F = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$-(1\,500)(9,8)(200 - 0) \checkmark + W_f + 4,8 \times 10^6 \checkmark = \frac{1}{2} (1\,500)(25^2 - 0) \checkmark$$

$$-2\,940\,000 + W_f + 4,8 \times 10^6 = 468\,750$$

$$W_f = -1\,391\,250 \text{ J}$$

$$= -1,39 \times 10^6 \text{ J} \checkmark$$

NOTE/LET WEL

0 can be omitted in above substitutions.
 0 kan in bogenoemde vervangings weggelaat word.

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OPTION 2/OPSIE 2

$$W_{\text{nc}} = \Delta K + \Delta U$$

$$W_{\text{nc}} = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 + m g h_f - m g h_i \checkmark$$

$$= \frac{1}{2} m (v_f^2 - v_i^2) + m g (h_f - h_i)$$

$$W_{\text{nc}} = \frac{1}{2} m v_f^2 + m g h_f - \frac{1}{2} m v_i^2 - m g h_i$$

$$W_f + W_F = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 + m g h_f - m g h_i$$

$$W_f + 4,8 \times 10^6 \checkmark = \frac{1}{2} (1\,500)(25^2) - 0 \checkmark + [(1\,500)(9,8)(200) - 0] \checkmark$$

$$W_f = -1,39 \times 10^6 \text{ J (-1,40 x 10}^6 \text{ J)} \checkmark$$

OR/OF

$$W_{\text{nc}} = \Delta K + \Delta U$$

$$W_{\text{nc}} = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 + m g h_f - m g h_i \checkmark$$

$$= \frac{1}{2} m (v_f^2 - v_i^2) + m g (h_f - h_i)$$

$$W_{\text{nc}} = \frac{1}{2} m v_f^2 + m g h_f - \frac{1}{2} m v_i^2 - m g h_i$$

$$W_f + 4,8 \times 10^6 \checkmark = \frac{1}{2} (1\,500)(25^2) - 0 \checkmark + (1\,500)(9,8)(200) \checkmark - [0 + 0]$$

$$W_f = -4,8 \times 10^6 + 3,4 \times 10^6$$

$$= -1,39 \times 10^6 \text{ J (-1,40 x 10}^6 \text{ J)} \checkmark$$

ACCEPT THE FOLLOWING FOR: IAANVAAR DIE VOLGENDE VIR: (3/5)**POSITIVE MARKING FROM 5.3/POSITIEWE NASIEN VANAF 5.3**

$$v_f = v_i + a \Delta t$$

$$25 = 0 + a(90)$$

$$a = 0,277 \dots \text{m} \cdot \text{s}^{-2}$$

$$F_{\text{net}} = m a$$

$$= (1\,500)(0,2777 \dots) = 416,66 \dots \text{ N}$$

$$F + (w_{\parallel}) + (-f_k) = 416,666 \dots$$

$$4\,266,667 - 1\,500(9,8) \sin \theta - f_k = 416,666 \dots$$

$$f_k = 1\,236,667 \text{ N}$$

$$W_f = f_k \Delta x \cos \theta \checkmark$$

$$= (1\,236,667)(1\,125)(\cos 180^\circ) \checkmark$$

$$= -1\,391\,250 \text{ J} \checkmark$$

(5)
[13]

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QUESTION 6/VRAAG 6

- 6.1 The change in frequency (or pitch), of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓
 Die verandering in frekwensie (of toonhoogte) (golflengte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het. ✓✓

OR/OF

An (apparent) change in observed/detected frequency (pitch), as a result of the relative motion between a source and an observer. ✓✓ (listener).
 'n (Skynbare) verandering in waargenome frekwensie (toonhoogte) (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. ✓✓

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
 Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

- 6.2 Away from/Weg vanaf ✓
 Observed frequency lower/Waargenome frekwensie is laer ✓

$$v = f \lambda \checkmark$$

$$340 = f (0,34) \checkmark$$

$$f = 1\,000 \text{ Hz} \checkmark$$

6.4 **POSITIVE MARKING FROM 6.3/POSITIEWE NASIEN VANAF 6.3**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark$$

OR/OF $f_L = \frac{v - v_L}{v} f_s$

$$950 = \frac{340 - v_L}{340 + 0} (1\,000) \checkmark$$

$$v_L = 17 \text{ m} \cdot \text{s}^{-1}$$

$$\text{distance/afstand } x = v \Delta t$$

$$= (17)(10) \checkmark$$

$$= 170 \text{ m} \checkmark$$

OR/OF

$$f_L = \frac{v - v_L}{v} f_s \checkmark$$

$$950 = \frac{340 - v_L}{340 + 0} (1\,000) \checkmark$$

$$\text{distance/afstand } x = 170 \text{ m} \checkmark$$

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ACCEPT/AANVAAR

$$v_i = \Delta f \checkmark$$

$$= (50) \checkmark (0,34) \checkmark$$

$$= 17 \text{ m} \cdot \text{s}^{-1} \checkmark$$

distance/afstand $x = v \Delta t$

$$= (17)(10) \checkmark$$

$$= 170 \text{ m} \checkmark$$

(6)
[13]**QUESTION 7/VRAAG 7**

7.1

$$Q_{\text{net/netto}} = \frac{Q_1 + Q_2 + Q_3}{3}$$

$$-3 \times 10^{-9} = \frac{-15 \times 10^{-9} + Q + 2 \times 10^{-9}}{3} \checkmark$$

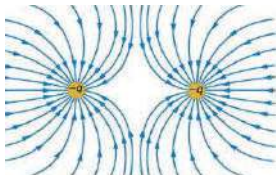
$$Q = +4 \times 10^{-9} \text{ C} \checkmark$$

NOTE/LET WEL

✓ for addition of the three correct charges
✓ correct answer

(2)

7.2

**NOTES/NOTAS**

Correct shape /Korrekte vorm ✓
Correct direction/Korrekte rigting ✓
Lines must not cross and must touch spheres ✓
Lyne moet nie kruis nie en moet die sfere raak

(3)

7.3

The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) 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 elektrostatische krag uitgeoefen deur een puntlading (Q_1) op 'n ander puntlading (Q_2) is direk eweredig aan die produk van die (groottes) van die ladinge en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

NOTE/LET WEL

If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark. If masses used (0/2)
Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelat is, trek 1 punt af. Indien massas gebruik word, (0/2)

(2)

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7.4

OPTION 1/OPSIE 1

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F_{SP} = \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(0,1)^2} \checkmark$$

$$= 8,1 \times 10^{-6} \text{ N downwards/afwaarts}$$

$$F_{TP} = \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(0,3)^2} \checkmark$$

$$= 9 \times 10^{-7} \text{ N left/links } (0,9 \times 10^{-6} \text{ N to the left/na links})$$

$$F_{\text{net}}^2 = (F_{SP})^2 + (F_{TP})^2$$

$$F_{\text{net}} = \sqrt{(F_{SP})^2 + (F_{TP})^2} \checkmark \text{ for either}$$

$$F_{\text{net}} = \sqrt{(8,1 \times 10^{-6})^2 + (0,9 \times 10^{-6})^2}$$

$$F_{\text{net}} = 8,15 \times 10^{-6} \text{ N} \checkmark$$

OPTION 2/OPSIE 2

$$E_s = \frac{kQ}{r^2} \checkmark$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2}$$

$$= 2700 \text{ N} \cdot \text{C}^{-1}$$

$$E_T = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,3)^2}$$

$$= 300 \text{ N} \cdot \text{C}^{-1}$$

✓ both substitutions
beide vervangings

$$E_{\text{net}} = \sqrt{E_s^2 + E_T^2}$$

$$= \sqrt{(2700)^2 + (300)^2} \checkmark$$

$$= 2716,62 \text{ N} \cdot \text{C}^{-1}$$

$$F = Eq$$

$$= (2716,62)(3 \times 10^{-9}) \checkmark$$

$$= 8,15 \times 10^{-6} \text{ N} \checkmark$$

(5)

7.5

POSITIVE MARKING FROM 7.4 / POSITIEWE NASIEN VANAF 7.4**OPTION 1/OPSIE 1**

$$E = \frac{F}{q} \checkmark$$

$$= \frac{8,15 \times 10^{-6}}{3 \times 10^{-9}} \checkmark$$

$$= 2,72 \times 10^3 \text{ N} \cdot \text{C}^{-1} \checkmark$$

(3)

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OPTION 2/OPSIE 2

$$E_s = \frac{kQ}{r^2} \checkmark$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2} \checkmark$$

$$= 2700 \text{ N} \cdot \text{C}^{-1}$$

$$E_T = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,3)^2} \checkmark$$

$$= 300 \text{ N} \cdot \text{C}^{-1}$$

$$E_{\text{net}} = \sqrt{E_s^2 + E_T^2}$$

$$= \sqrt{(2700)^2 + (300)^2} \checkmark$$

$$= 2716,62 \text{ N} \cdot \text{C}^{-1} \checkmark$$

NOTE/LET WEL**Mark Allocation/Punttoekenning**

✓ correct formula/korrekte formula
✓ both substitutions/beide vervangings
✓ correct answer/korrekte antwoord
If calculation done in 7.4 award full marks for answer written here. / Indien berekening in 7.4 gedoen is, moet volle punte vir die antwoord wat hier geskryf is, toegeken word.

7.6.1

Sphere/Sfeer P or/of T ✓

(1)

7.6.2

SPHERE P/SFEER P

$$n_e = \frac{Q}{q_e} \text{ or/of } n_e = \frac{Q}{e}$$

$$= \frac{-15 \times 10^{-9}}{-1,6 \times 10^{-19}} \checkmark = 9,38 \times 10^{10}$$

mass gained/massa gewin $= n_e m_e$
m gained /gewin $= (9,38 \times 10^{10})(9,11 \times 10^{-31}) \checkmark$
 $= 8,55 \times 10^{-20} \text{ kg} \checkmark$

SPHERE T/SFEER T

$$n_e = \frac{Q}{q_e} \text{ or/of } n_e = \frac{Q}{e}$$

$$= \frac{-5 \times 10^{-9}}{-1,6 \times 10^{-19}} \checkmark = 3,125 \times 10^{10}$$

mass gained/massa gewin $= n_e m_e$
m gained /gewin $= (3,125 \times 10^{10})(9,11 \times 10^{-31}) \checkmark$
 $= 2,85 \times 10^{-20} \text{ kg} \checkmark$

(3)
[19]

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QUESTION 8/VRAAG 8

8.1

The battery supplies 12 J per coulomb/12 J per unit charge. ✓✓
Die battery verskaf 12 J per coulomb lading

OR /OF

The potential difference of the battery in an open circuit is 12 V. ✓✓
Die potensiaal verskil van die battery in 'n oop stroombaan is 12 V

OR/OF

The battery does 12 J of work per coulomb of charge. ✓✓
Die battery verrig 12 J arbeid per coulomb lading

OR/OF

Maximum work done by the battery per unit charge is 12 J
Maksimum arbeid verrig deur die battery per eenheidslading is 12 J

OR/OF

Maximum energy supplied by the battery per unit charge is 12 J
Maksimum energie verskaf deur die battery per eenheidslading is 12 J

OR/OF

The battery supplies 12 J of energy per coulomb/ 12 J of energy per unit charge
Die battery verskaf 12 J energie per coulomb/12 J energie per eenheidslading

OR/OF

The greatest potential difference that can be generated by a battery is 12 V
Die grootste potensiaalverskil wat deur 'n battery gelewer word, is 12 V

OR/OF

The total energy transferred by a battery to a unit electric charge is 12 J
Die totale energie oordra deur die battery aan 'n eenheid elektriese lading is 12 J

OR/OF

The total amount of electric energy supplied by the battery per coulomb/per unit charge is 12 J
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheid lading is 12 J

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark.
Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelat is, trek 1 punt af

8.2.1

OPTION 1/OPSIE 1

$$V_{\text{lost/verlore}} = I r \checkmark$$

$$= (2)(0,5)$$

$$= 1 \text{ V}$$

$$V_{\text{ext/eks}} = \mathcal{E} - V_{\text{lost/verlore}}$$

$$= (12 - 1) \checkmark$$

OPTION 2/OPSIE 2

$$\begin{aligned}\epsilon &= I(R + r) \checkmark \\ 12 &= V_{\text{ext/eks}} + (2)(0,5) \checkmark \\ V_{\text{ext/eks}} &= 11 \text{ V} \checkmark\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}\epsilon &= I(R + r) \checkmark \\ 12 &= 2(R + 0,5) \\ R &= 5,5 \Omega \\ V &= IR \\ &= 2(5,5) \checkmark \\ &= 11 \text{ V} \checkmark\end{aligned}$$

(3)

8.2.2 **POSITIVE MARKING FROM 8.2.1/POSITIEWE NASIEN VANAF 8.2.1****OPTION 1/OPSIE 1**

$$\begin{aligned}R &= \frac{V}{I} \\ &= \frac{11}{2} \checkmark \\ &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}0,5R & \checkmark \\ 1:11 & \checkmark \\ R &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}\frac{1}{0,5} &= \frac{11}{R} \checkmark \\ R &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 4/OPSIE 4

$$\begin{aligned}V_{\text{total}} &= IR_{\text{total}} \\ 12 &= (2)R_{\text{total}} \\ R_{\text{total}} &= 6 \Omega \\ R &= 6 - 0,5 \checkmark \\ &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 5/OPSIE 5

$$\begin{aligned}\epsilon &= I(R + r) \\ 12 &= 2(R + 0,5) \checkmark \\ R &= 5,5 \Omega \checkmark\end{aligned}$$

(2)

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8.3 **Decreases /Neem af ✓**

Total resistance decreases /Totale weerstand neem af ✓
Current increases/Stroom neem toe ✓
"Lost volts" increases, ✓(emf the same)/"Verlore volts" neem toe, (emk dieselfde)
External potential difference decreases/eksterne potensiaal verskil neem af

OR/OF

Decreases /Neem af ✓
Total resistance decreases /Totale weerstand neem af ✓
Current increases/Stroom neem toe ✓
 $\epsilon = V_{\text{ext/eks}} + Ir$
Ir increases/Ir neem toe ✓
 ϵ is constant/is konstant
 $\therefore V_{\text{ext/eks}}$ decreases/neem af

(4)

[11]

QUESTION 9/VRAAG 9

9.1 Temperature/Temperatuur ✓

(1)

9.2.1 $r = 3 \Omega$ or/of $1,5 \Omega$ ✓✓

Accept for one mark only: /Aanvaar vir slegs een punt
 $r = -3 \Omega$ ✓ or/of $-1,5 \Omega$

(2)

9.2.2 ϵ = slope (gradient) of the graph/helling(gradient) van die grafiek ✓

$$\begin{aligned}\epsilon &= \frac{7,5 - (-3)}{1,5 - 0} \checkmark \\ &= 7 \text{ V} \checkmark\end{aligned}$$

Accept any correct values from the graph
Aanvaar enige korrekte waardes vanaf die grafiek

OR/OF**POSITIVE MARKING FROM 9.2.1 / POSITIEWE NASIEN VANAF 9.2.1**

$$\begin{aligned}R &= \frac{\epsilon}{I} - r \checkmark \\ 7,5 &= 15\epsilon - 3 \checkmark \\ \epsilon &= 7 \text{ V} \checkmark\end{aligned}$$

Accept any correct values on the line from the graph
Aanvaar enige korrekte waardes op die lyn vanaf die grafiek

OR/OF

$$\begin{aligned}\epsilon &= I(R + r) \checkmark \\ &= 0,5(11 + 3) \checkmark \\ \epsilon &= 7 \text{ V} \checkmark\end{aligned}$$

(3)

[6]

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QUESTION 10/VRAAG 10

10.1.1 Y to/na X ✓

(1)

10.1.2 Faraday's Law Electromagnetic Induction ✓
Faraday se wet van Elektromagnetiese Induksie

OR/OF

Electromagnetic induction/Faraday's Law ✓
Elektromagnetiese induksie/Faraday se wet

(1)

10.1.3 Mechanical (kinetic) energy ✓ to electrical energy ✓
Meganiese (kinetiese) energie na elektriese energie

(2)

10.2.1 340 V ✓

(1)

Accept / Aanvaar
-340 V

10.2.2 **POSITIVE MARKING FROM 10.2.1/POSITIEWE NASIEN VANAF 10.2.1**

$$\begin{aligned}V_{\text{rms/wgk}} &= \frac{V_{\text{max/maks}}}{\sqrt{2}} \checkmark \\ &= \frac{340}{\sqrt{2}} \checkmark \\ V_{\text{rms/wgk}} &= 240,42 \text{ V} \checkmark\end{aligned}$$

(3)

10.2.3 **POSITIVE MARKING FROM 10.2.2 / POSITIEWE NASIEN VANAF 10.2.3****OPTION 1/OPSIE 1**

$$\begin{aligned}P_{\text{ave/gemid}} &= \frac{V_{\text{rms/wgk}}^2}{R} \checkmark \\ 1\,600 &= \frac{(240,42)^2}{R} \checkmark \\ R &= 36,13 \Omega \text{ (36,126 } \Omega) \checkmark\end{aligned}$$

OR/OF

$$R = 36,12 \Omega \text{ (36,124 } \Omega)$$

OPTION 2/ OPSIE 2

$$\begin{aligned}P_{\text{ave/gemid}} &= \frac{V_{\text{rms/wgk}}^2}{R} \checkmark = \frac{V_{\text{max/maks}}^2}{2R} \checkmark = \frac{V_{\text{max/maks}}^2}{2R} \\ 1\,600 &= \frac{(340)^2}{2R} \checkmark \\ R &= 36,13 \Omega \text{ (36,125 } \Omega) \checkmark\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}P_{\text{ave/gemid}} &= V_{\text{rms/wgk}} I_{\text{rms/wgk}} \checkmark \\ 1600 &= (240,416) I_{\text{rms/wgk}} \checkmark \\ I_{\text{rms/wgk}} &= 6,66 \text{ A} \\ R &= \frac{V_{\text{rms}}}{I_{\text{rms}}} \checkmark \\ &= \frac{240,416}{6,66} \checkmark \\ &= 36,1 \Omega \text{ (36,09 } \Omega) \checkmark\end{aligned}$$

(Do not penalise if rms is omitted
in $R = \frac{V_{\text{rms}}}{I_{\text{rms}}}$ Moenie penaliseer
indien wgk uitgelaat is nie.)

OPTION 4/OPSIE 4

$$\begin{aligned}P_{\text{ave/gemid}} &= \frac{V_{\text{max/maks}} I_{\text{max/maks}}}{2} \\ 1600 &= \frac{340 I_{\text{max/maks}}}{2} \\ I_{\text{max/maks}} &= 9,412 \text{ A} \\ R &= \frac{V_{\text{max}}}{I_{\text{max}}} \checkmark \\ &= \frac{340}{9,412} \checkmark \\ &= 36,12 \Omega \checkmark\end{aligned}$$

(Do not penalise if max is
omitted in $R = \frac{V_{\text{max}}}{I_{\text{max}}}$ Moenie
penaliseer indien maks uitgelaat

(3)

[11]

QUESTION 11/VRAAG 11

11.1 Work function of a metal is the minimum energy needed to eject an electron from the metal surface ✓✓
Arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron uit die oppervlakte van 'n metaal vry te stel.

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

11.2 **Potassium / Kalium / K ✓**

f_0 for potassium is greater than f_0 for caesium ✓
 f_0 vir kalium is groter as f_0 vir sesium

OR/OF

Work function is directly proportional to threshold frequency ✓
Arbeidsfunksie is direk eweredig aan die drumpel frekwensie

ACCEPT/AANVAAR

$$\begin{aligned}W_0 &= hf_0 \\ W_0 &\propto f_0\end{aligned}$$

(2)

11.3 **OPTION 1/OPSIE 1**

$$\begin{aligned}c &= f\lambda \checkmark \\ 3 \times 10^8 &= f(5,5 \times 10^{-2}) \checkmark \\ f &= 5,45 \times 10^{14} \text{ Hz} \\ f_{\text{uv}} &< f_0 \text{ of K (potassium)}\end{aligned}$$

$\therefore$ Ammeter in circuit **B** will not show a reading ✓
Die stroommeter in die kring **B** sal nie 'n lesing toon nie.

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OPTION 2/OPSIE 2

$$E = \frac{hc}{\lambda} = \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5,5 \times 10^{-7}} = 3,6164 \times 10^{-19} \text{ J}$$

$$W_o = hf_o = (6,63 \times 10^{-34})(5,55 \times 10^{14}) = 3,68 \times 10^{-19} \text{ J}$$

$$W_o > E \text{ or/of } hf_o > hf$$

∴ The ammeter will not register a current / *ammeter sal nie lesing registreer* ✓
Mark allocation / Punttoekening

✓ both correct formulae/beide korrekte formules: $E = \frac{hc}{\lambda}$ and $W_o = hf_o$

✓ both substitutions/beide vervangings: $\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5,5 \times 10^{-7}}$ and/en

$$(6,63 \times 10^{-34})(5,55 \times 10^{14})$$

✓ correct conclusion

OPTION 3/OPSIE 3

$$c = f_o \lambda_o \checkmark$$

$$3 \times 10^8 = (5,55 \times 10^{14}) \lambda \checkmark$$

$$\lambda_o = 5,41 \times 10^{-7} \text{ m}$$

λ_o (threshold wavelength) < λ (incident wavelength)

λ_o (drumpelgolflengte) < λ (invallende golflengte)

∴ the ammeter will not register a current / *ammeter sal nie lesing registreer* ✓

(3)

11.4

OPTION 1/OPSIE 1

$$E = W_o + E_{k(\max)}$$

$$hf = hf_o + \frac{1}{2}mv_{\max}^2 \checkmark$$

$$h \frac{c}{\lambda} = h \frac{c}{\lambda_o} + E_{k(\max)} \checkmark$$

NOTE: If E_K of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.

LET WEL: Indien E_K van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord

$$\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5,5 \times 10^{-7}} \checkmark = \frac{(6,63 \times 10^{-34})(5,07 \times 10^{14})}{5,5 \times 10^{-7}} + E_{k(\max)} \checkmark$$

$$E_K = 2,55 \times 10^{-20} \text{ J} \checkmark \quad (\text{Range/Gebied: } 2,52 \times 10^{-20} - 2,6 \times 10^{-20} \text{ J})$$

OPTION 2/OPSIE 2**POSITIVE MARKING FROM 11.3/POSITIEWE NASIEN VANAF 11.3**

$$E = W_o + E_{k(\max)}$$

$$hf = hf_o + \frac{1}{2}mv_{\max}^2 \checkmark$$

$$h \frac{c}{\lambda} = h \frac{c}{\lambda_o} + E_{k(\max)} \checkmark$$

NOTE: If E_K of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.

LET WEL: Indien E_K van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord

$$(6,63 \times 10^{-34})(5,45 \times 10^{14}) \checkmark = \frac{(6,63 \times 10^{-34})(5,07 \times 10^{14})}{5,5 \times 10^{-7}} + E_{k(\max)} \checkmark$$

$$E_K = 2,52 \times 10^{-20} \text{ J} \checkmark \quad (\text{Range/Gebied: } 2,52 \times 10^{-20} - 2,6 \times 10^{-20} \text{ J})$$

(5)

11.5 Remains the same/Bly dieselfde ✓

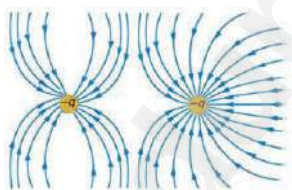
(1)

[13]

TOTAL/TOTAAL: 150**ADDENDUM****QUESTION 7.2**

Accept the following electric field diagram which would be formed if the effect of the third charge is considered.

Aanvaar die volgende elektrieseveld diagram wat gevorm sal word indien die effek van die derde lading in ag geneem is.



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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 dm³ 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 CaCO₃ 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):
 - Dipole-dipole forces:
Forces between two polar molecules
 - Induced dipole forces or London forces:
Forces between non-polar molecules
 - 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.

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- 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.

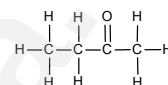
Organic Molecules

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

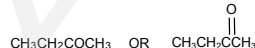
- Define organic molecules as molecules containing carbon atoms.

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: C₄H₈O
 - 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.



- 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 CH₂ group
- Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains

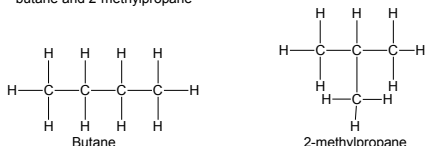
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- Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains
- Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds

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		-
Alcohols		Hydroxyl group
Aldehydes		Formyl group
Ketones		Carbonyl group
Carboxylic acids		Carboxyl group
Esters		-

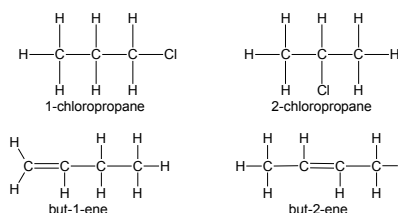
- Structural isomer: Organic molecules with the same molecular formula, but different structural formulae
- Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.
- Restrict structural isomers to chain isomers, positional isomers and functional isomers.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



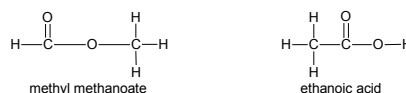
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- Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene



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

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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, Cl_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 ($\text{X} = \text{Cl}, \text{Br}$) with alcohols to produce haloalkanes - Halogenation of alkanes: The reaction of a halogen (Br_2, Cl_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
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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 poly(ethene). - State the industrial uses of poly(ethene).
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: $\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$) 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.

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- 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. 125–128.) 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-Bronsted theories: - Arrhenius theory: An acid is a substance that produces hydrogen ions (H^+) in water. A base produces hydroxide ions (OH^-) in water. - Lowry-Bronsted 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.

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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: $\text{HCl}(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq})$ (HCl is a monoprotic acid.) $\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_3\text{O}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$ (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: $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq})/\text{KOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq})/\text{KCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$ $\text{HCl}(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ $\text{HNO}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$ $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ $(\text{COOH})_2(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow (\text{COO})_2\text{Na}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$ $\text{CH}_3\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{CH}_3\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l})$ 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 $\text{pH} > 7$. 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 $\text{pH} < 7$. 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. $\text{pH} = 7$. - 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 product of the concentration of H^+ and OH^- ions (at a constant amount of water).
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- 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 $V_{\text{cell}} = 0$ (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 $\text{H}_2|\text{H}^+$ 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: $\text{Pt} | \text{Cr}(\text{aq}) | \text{Cr}_2(\text{g}) || \text{F}_2(\text{g}) | \text{F}(\text{aq}) | \text{Pt}$
- 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 of 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 ; $(\text{NH}_4)_2\text{SO}_4$
- Evaluate the use of inorganic fertilisers on humans and the environment.
- Define eutrophication as the process by which an ecosystem, e.g. a river or dam, becomes enriched with inorganic plant nutrients, especially phosphorus and nitrogen, resulting in excessive plant (algae) growth. As plant growth becomes excessive, the amount of dead and decaying plant material increases rapidly.
- Discuss alternatives to inorganic fertilisers as used by some communities.

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4.3 INFORMATION SHEETS – PAPER 2 (CHEMISTRY)**TABLE 1: PHYSICAL CONSTANTS**

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Standard pressure	p^θ	$1,01 \times 10^5 \text{ Pa}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature	T^θ	273 K

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$	
$E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta$	
$E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
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	

KEY/SLEUTEL

Atomic number
*Atoomgetal*Electronegativity
*Elektronegatiwiteit*Symbol
*Simbool*Approximate relative atomic mass
Benaderde relatiewe atoommassa

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions		E° (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
$Cl_2(g) + 2e^-$	$\rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^-$	$\rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons Hg(l)$	+ 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
$2H^+ + 2e^-$	$\rightleftharpoons H_2(g)$	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
$Al^{3+} + 3e^-$	$\rightleftharpoons Al$	- 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 oxidising ability

Increasing reducing ability/

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			E° (V)
$\text{Li}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Li	-3,05
$\text{K}^{+} + \text{e}^{-}$	$\rightleftharpoons$	K	-2,93
$\text{Cs}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Cs	-2,92
$\text{Ba}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Ba	-2,90
$\text{Sr}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Sr	-2,89
$\text{Ca}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Ca	-2,87
$\text{Na}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Na	-2,71
$\text{Mg}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Mg	-2,36
$\text{Al}^{3+} + 3\text{e}^{-}$	$\rightleftharpoons$	Al	-1,66
$\text{Mn}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Mn	-1,18
$\text{Cr}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Cr	-0,91
$2\text{H}_2\text{O} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{H}_2(\text{g}) + 2\text{OH}^{-}$	-0,83
$\text{Zn}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Zn	-0,76
$\text{Cr}^{3+} + 3\text{e}^{-}$	$\rightleftharpoons$	Cr	-0,74
$\text{Fe}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Fe	-0,44
$\text{Cr}^{3+} + \text{e}^{-}$	$\rightleftharpoons$	Cr^{2+}	-0,41
$\text{Cd}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Cd	-0,40
$\text{Co}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Co	-0,28
$\text{Ni}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Ni	-0,27
$\text{Sn}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Sn	-0,14
$\text{Pb}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Pb	-0,13
$\text{Fe}^{3+} + 3\text{e}^{-}$	$\rightleftharpoons$	Fe	-0,06
$2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^{-}$	$\rightleftharpoons$	Sn^{2+}	+0,15
$\text{Cu}^{2+} + \text{e}^{-}$	$\rightleftharpoons$	Cu^{+}	+0,16
$\text{SO}_4^{2-} + 4\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Cu	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-}$	$\rightleftharpoons$	4OH^{-}	+0,40
$\text{SO}_2 + 4\text{H}^{+} + 4\text{e}^{-}$	$\rightleftharpoons$	$\text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Cu	+0,52
$\text{I}_2 + 2\text{e}^{-}$	$\rightleftharpoons$	2I^{-}	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	H_2O_2	+0,68
$\text{Fe}^{3+} + \text{e}^{-}$	$\rightleftharpoons$	Fe^{2+}	+0,77
$\text{NO}_3^{-} + 2\text{H}^{+} + \text{e}^{-}$	$\rightleftharpoons$	$\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Ag	+0,80
$\text{Hg}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{Hg}(\text{l})$	+0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-}$	$\rightleftharpoons$	$\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2\text{e}^{-}$	$\rightleftharpoons$	2Br^{-}	+1,07
$\text{Pt}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Pt	+1,20
$\text{MnO}_2 + 4\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^{+} + 4\text{e}^{-}$	$\rightleftharpoons$	$2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^{+} + 6\text{e}^{-}$	$\rightleftharpoons$	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^{-}$	$\rightleftharpoons$	2Cl^{-}	+1,36
$\text{MnO}_4^{-} + 8\text{H}^{+} + 5\text{e}^{-}$	$\rightleftharpoons$	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^{-}$	$\rightleftharpoons$	Co^{2+}	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^{-}$	$\rightleftharpoons$	2F^{-}	+2,87

Increasing oxidising ability
↓↑
Increasing reducing ability



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2017

MARKS: 150

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 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 $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{H} \end{array}$ B $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$
C $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{C}- \\ | \end{array}$ D $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{C}-\text{C}- \\ | \quad | \quad | \end{array}$ (2)
- 1.3 Which ONE of the following equations represents a cracking process?
- A $5\text{CH}_2 = \text{CH}_2 \rightarrow (\text{CH}_2\text{CH}_2)_5$ —
B $\text{CH}_3(\text{CH}_2)_5\text{CH} = \text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3(\text{CH}_2)_6\text{CH}_3$
C $\text{CH}_3(\text{CH}_2)_6\text{CH}_3 \rightarrow \text{CH}_3(\text{CH}_2)_4\text{CH}_3 + \text{CH}_2 = \text{CH}_2$
D $\text{CH}_3(\text{CH}_2)_7\text{OH} \rightarrow \text{CH}_3(\text{CH}_2)_5\text{CH} = \text{CH}_2 + \text{H}_2\text{O}$ (2)

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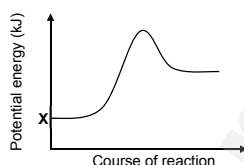
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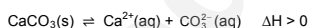
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- 1.4 The potential energy diagram for a chemical reaction is shown below.



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:



- 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)

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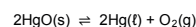
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- 1.6 Consider the following chemical reaction at equilibrium in a closed container:



More $\text{HgO}(\text{s})$ is now added to the container at constant temperature.

How will the number (in moles) of $\text{O}_2(\text{g})$ 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 $0,1 \text{ mol}\cdot\text{dm}^{-3}$, has the highest pH?
- A $\text{HNO}_3(\text{aq})$
B $\text{NH}_4\text{Cl}(\text{aq})$
C $\text{Na}_2\text{CO}_3(\text{aq})$
D $\text{CH}_3\text{COOH}(\text{aq})$ (2)
- 1.8 The cell notation for a galvanic cell is as follows:
- $$\text{Ni}(\text{s}) \mid \text{Ni}^{2+} (1 \text{ mol}\cdot\text{dm}^{-3}) \parallel \text{Pb}^{2+} (1 \text{ mol}\cdot\text{dm}^{-3}) \mid \text{Pb}(\text{s})$$
- Which ONE of the following statements is CORRECT for this cell?
- A Ni is oxidised.
B $\text{Pb}(\text{s})$ is reduced.
C $\text{Ni}^{2+}(\text{aq})$ is the oxidising agent.
D Pb^{2+} is the reducing agent. (2)

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- 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]

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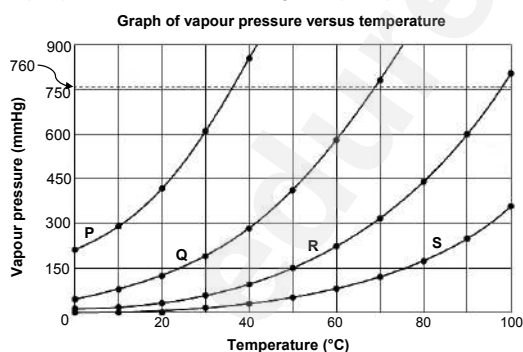
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QUESTION 3 (Start on a new page.)

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.



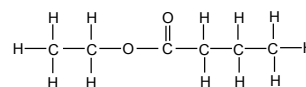
- 3.1 Give a reason why alkanes are said to be SATURATED. (1)
- 3.2 Define *vapour pressure*. (2)
- 3.3 Use the information in the graph above to answer the following questions. (1)
- 3.3.1 What is the effect of an increase in temperature on vapour pressure? Choose from INCREASES, DECREASES or NO EFFECT. (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. (1)
- 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)

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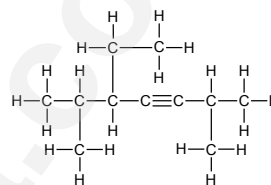
QUESTION 2 (Start on a new page.)

- 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)

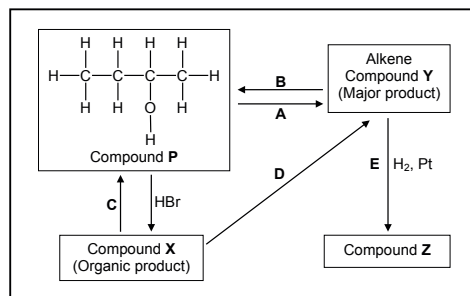
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QUESTION 4 (Start on a new page.)

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: (1)
- 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. (1)
- 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]

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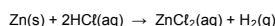
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QUESTION 5 (Start on a new page.)

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:

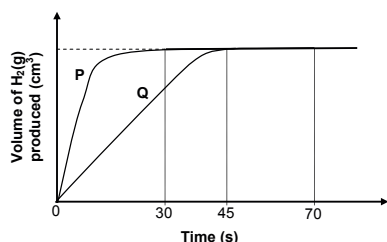


They conduct two experiments. The reaction conditions used are summarised in the table below.

EXPERIMENT	TEMPERATURE (°C)	VOLUME OF HCl (cm ³)	CONCENTRATION OF HCl (mol·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 H₂(g) produced versus time



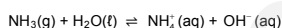
- 5.1 Define *reaction rate*. (2)
- 5.2 Write down an investigative question for this investigation. (2)
- 5.3 Which curve, **P** or **Q**, represents the results of experiment I? Explain the answer. (3)
- 5.4 The average rate of the production of hydrogen gas, as represented by graph **P**, was 15 cm³·s⁻¹. Calculate the mass of zinc used. **Take the molar gas volume at 25 °C as 24 000 cm³.** (5)

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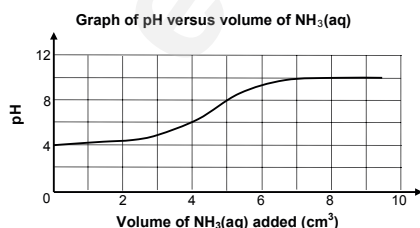
QUESTION 7 (Start on a new page.)

- 7.1 Ammonia ionises in water to form a basic solution according to the following balanced equation:



- 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 NH₃(g). (1)
- 7.1.3 Identify ONE substance in this reaction that can behave as an amphoteric 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, NH₃(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 cm³ of NH₃(aq). (4)

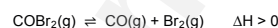
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- 5.5 In a third experiment (experiment III), 200 cm³ of a 0,25 mol·dm⁻³ dilute hydrochloric acid solution at 35 °C reacts with the same amount of zinc powder as in experiment I and experiment II.
 - 5.5.1 How will the heat of reaction of experiment 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, COBr₂, decomposes into carbon monoxide and bromine according to the following balanced equation:



Initially COBr₂(g) is sealed in a 2 dm³ 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 COBr₂(g) (7)
 - 6.2.2 Percentage of COBr₂(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? (1)

K _c < 0,19	K _c > 0,19	K _c = 0,19
-----------------------	-----------------------	-----------------------
 - 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.

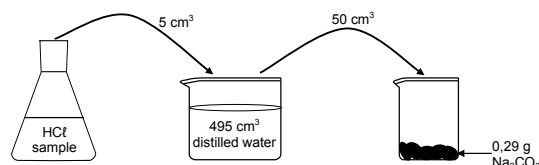
How will the number of moles of COBr₂(g) be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3) [17]

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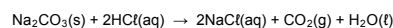
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- 7.3 A laboratory technician wants to determine the concentration of a hydrochloric acid (HCl) sample. He adds 5 cm³ of the HCl sample to 495 cm³ of distilled water to give 500 cm³ of dilute hydrochloric acid, HCl(aq).

During a reaction 50 cm³ of this dilute hydrochloric acid solution, HCl(aq), reacts completely with 0,29 g of sodium carbonate, Na₂CO₃(s).



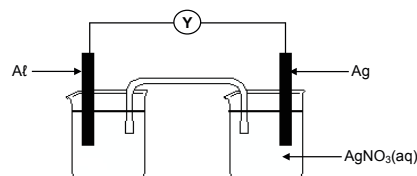
The balanced equation for the reaction is:



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)

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8.2 Consider the half-cells, **P**, **Q** and **R**, represented in the table below.

HALF-CELL		
P	Q	R
Zn Zn ²⁺ (aq)	Ct ₂ Ct ⁻ (aq)	Cu Cu ²⁺ (aq)

Different combinations of the half-cells above are compared to determine the highest emf produced under standard conditions.

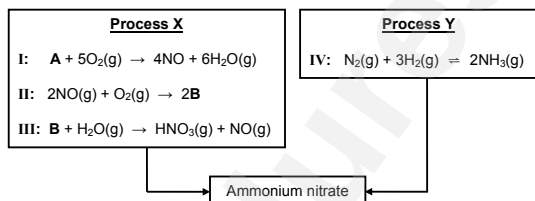
- 8.2.1 Write down the NAME of a suitable electrode for half-cell **Q**. (1)
- 8.2.2 State the standard conditions under which the half-cells should operate to ensure a fair comparison. (2)
- 8.2.3 Write down the NAME or FORMULA of the strongest reducing agent in the half-cells above. (1)
- 8.2.4 Which combination of half-cells will produce the highest emf? Choose from **PR**, **PQ** or **QR**. (NO calculation is required.) (1)
- [14]**

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QUESTION 10 (Start on a new page.)

10.1 The equations below represent two industrial processes involved in the preparation of ammonium nitrate.



Write down the:

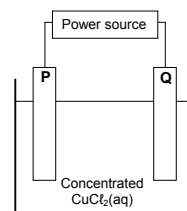
- 10.1.1 NAME of substance **A** (1)
- 10.1.2 FORMULA of substance **B** (1)
- 10.1.3 NAME given for reaction **I** (1)
- 10.1.4 NAME or FORMULA of the catalyst used in reaction **I** (1)
- 10.1.5 Name of process **X** (1)
- 10.1.6 Name of process **Y** (1)
- 10.1.7 Balanced equation for the preparation of ammonium nitrate from the products obtained in process **X** and process **Y** (3)
- 10.2 A 15 kg bag of fertiliser contains 5% phosphorus, 10% nitrogen and 15% potassium.
- Calculate the:
- 10.2.1 Mass of phosphorus in the bag (2)
- 10.2.2 Mass of filler in the bag (3)
- [14]**

TOTAL: 150

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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 CuCl₂(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]**

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**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FEBRUARY/MARCH 2018

MARKS: 150
TIME: 3 hours

This question paper consists of 16 pages, 4 data sheets and 1 graph sheet.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 Which ONE of the following is the general formula of alkynes?
 A C_nH_{2n}
 B $C_{2n}H_{2n}$
 C C_nH_{2n-2}
 D C_nH_{2n+2} (2)
- 1.2 The type of reaction that takes place when a carboxylic acid and an alcohol react in the presence of an acid:
 A Addition
 B Hydrolysis
 C Substitution
 D Esterification (2)
- 1.3 Which ONE of the following isomers has the LOWEST boiling point?
 A $CH_3CH_2CH_2CH_2CH_2CH_3$
 B $CH_3CH_2C(CH_3)_2CH_3$
 C $CH_3CH(CH_3)CH_2CH_2CH_3$
 D $CH_3CH_2CH(CH_3)CH_2CH_3$ (2)

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- 1.6 The following equilibrium exists in pure water at 25 °C.
 $2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq) \quad \Delta H > 0$
 At this temperature, the pH = 7 and $K_w = 1 \times 10^{-14}$.
 The temperature of the water is now increased to 90 °C.
 Which ONE of the following is TRUE at the new temperature?
 A pH = 7
 B $[H_3O^+] = [OH^-]$
 C $[H_3O^+][OH^-] = 10^{-14}$
 D $[H_3O^+] = 10^{-7} \text{ mol} \cdot \text{dm}^{-3}$ (2)
- 1.7 A hydrochloric acid solution is titrated against an ammonia solution. The balanced equation for the reaction is:
 $HCl(aq) + NH_4OH(aq) \rightarrow NH_4Cl(aq) + H_2O(l)$
 Which ONE of the following gives the pH of the solution at the end point and the reason for this pH?

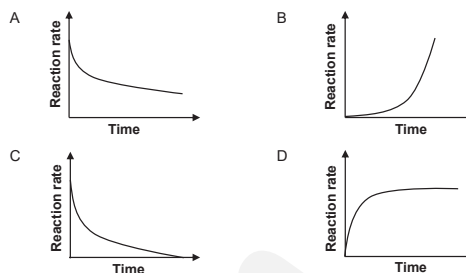
	pH	REASON
A	3	$H_3O^+(aq)$ is formed during the ionisation of $HCl(aq)$.
B	5	$H_3O^+(aq)$ is formed during hydrolysis of $NH_4^+(aq)$.
C	7	Neutralisation takes place at the end point.
D	9	$OH^-(aq)$ is formed during hydrolysis of $NH_4^+(aq)$.

 (2)
- 1.8 A decrease in the oxidation number of an atom during a chemical reaction is known as ...
 A redox.
 B oxidation.
 C reduction.
 D electrolysis. (2)

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- 1.4 Which ONE of the reaction rate versus time graphs below best represents the reaction between magnesium and EXCESS dilute hydrochloric acid?



- 1.5 Which ONE of the following will NOT affect the equilibrium position of reversible chemical reactions?
 A Temperature
 B Catalyst
 C Pressure
 D Concentration (2)

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- 1.9 The two half-reactions below are used to construct a galvanic cell.
 $X^+(aq) + e^- \rightleftharpoons X(s) \quad E_{\text{reduction}}^0 = +0,15 \text{ V}$
 $Y^{2+}(aq) + 2e^- \rightleftharpoons Y(s) \quad E_{\text{reduction}}^0 = -0,15 \text{ V}$
 Which ONE of the statements below is CORRECT when the cell is in operation?
 A $X^+(aq)$ is reduced.
 B $Y(s)$ is reduced.
 C $X(s) | X^+(aq)$ is the negative electrode.
 D Electrons flow from $X(s)$ to $Y(s)$ in the external circuit. (2)
- 1.10 Which ONE of the following is CORRECT for the industrial preparation of sulphuric acid?

	PROCESS	CATALYST
A	Ostwald	Platinum
B	Haber	Iron
C	Contact	Iron
D	Contact	Vanadium pentoxide

(2)
[20]

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QUESTION 2 (Start on a new page.)

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

A		B	
C	Butan-1-ol	D	Butan-2-one
E			

- 2.1 Write down the LETTER that represents EACH of the following:
- 2.1.1 A tertiary alcohol (1)
- 2.1.2 An aldehyde (1)
- 2.1.3 A ketone (1)
- 2.1.4 A functional isomer of compound B (1)
- 2.2 Write down the IUPAC name of:
- 2.2.1 Compound B (1)
- 2.2.2 Compound E (4)
- 2.3 Define *positional isomers*. (2)
- 2.4 Write down the STRUCTURAL FORMULA of:
- 2.4.1 A positional isomer of compound C (2)
- 2.4.2 Compound D (2)
- 2.4.3 The organic acid that will react with compound C to form butyl propanoate (2)
- [17]

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QUESTION 4 (Start on a new page.)

Consider the incomplete equations for reactions I to IV below. P, Q, R and S are organic compounds.

I	$Q + Br_2 \longrightarrow$ 2-bromobutane + HBr
II	$nP \longrightarrow$ $\left[CH_2-CH_2\right]_n$
III	$R \xrightarrow{\text{heat}} 2P + Q$
IV	$2\text{-bromobutane} + KOH \text{ (in ethanol)} \xrightarrow{\text{heat}} S + T + H_2O$

- 4.1 Define a *cracking reaction*. (2)
- 4.2 Write down the reaction number (I, II, III or IV) that represents EACH of the following:
- 4.2.1 A cracking reaction (1)
- 4.2.2 An addition reaction (1)
- 4.2.3 A substitution reaction (1)
- 4.3 Write down:
- 4.3.1 ONE reaction condition for reaction I (1)
- 4.3.2 The compound (P, Q, R or S) that represents an unsaturated hydrocarbon (1)
- 4.3.3 The IUPAC name of compound P (1)
- 4.3.4 The molecular formula of compound R (2)
- 4.3.5 The structural formula of compound Q (2)
- 4.3.6 The structural formula of compound S (2)
- [14]

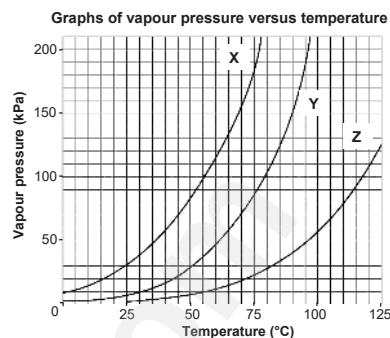
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QUESTION 3 (Start on a new page.)

Study the vapour pressure versus temperature graphs for three organic compounds, X, Y and Z, below which belong to different homologous series.

Atmospheric pressure is 100 kPa.



- 3.1 Write down the vapour pressure of compound Y at 90 °C. (1)
- 3.2 The graphs can be used to determine the boiling points of the three compounds.
- 3.2.1 Define *boiling point*. (2)
- 3.2.2 Determine the boiling point of compound X. (1)
- 3.3 The homologous series to which the three compounds of similar molecular masses belong, were identified in random order as:
- alcohol; carboxylic acid; ketone
- 3.3.1 Which compound (X, Y or Z) is the carboxylic acid? (1)
- 3.3.2 Explain the answer to QUESTION 3.3.1 by referring to the type of intermolecular forces in compounds of each of the homologous series above. (4)
- 3.3.3 Compound X has three carbon atoms per molecule. Write down the IUPAC name of compound X. (1)
- [10]

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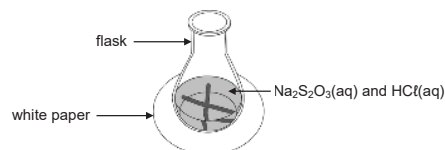
QUESTION 5 (Start on a new page.)

ANSWER QUESTION 5.3 ON THE ATTACHED GRAPH PAPER.

Learners use the reaction between sodium thiosulphate and hydrochloric acid to investigate one of the factors that affects reaction rate. The balanced equation for the reaction is:



The diagram below shows the experimental setup.



In the first experiment, 50 cm³ of the sodium thiosulphate solution is added to 100 cm³ of a 2 mol·dm⁻³ dilute hydrochloric acid solution in a flask that is placed over a cross drawn on a sheet of white paper. The hydrochloric acid is in EXCESS.

The time taken for the cross to become invisible, when viewed from the top, is recorded.

The experiment is then repeated four times with different volumes of the sodium thiosulphate solution. The results obtained are shown in the table below.

EXPERIMENT	VOLUME OF Na ₂ S ₂ O ₃ (cm ³)	VOLUME OF H ₂ O (cm ³)	TIME (s)	AVERAGE RATE ($\frac{1}{\text{time}}$) ($\times 10^{-2} \text{ s}^{-1}$)
1	50	0	22,7	4,4
2	40	10	28,6	3,5
3	30	20	38,5	2,6
4	20	30	58,8	1,7
5	10	40	111,1	0,9

- 5.1 Define *reaction rate*. (2)
- 5.2 How does the concentration of the sodium thiosulphate solution used in experiment 2 compare to that used in experiment 5? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)

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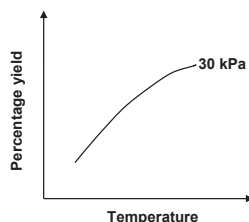
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- 5.3 Draw a graph of average reaction rate versus volume of sodium thiosulphate used on the attached GRAPH SHEET. (ATTACH THIS GRAPH SHEET TO YOUR ANSWER BOOK.) (3)
- 5.4 Use the information in the graph to answer the following questions.
- 5.4.1 Determine the volume of dilute sodium thiosulphate solution that needs to react in order for the cross to become invisible in 40 seconds.
- USE DOTTED LINES ON THE GRAPH TO SHOW HOW YOU ARRIVED AT THE ANSWER. (3)
- 5.4.2 Write down a conclusion for this investigation. (2)
- 5.5 Use the collision theory to explain the effect of an increase in concentration on reaction rate. (3)
- 5.6 The mass of sulphur produced in experiment 1 is 1,62 g. Calculate the mass of the sodium thiosulphate used in experiment 1. (4) [18]

QUESTION 6 (Start on a new page.)

- 6.1 A reversible gaseous reaction is allowed to reach equilibrium in a closed container at different temperatures and pressures.

The graph below shows the percentage yield for this reaction at 30 kPa as the temperature is increased.



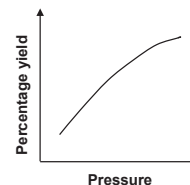
Use the information in the graph above to answer the following questions.

- 6.1.1 State Le Chatelier's principle. (2)
- 6.1.2 The heat of reaction (ΔH) for the forward reaction is POSITIVE. Use Le Chatelier's principle to explain this statement. (3)

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The graph below show the percentage yield for this reaction as pressure changes at constant temperature.



- 6.1.3 Explain the effect of an increase in pressure on the equilibrium position of a reaction. (2)
- 6.1.4 Which ONE of the following equations (I, II or III) represents the equilibrium above?
- I: $2A(g) + 3B(g) \rightleftharpoons 3C(g)$
- II: $A(g) + B(g) \rightleftharpoons 3C(g)$
- III: $A(g) + B(g) \rightleftharpoons 2C(g)$ (2)
- 6.2 A mixture of 0,2 moles of hydrogen chloride (HCl) and 0,11 moles of oxygen gas (O_2) is sealed in a 200 cm³ flask at a certain temperature. The reaction reaches equilibrium according to the balanced equation below:
- $$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(g)$$
- It is found that 1,825 g of hydrogen chloride is present at equilibrium.
- Calculate the equilibrium constant, K_c , for this reaction at this temperature. (9) [18]

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QUESTION 7 (Start on a new page.)

- 7.1 The balanced equation below represents the first step in the ionisation of sulphuric acid (H_2SO_4) in water:



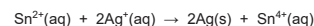
- 7.1.1 Write down the FORMULAE of the TWO bases in the equation above. (2)
- 7.1.2 Is sulphuric acid a STRONG or a WEAK acid? Give a reason for the answer. (2)
- 7.2 Learners use the reaction of a 0,15 mol·dm⁻³ sulphuric acid solution with a sodium hydroxide solution in two different experiments. The balanced equation for the reaction is:
- $$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$$
- 7.2.1 They use 24 cm³ of $H_2SO_4(aq)$ in a titration to neutralise 26 cm³ of $NaOH(aq)$.
- Calculate the concentration of the $NaOH(aq)$. (5)
- 7.2.2 In another experiment, 30 cm³ of the $H_2SO_4(aq)$ is added to 20 cm³ of a 0,28 mol·dm⁻³ $NaOH$ solution in a beaker.
- Calculate the pH of the final solution. (8) [17]

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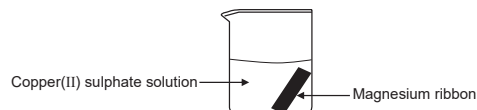
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QUESTION 8 (Start on a new page.)

- 8.1 A group of learners use the redox reaction below to construct an electrochemical cell.



- 8.1.1 Define a *reducing agent* in terms of *electron transfer*. (2)
- 8.1.2 Name a substance that should be used as electrode in the anode half-cell. (1)
- 8.1.3 Write down the NAME or FORMULA of the reducing agent. (1)
- 8.1.4 Write down the cell notation of the cell. (3)
- 8.1.5 Calculate the initial emf of this cell under standard conditions. (4)
- 8.2 In a separate experiment, the learners place magnesium ribbon in a beaker containing a blue solution of copper(II) sulphate. After a while the solution becomes colourless.



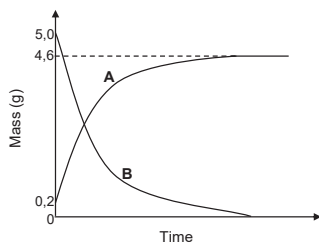
- 8.2.1 State ONE observable change in the beaker, besides a colour change of the solution, that the learners can make. (1)
- 8.2.2 Refer to the relative strengths of oxidising agents or reducing agents to explain why the solution becomes colourless. (3) [15]

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QUESTION 9 (Start on a new page.)

The graph below represents the changes in mass that occur at electrode **A** and electrode **B** in an electrolytic cell during the purification of copper.



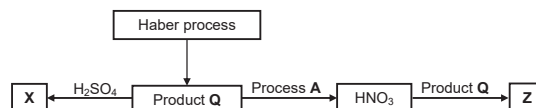
- 9.1 Define *electrolysis*. (2)
- 9.2 Which graph, **A** or **B**, represents the change in mass of the anode during electrolysis? (1)
- 9.3 Write down the equation of the half-reaction which takes place at the cathode of this cell. (2)
- 9.4 Use the information in the graph and calculate the percentage purity of the impure copper. (4)
- [9]

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QUESTION 10 (Start on a new page.)

- 10.1 The diagram below shows processes involved in the production of fertiliser **X** and fertiliser **Z**.



Write down the:

- 10.1.1 Balanced equation for the formation of product **Q** (3)
- 10.1.2 FORMULA of fertiliser **X** (1)
- 10.1.3 NAME of process **A** (1)
- 10.1.4 NAME of fertiliser **Z** (1)
- 10.2 A 10 kg bag of NPK fertiliser is labelled 6 : 1 : 5 (22).
- 10.2.1 What is the meaning of NPK? (1)
- 10.2.2 What is the meaning of (22) on the label? (1)
- 10.2.3 Calculate the mass of potassium in the bag. (4)
- [12]

TOTAL: 150

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SENIOR CERTIFICATE EXAMINATIONS**PHYSICAL SCIENCES: CHEMISTRY (P2)****2018****MARKS: 150****TIME: 3 hours**

This question paper consists of 16 pages and 4 data sheets.

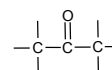
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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 An example of a saturated organic compound is ... (2)
- A ethyne.
- B propene.
- C but-2-ene.
- D 2-chloropropane.
- 1.2 When ethene reacts with hydrogen gas in the presence of a catalyst, the product is ... (2)
- A ethane.
- B ethyne.
- C ethanol.
- D ethanal.
- 1.3 Study the structural formula of the functional group below. (2)



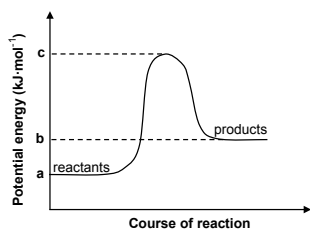
The structure above is the functional group of ...

- A esters.
- B ketones.
- C aldehydes.
- D carboxylic acids. (2)

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- 1.4 The potential energy graph for a hypothetical chemical reaction is shown below.

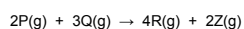


What type of reaction is taking place and what are the correct methods to calculate ΔH and E_a ?

	TYPE OF REACTION	ΔH	E_a
A	Exothermic	$b - a$	$c - b$
B	Endothermic	$b - a$	$c - a$
C	Endothermic	$a - b$	$a - c$
D	Exothermic	$a - b$	$b - c$

(2)

- 1.5 Study the hypothetical reaction below:



The rate of the reaction in terms of the number of moles of substance **P** used up, is $1 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$. What is the rate (in $\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$) at which product **R** is formed?

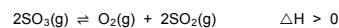
- A 1×10^{-3}
 B $4(1 \times 10^{-3})$
 C $\frac{1 \times 10^{-3}}{2}$
 D $2(1 \times 10^{-3})$

(2)

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- 1.6 Study the following reaction at equilibrium at a certain temperature.



Which ONE of the following factors will change the K_c value?

- A Adding more $\text{SO}_2(g)$.
 B Adding a catalyst.
 C Increasing the temperature.
 D Increasing the pressure by decreasing the volume.

(2)

- 1.7 Which ONE of the following represents the products formed during the hydrolysis of $\text{NH}_4^+(aq)$?

- A $\text{NH}_3(aq) + \text{H}_2\text{O}(l)$
 B $\text{NH}_3(aq) + \text{H}_3\text{O}^+(aq)$
 C $\text{NH}_3(aq) + \text{OH}^-(aq)$
 D $\text{NH}_3(aq) + \text{OH}^-(aq) + \text{H}_2\text{O}(l)$

(2)

- 1.8 Potassium nitrate is used as an electrolyte in the salt bridge of a copper-zinc cell.

Which ONE of the following CORRECTLY shows the direction of migration of potassium and nitrate ions in the cell?

	POTASSIUM IONS TO THE:	NITRATE IONS TO THE:
A	Anode	Cathode
B	Negative electrode	Positive electrode
C	Zinc electrode	Copper electrode
D	Copper electrode	Zinc electrode

(2)

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- 1.9 Which ONE of the following shows the electrode where the electrons are gained in an **electrolytic cell** and the chemical change that occurs at this electrode?

	ELECTRODE WHERE ELECTRONS ARE GAINED	CHEMICAL CHANGE
A	Anode	Oxidation
B	Anode	Reduction
C	Cathode	Oxidation
D	Cathode	Reduction

(2)

- 1.10 The industrial preparation of nitric acid is known as the ...

- A Haber process.
 B contact process.
 C Ostwald process.
 D catalytic oxidation of ammonia.

(2)
[20]

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QUESTION 2 (Start on a new page.)

Next to each letter, **A** to **F**, in the table below is the molecular formula of an organic compound.

A	$\text{C}_2\text{H}_5\text{Br}$	B	C_2H_4
C	C_4H_{10}	D	$\text{C}_2\text{H}_6\text{O}$
E	$\text{C}_3\text{H}_6\text{O}$	F	$\text{C}_3\text{H}_6\text{O}_2$

- 2.1 Choose a molecular formula above that represents an organic compound below. Write down only the letter (**A** to **F**) next to the question numbers (2.1.1 to 2.1.5), e.g. 2.1.6 G.

- 2.1.1 A haloalkane (1)
 2.1.2 An alcohol (1)
 2.1.3 An unsaturated hydrocarbon (1)
 2.1.4 An aldehyde (1)
 2.1.5 A product of thermal cracking of compound **C** (1)

- 2.2 If compound **F** is a carboxylic acid, write down the following:

- 2.2.1 The structural formula of a FUNCTIONAL isomer of **F** (2)
 2.2.2 The IUPAC name of a FUNCTIONAL isomer of **F** (2)

- 2.3 Compound **B** is a monomer used to make a polymer.

Write down the:

- 2.3.1 Definition of a *polymer* (2)
 2.3.2 IUPAC name of the polymer (1)
 2.3.3 Balanced equation for the polymerisation reaction (3)

- 2.4 Compound **A** is used as a reactant in the production of compound **D**. Name the type of reaction that takes place. (1)

- 2.5 State TWO changes that can be made to the reaction conditions in QUESTION 2.4 to obtain compound **B**, instead of **D**, as product. (2)

[18]

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QUESTION 3 (Start on a new page.)

The boiling points of straight-chain alkanes and straight-chain alcohols are compared in the table below.

NUMBER OF CARBON ATOMS	BOILING POINTS OF ALKANES (°C)	BOILING POINTS OF ALCOHOLS (°C)
1	-162	64
2	-89	78
3	-42	98
4	-0,5	118

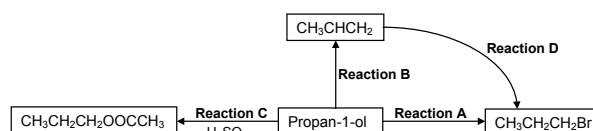
- 3.1 Explain the increase in boiling points of the alkanes, as indicated in the table. (3)
- 3.2 Explain the difference between the boiling points of an alkane and an alcohol, each having THREE carbon atoms per molecule, by referring to the TYPE of intermolecular forces. (4)
- 3.3 Does the vapour pressure of the alcohols INCREASE or DECREASE with an increase in the number of carbon atoms? (1)
- 3.4 How will the boiling point of 2-methylpropane compare to that of its chain isomer? (2)
- Write down HIGHER THAN, LOWER THAN or EQUAL TO. Give a reason for the answer by referring to the structural differences between the two compounds. [10]

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QUESTION 4 (Start on a new page.)

Propan-1-ol can undergo a number of organic reactions, as indicated by the letters A to D in the diagram below.



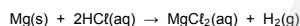
- 4.1 Write down the type of reaction represented by:
- 4.1.1 A (1)
- 4.1.2 B (1)
- 4.1.3 C (1)
- 4.1.4 D (1)
- 4.2 For reaction C, write down the:
- 4.2.1 Function of H₂SO₄ (1)
- 4.2.2 IUPAC name of the organic product (2)
- 4.2.3 Structural formula of the other organic reactant (2)
- 4.3 Use STRUCTURAL FORMULAE for all organic reactants and products to write a balanced equation for reaction A. (5)
- [14]

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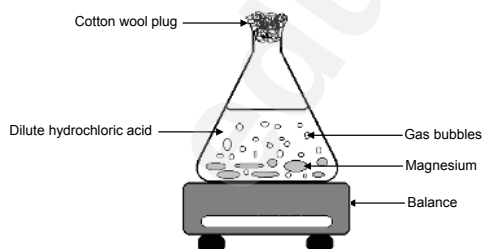
QUESTION 5 (Start on a new page.)

Two experiments are carried out to investigate one of the factors that affects the reaction rate between magnesium and dilute hydrochloric acid. The balanced equation below represents the reaction that takes place.



In **experiment 1** a certain mass of magnesium *ribbon* reacts with excess dilute hydrochloric acid. In **experiment 2** magnesium *powder* of the same mass as the magnesium ribbon, reacts with the same volume of excess dilute hydrochloric acid. The concentration of the acid is the same in both experiments.

The apparatus below is used for the investigation.

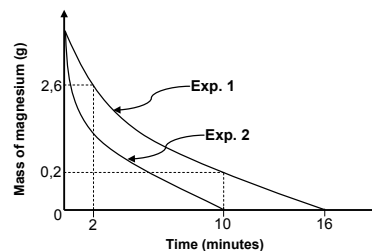


- 5.1 Define *reaction rate*. (2)
- 5.2 For this investigation, write down the:
- 5.2.1 Independent variable (1)
- 5.2.2 Control variable (1)

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The change in mass of magnesium is calculated and recorded in 2-minute intervals for both experiments. The results obtained are shown in the graph below (NOT drawn to scale).



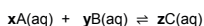
- 5.3 Use the information on the graph to:
- 5.3.1 Calculate the volume of hydrogen gas produced in **experiment 1** from t = 2 minutes to t = 10 minutes. (5)
- Take the molar gas volume as 25 dm³·mol⁻¹.
- 5.3.2 Calculate the initial mass of magnesium used if the average rate of formation of hydrogen gas in **experiment 2** was 2,08 x 10⁻³ mol·s⁻¹. (5)
- 5.4 Use the collision theory to explain why the curve of **experiment 2** is steeper than that of **experiment 1**. (3)
- [17]

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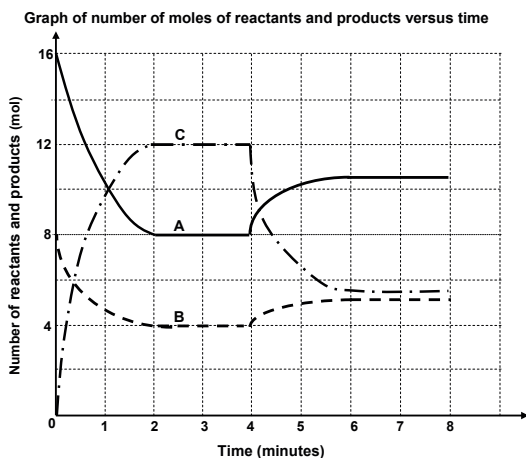
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QUESTION 6 (Start on a new page.)

The equation below represents a hypothetical reaction that reaches equilibrium in a closed container after 2 minutes at room temperature. The letters **x**, **y** and **z** represent the number of moles in the balanced equation.



The graph below shows the change in the number of moles of reactants and products versus time during the reaction.



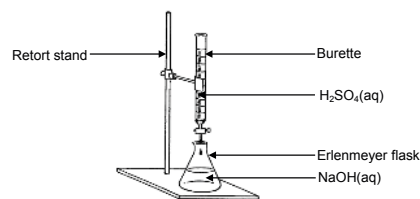
- 6.1 Define a *dynamic equilibrium*. (2)
- 6.2 Use the information in the graph and write down the value of: (1)
- 6.2.1 **x** (1)
- 6.2.2 **y** (1)
- 6.2.3 **z** (1)
- 6.3 Calculate the equilibrium constant, K_c , for this hypothetical reaction at room temperature if the volume of the closed container is 3 dm^3 . (7)
- 6.4 At $t = 4$ minutes, the temperature of the system was increased to 60°C . Is the REVERSE reaction EXOTHERMIC or ENDOTHERMIC? Explain how you arrived at the answer. (3)
- [15]**

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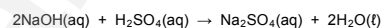
QUESTION 7 (Start on a new page.)

The reaction between a sulphuric acid (H_2SO_4) solution and a sodium hydroxide (NaOH) solution is investigated using the apparatus illustrated below.



- 7.1 Write down the name of the experimental procedure illustrated above. (1)
- 7.2 What is the function of the burette? (1)
- 7.3 Define an *acid* in terms of the Arrhenius theory. (2)
- 7.4 Give a reason why sulphuric acid is regarded as a strong acid. (1)
- 7.5 Bromothymol blue is used as indicator. Write down the colour change that will take place in the Erlenmeyer flask on reaching the endpoint of the titration. Choose from the following: (1)
- BLUE TO YELLOW YELLOW TO BLUE GREEN TO YELLOW

During the titration a learner adds 25 cm^3 of $\text{NaOH}(\text{aq})$ of concentration $0,1 \text{ mol} \cdot \text{dm}^{-3}$ to an Erlenmeyer flask and titrates this solution with $\text{H}_2\text{SO}_4(\text{aq})$ of concentration $0,1 \text{ mol} \cdot \text{dm}^{-3}$. The balanced equation for the reaction that takes place is:



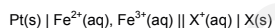
- 7.6 Determine the volume of $\text{H}_2\text{SO}_4(\text{aq})$ which must be added to neutralise the $\text{NaOH}(\text{aq})$ in the Erlenmeyer flask completely. (4)
- 7.7 If the learner passes the endpoint by adding 5 cm^3 of the same $\text{H}_2\text{SO}_4(\text{aq})$ in excess, calculate the pH of the solution in the flask. (7)
- [17]**

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QUESTION 8 (Start on a new page.)

- 8.1 Consider the electrochemical cell represented by the cell notation below, where **X** is an unknown metal:



The cell potential of this cell was found to be $0,03 \text{ V}$.

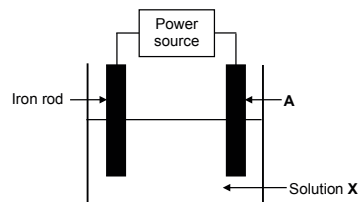
- 8.1.1 Write down the type of electrochemical cell illustrated above. (1)
- 8.1.2 What does the single line (|) in the above cell notation represent? (1)
- 8.1.3 Write down the half-reaction that takes place at the anode in the above cell. (2)
- 8.1.4 Identify **X** with the aid of a calculation. (5)
- 8.2 A $\text{Pt}(\text{s}) | \text{Fe}^{2+}(\text{aq}), \text{Fe}^{3+}(\text{aq})$ half-cell is connected to a $\text{Cu}(\text{s}) | \text{Cu}^{2+}(\text{aq})$ half-cell. Write down the: (1)
- 8.2.1 Chemical symbol for the electrode in the cathode half-cell (1)
- 8.2.2 NAME of the oxidising agent (1)
- 8.2.3 Overall balanced cell reaction that takes place in this cell (3)
- [14]**

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QUESTION 9 (Start on a new page.)

The diagram below shows an electrolytic cell used to electroplate an iron rod with COPPER. Solution **X** is made up of an unknown NITRATE.



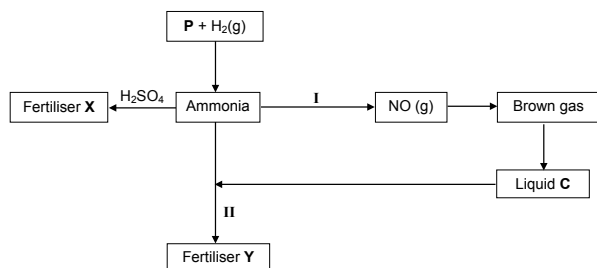
- 9.1 Solutions, such as solution **X**, are always used in electrochemical cells. (1)
- 9.1.1 Write down the general term used to describe these solutions. (1)
- 9.1.2 What is the function of these solutions in electrochemical cells? (1)
- 9.2 Write down the FORMULA of solution **X**. (1)
- 9.3 Which electrode (**A** or **IRON ROD**) is the negative electrode? Give a reason for the answer. (2)
- 9.4 Write down the half-reaction that takes place at electrode **A**. (2)
- 9.5 Electrode **A** is now replaced by a silver rod without making any other changes to the cell. After a while, TWO metallic ions are found to be present in the solution. (2)
- 9.5.1 Name the TWO metallic ions present in the solution. (2)
- 9.5.2 Refer to the relative strengths of oxidising agents to explain which ONE of the two ions will preferably be involved in the plating process. (2)
- [11]**

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QUESTION 10 (Start on a new page.)

The flow diagram below shows the steps used to prepare fertilisers X and Y. Labels I and II represent types of chemical reactions and P is a compound.



- 10.1 Write down the NAME of the reaction labelled:
- 10.1.1 I (1)
- 10.1.2 II (1)
- 10.2 Write down the NAME or FORMULA of:
- 10.2.1 Compound P (1)
- 10.2.2 The brown gas (1)
- 10.2.3 Liquid C (1)
- 10.3 Write down a balanced equation for:
- 10.3.1 The preparation of fertiliser X (3)
- 10.3.2 Reaction I (3)
- 10.4 Fertiliser Y is ammonium nitrate. Calculate the mass percentage of nitrogen in fertiliser Y. (3)
- [14]**
- TOTAL: 150**

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**basic education**Department:
Basic Education
REPUBLIC OF SOUTH AFRICA**NATIONAL
SENIOR CERTIFICATE****GRADE 12****PHYSICAL SCIENCES: CHEMISTRY (P2)****NOVEMBER 2018****MARKS: 150****TIME: 3 hours**

This question paper consists of 15 pages and 4 data sheets.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

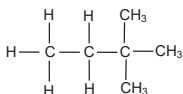
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

- 1.1 Which ONE of the following is the structural formula of the functional group of the KETONES?

A		B	
C		D	

- 1.2 Which ONE of the formulae below represents an ALKANE?
- A C₂H₄
- B C₅H₁₀
- C C₁₄H₃₀
- D C₈H₁₄ (2)

- 1.3 Consider the organic compound below.



The IUPAC name of this compound is ...

- A 2,3-dimethyl butane.
- B 3,3-dimethyl butane.
- C 2,2-dimethyl butane.
- D 1,1,1-trimethyl propane. (2)

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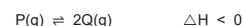
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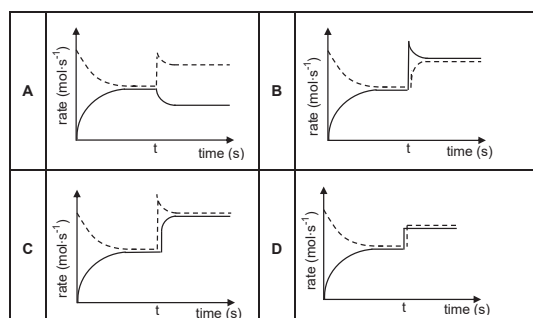
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- 1.4 Activation energy can best be described as the minimum energy required to ...
- A cause effective collisions.
- B make reactant molecules collide.
- C change the orientation of reactant molecules.
- D increase the kinetic energy of reactant molecules. (2)
- 1.5 Which statement is CORRECT for a system in DYNAMIC EQUILIBRIUM?
- A All reactants are used up.
- B The forward reaction is equal to the reverse reaction.
- C All substances in the reaction are of equal concentration.
- D The concentration of the reactants and products remain constant. (2)
- 1.6 Initially, a certain amount of P(g) was placed in an empty container. The hypothetical reaction reaches equilibrium in a closed container according to the following balanced equation:



At time t, the temperature is increased.

Which graph below best illustrates the resulting changes in the rates of the forward and reverse reactions after the temperature is increased?



(2)

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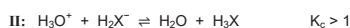
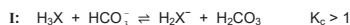
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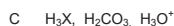
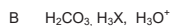
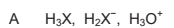
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- 1.7 Reactions **I** and **II** below have equilibrium constants (K_c) greater than 1.



Based on the reactions above, the ACIDS in order of INCREASING STRENGTH (weakest to strongest) are ...

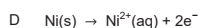
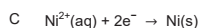
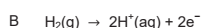
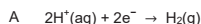


(2)

- 1.8 Consider the cell notation for a galvanic cell below.



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



(2)

- 1.9 Which ONE of the following is applicable to an ELECTROLYTIC CELL?

A Reduction takes place at the anode.

B Oxidation takes place at the cathode.

C It uses alternating current.

D A battery is used for the cell to function.

(2)

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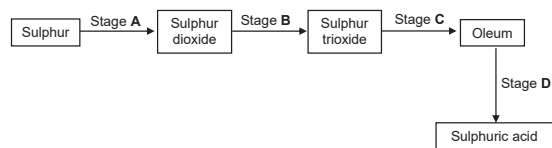
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- 1.10 The flow diagram below shows four stages (A, B, C and D) in the conversion of sulphur to sulphuric acid.



At which stage is a catalyst used?

A **A**

B **B**

C **C**

D **D**

(2)
[20]

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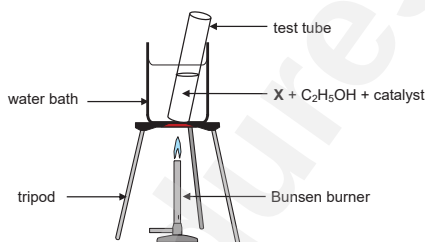
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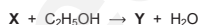
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QUESTION 2 (Start on a new page.)

A test tube containing a straight chain organic acid **X**, ethanol and a catalyst is heated in a water bath, as illustrated below.



Organic compound **Y** is produced according to the following equation:



- 2.1 Give a reason why the test tube is heated in a water bath instead of directly over the flame. (1)
- 2.2 Write down the: (1)
- 2.2.1 Type of reaction that takes place here (1)
- 2.2.2 FORMULA of the catalyst needed (1)
- 2.2.3 Homologous series to which compound **Y** belongs (1)

The molecular mass of compound **Y** is 144 g mol^{-1} and its empirical formula is $\text{C}_4\text{H}_8\text{O}$.

- 2.3 Determine the molecular formula of compound **Y**. (2)
- 2.4 Write down the IUPAC name of compound **Y**. (2)
- 2.5 Write down the structural formula of the organic acid **X**. (2)

[10]

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QUESTION 3 (Start on a new page.)

The boiling points of different organic compounds are given below.

	COMPOUND	BOILING POINT (°C)
A	HCOOH	101
B	CH_3COOH	118
C	$\text{CH}_3\text{CH}_2\text{COOH}$	141
D	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	164

- 3.1 Define *boiling point*. (2)
- 3.2 Write down the: (1)
- 3.2.1 Name of the FUNCTIONAL GROUP of these compounds (1)
- 3.2.2 IUPAC name of compound **C** (1)
- 3.2.3 Structural formula of the FUNCTIONAL isomer of compound **B** (2)
- 3.3 Which ONE of the compounds, **A** or **B** or **C**, has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)
- 3.4 The boiling point of compound **B** is now compared with of compound **X**.

	COMPOUND	BOILING POINT (°C)
B	CH_3COOH	118
X	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	98

- 3.4.1 Besides the conditions used to determine boiling points, give a reason why this is a fair comparison. (1)
- 3.4.2 Is compound **X** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)
- 3.4.3 Fully explain the difference between the boiling points by referring to the types of intermolecular forces present in each of these compounds. (4)

[15]

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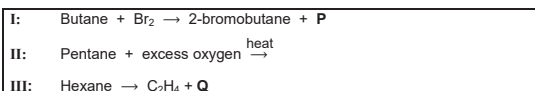
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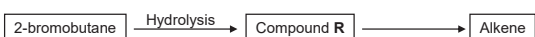
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QUESTION 4 (Start on a new page.)

- 4.1 Three reactions of organic compounds from the same homologous series are shown below.



- 4.1.1 Define a *homologous series*. (2)
- 4.1.2 Name the type of reaction represented by I. (1)
- 4.1.3 Write down the formula of the inorganic compound P. (1)
- 4.1.4 Give the structural formula of a POSITIONAL isomer of 2-bromobutane. (2)
- 4.1.5 Using molecular formulae, write down the balanced equation for reaction II. (3)
- Reaction III is an example of a cracking reaction.
- 4.1.6 Define a *cracking reaction*. (2)
- 4.1.7 Give the structural formula of organic compound Q. (2)
- 4.2 Study the flow diagram below.



- 4.2.1 Write down the IUPAC name of compound R. (2)
- 4.2.2 Compound R reacts in the presence of concentrated phosphoric acid to form an alkene. Write down the structural formula of the MAJOR PRODUCT in this reaction. (2)

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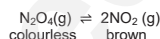
- 5.5 Experiment 6 is now conducted using a catalyst and the SAME reaction conditions as for Experiment 1.
- 5.5.1 What is the function of the catalyst in this experiment? (1)
- 5.5.2 How will the heat of reaction in experiment 6 compare to that in experiment 1? Choose from: GREATER THAN, EQUAL TO or LESS THAN. (1)
- 5.6 Calculate the average rate of the reaction (in mol·min⁻¹) with respect to zinc for experiment 2 if 1,5 g of zinc is used. (4)

QUESTION 6 (Start on a new page.)

Dinitrogen tetroxide, N₂O₄(g), decomposes to nitrogen dioxide, NO₂(g), in a sealed syringe of volume 2 dm³.



The mixture reaches equilibrium at 325 °C according to the following balanced equation:



When equilibrium is reached, it is observed that the colour of the gas in the syringe is brown.

- 6.1 State Le Chatelier's principle. (2)
- 6.2 The syringe is now dipped into a beaker of ice water. After a while the brown colour disappears. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer using Le Chatelier's principle. (3)
- 6.3 The volume of the syringe is now decreased while the temperature is kept constant. How will EACH of the following be affected? Choose from: INCREASES, DECREASES or REMAINS THE SAME. (8)
- 6.3.1 The number of moles of N₂O₄(g) (1)
- 6.3.2 The value of the equilibrium constant (1)
- 6.3.3 The rate of the forward and reverse reactions (1)
- 6.4 Initially X moles of N₂O₄(g) were placed in the syringe of volume 2 dm³. When equilibrium was reached, it was found that 20% of the N₂O₄(g) had decomposed. If the equilibrium constant, K_c, for the reaction is 0,16 at 325 °C, calculate the value of X. (5)

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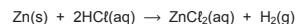
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QUESTION 5 (Start on a new page.)

The reaction of zinc and EXCESS dilute hydrochloric acid is used to investigate factors that affect reaction rate. The balanced equation for the reaction is:

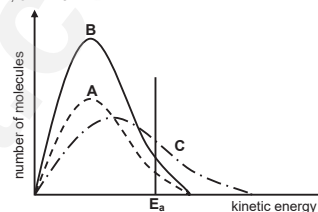


The reaction conditions used and the results obtained for each experiment are summarised in the table below.

The same mass of zinc is used in all the experiments. The zinc is completely covered in all reactions. The reaction time is the time it takes the reaction to be completed.

EXPERIMENT	CONCENTRATION OF HCl (mol·dm ⁻³)	VOLUME OF HCl (cm ³)	STATE OF DIVISION OF Zn	TEMPERATURE OF HCl (°C)	REACTION TIME (min.)
1	2,0	200	powder	25	7
2	1,5	200	granules	25	14
3	5,0	200	powder	25	5
4	1,5	400	granules	25	x
5	2,0	200	powder	35	4

- 5.1 Experiment 1 and experiment 5 are compared. Write down the independent variable. (1)
- 5.2 Define *reaction rate*. (2)
- 5.3 Write down the value of x in experiment 4. (2)
- 5.4 The Maxwell-Boltzmann energy distribution curves for particles in each of experiments 1, 3 and 5 are shown below.



Identify the graph (A or B or C) that represents the following:

- 5.4.1 Experiment 3 Give a reason for the answer. (2)
- 5.4.2 Experiment 5 Give a reason for the answer. (2)

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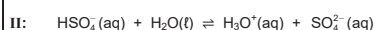
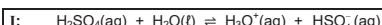
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QUESTION 7 (Start on a new page.)

- 7.1 Sulphuric acid is a strong acid present in acid rain. It ionises in two steps as follows:



- 7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)
- 7.1.2 Write down the FORMULA of the conjugate base of H₃O⁺(aq). (1)
- 7.1.3 Write down the FORMULA of the substance that acts as an ampholyte in the ionisation of sulphuric acid. (2)
- 7.2 Acid rain does not cause damage to lakes that have rocks containing limestone (CaCO₃). Hydrolysis of CaCO₃ results in the formation of ions, which neutralise the acid.
- 7.2.1 Define *hydrolysis* of a salt. (2)
- 7.2.2 Explain, with the aid of the relevant HYDROLYSIS reaction, how limestone can neutralise the acid. (3)
- 7.3 The water in a certain lake has a pH of 5.
- 7.3.1 Calculate the concentration of the hydronium ions in the water. (3)
- The volume of water in the lake is 4 x 10⁹ dm³. Lime, CaO, is added to the water to neutralise the acid according to the following reaction:
- $$\text{CaO} + 2\text{H}_3\text{O}^+ \rightleftharpoons \text{Ca}^{2+} + 3\text{H}_2\text{O}$$
- 7.3.2 If the final amount of hydronium ions is 1,26 x 10³ moles, calculate the mass of lime that was added to the lake. (7)

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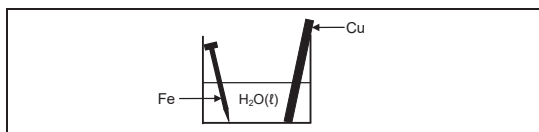
QUESTION 8 (Start on a new page.)

- 8.1 Corrosion is a redox reaction that takes place in the presence of oxygen and water. Rusting is the corrosion of iron leading to the formation of iron(III) ions.

8.1.1 Define *oxidation* in terms of electron transfer.

(2)

A cleaned copper rod and a cleaned iron nail are placed in a beaker containing water at 25°C, as shown below.



After a while it was observed that the iron nail was coated with rust. The copper rod showed no visible signs of corrosion.

8.1.2 Write down the half-reaction for the iron nail.

(2)

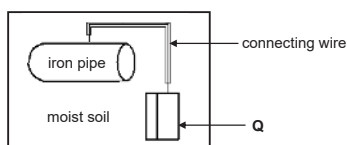
8.1.3 Does iron act as REDUCING AGENT or OXIDISING AGENT in the beaker?

(1)

8.1.4 Explain the above observation by referring to the Table of Standard Reduction Potentials.

(3)

To prevent rusting of an underground iron pipe, the pipe is connected to a metal (Q) that corrodes easily.



8.1.5 You are given two metals, Zn and Cu, to use as metal Q. Which metal would more suitable? Give a reason.

(2)

- 8.2 A galvanic cell is constructed using a Fe | Fe³⁺ half-cell and a Cu | Cu²⁺ half-cell.

8.2.1 Write down the overall (net) cell reaction that takes place when the cell is functioning.

(3)

8.2.2 Calculate the cell potential of this cell under standard conditions.

(4)

[17]

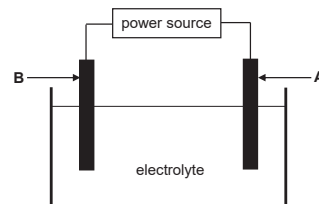
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QUESTION 9 (Start on a new page.)

The electrolytic cell below is set up to obtain pure copper from a piece of impure copper.



The impure copper contains other metals, such as platinum, iron, cobalt, silver and nickel.

The cell potential of the power source is adjusted so that only copper is deposited on electrode B.

9.1 Define an *electrolytic cell*.

(2)

9.2 Write down the FORMULA of a suitable electrolyte for this cell.

(1)

9.3 Which electrode (A or B) is the cathode?

Write down the relevant half-reaction taking place at this electrode.

(3)

9.4 Sludge forms below one of the electrodes while the cell above is in operation. Which of the metals, PLATINUM, IRON, COBALT, SILVER or NICKEL, will be present in the sludge?

(2)

[8]

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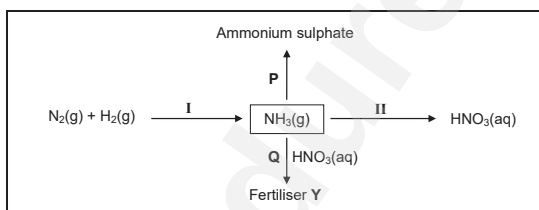


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QUESTION 10 (Start on a new page.)

In the flow diagram below, I and II represent industrial processes used in the fertiliser industry.

P and Q are chemical reactions that take place to produce ammonium sulphate and fertiliser Y respectively.



10.1 Write down the name of the industrial process:

10.1.1 I

(1)

10.1.2 II

(1)

10.2 Write down the NAME or FORMULA of:

10.2.1 Fertiliser Y

(1)

10.2.2 The catalyst used in process I

(1)

10.3 In reaction P, NH₃(g) reacts with another substance. Write down a balanced equation for this reaction.

(3)

10.4 The following substances are present in a bag of fertiliser:

- 20 kg ammonium nitrate (NH₄NO₃)
- 12 kg sodium phosphate (Na₃PO₄)
- 18 kg potassium chloride (KCl)

Calculate the NPK ratio of the fertiliser.

(5)

[12]

TOTAL: 150

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**NATIONAL
SENIOR CERTIFICATE/
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SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)**

NOVEMBER 2017

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

These marking guidelines consist of 11 pages.
Hierdie nasienriglyne bestaan uit 11 bladsye.

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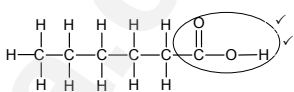
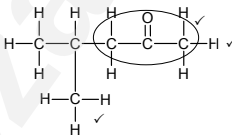
Physical Sciences P2/Fisiese Wetenskappe V2 2
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DBE/November 2017

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 (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)

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- 2.3 (1)
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-etiesel-2,6-dimetieselhept-3-yn/5-etiesel-2,6-dimetiesel-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 (1)
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. (1)

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)

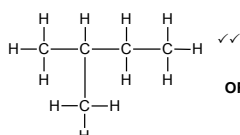
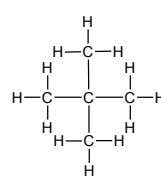
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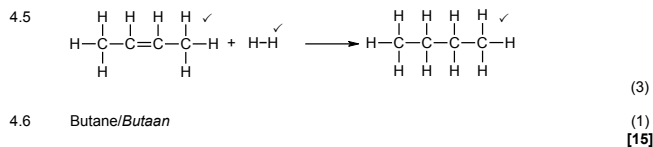
- 3.4 (3)
3.4.1  OR/OF 
2-methylbutane ✓
2-metieselbutaan
2,2-dimethylpropane ✓
2,2-dimetieselpropaan (3)
3.4.2 Higher than/Hoër as ✓ (1) [14]

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 (1)
4.2.1 Dehydration ✓
Dehidrasie/dehidratering (1)
4.2.2 Hydration ✓
Hidrasie/hidratering (1)
4.2.3 Dehydrohalogenation/dehydrobromination ✓
Dehidrohalogenasie/dehidrohalogenering/dehidrobrominasie/dehidrobrominerig (1)
4.3 (1)
4.3.1 Substitution/Hydrolysis ✓
Substitusie/Hidrolise (1)
4.3.2 Dilute base/sodium hydroxide/NaOH ✓
Verdunde basis/natriumhidroksied/NaOH
Moderate temperature/(mild) heat ✓
Matige temperatuur/(matige) hitte (2)
4.3.3 2-✓ bromobutane ✓ / 2-bromobutaan (2)
4.4 NaOH/KOH ✓ (1)

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QUESTION/VRAAG 5

- 5.1 **ANY ONE/ENIGE EEN:**
- Change in concentration of products/reactants per (unit) time. ✓✓
Verandering in konsentrasie van produkte/reaktante 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 reaktante 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 reaktante gebruik per (eenheid) tyd.

5.2

Marking criteria/Nasienriglyne:	
Dependent and independent variables correctly identified. <i>Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.</i>	✓
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?

- 5.3 Q ✓
- Smaller gradient./Less steep. ✓
Kleiner gradiënt./Minder steil.
 - Reaction 1 has the lowest HCl concentration and will take longer to reach completion/for the maximum volume of gas to be formed. ✓
Reaksie 1 het die laagste HCl-konsentrasie en neem langer om voltooi te word/die maksimum volume gas te vorm.

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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 reaktante en produkte konstant bly.

6.2

6.2.1

OPTION 1/OPSIE 1			
$n = \frac{m}{M}$			
$= \frac{1,12}{28}$			
$= 0,04 \text{ mol}$			
Initial quantity (mol)	COBr ₂	CO	Br ₂
Aanvangshoeveelheid (mol)		0	0
Change (mol)	0,04	0,04	0,04
Verandering (mol)			
Quantity at equilibrium (mol)		0,04	0,04 ✓
Hoeveelheid by ewewig (mol)			
Equilibrium concentration/ Ewewigskonsentrasie (mol·dm ⁻³)		0,02	0,02
$K_c = \frac{[\text{CO}][\text{Br}_2]}{[\text{COBr}_2]}$			
$0,19 = \frac{(0,02)^2}{[\text{COBr}_2]}$			
$[\text{COBr}_2] = 2,11 \times 10^{-3} \text{ mol·dm}^{-3}$			

Divide by 2 ✓
Deel deur 2

5.4

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
Ave rate/Gem. tempo = $\frac{\Delta V}{\Delta t}$	Ave rate/Gem. tempo = $\frac{15}{24\,000}$ ✓
$15 = \frac{\Delta V}{30 - 0}$ ✓	$V(\text{H}_2)_{\text{produced/berei}} = 6,25 \times 10^{-4} \text{ mol·s}^{-1}$ ✓
$V(\text{H}_2)_{\text{produced/berei}} = 450 \text{ cm}^3$	$n(\text{Zn}) = n(\text{H}_2) = 0,0188 \text{ mol}$ ✓
$n(\text{H}_2)_{\text{produced/berei}} = \frac{V}{V_m}$	$n(\text{Zn})_{\text{used}} = \frac{m}{M}$
$= \frac{450}{24\,000}$ ✓	$0,0188 = \frac{m}{65}$ ✓
$= 0,0188 \text{ mol}$	$\therefore m(\text{Zn}) = 1,22 \text{ g}$ ✓
$n(\text{Zn}) = n(\text{H}_2) = 0,0188 \text{ mol}$ ✓	
$n(\text{Zn})_{\text{used/gebruik}} = \frac{m}{M}$	
$\therefore 0,0188 = \frac{m}{65}$ ✓	
$\therefore m(\text{Zn}) = 1,22 \text{ g}$ ✓	
	OPTION 3/OPSIE 3
	Ave rate/Gem. tempo = $\frac{\Delta V}{\Delta t}$
	$15 = \frac{\Delta V}{30 - 0}$ ✓
	$V(\text{H}_2)_{\text{produced/berei}} = 450 \text{ cm}^3$
	$65 \text{ g} \checkmark \text{ Zn} \dots\dots\dots 24\,000 \text{ cm}^3 \checkmark$
	$x \text{ g Zn} \dots\dots\dots 450 \text{ cm}^3 \checkmark$
	$x = 1,22 \text{ g} \checkmark$

- 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.

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OPTION 2/OPSIE 2

$n = \frac{m}{M}$

$= \frac{1,2}{28}$ ✓

$= 0,04 \text{ mol}$

$n(\text{CO})_{\text{formed/ gevorm}} = n(\text{Br}_2)_{\text{formed/ gevorm}}$ ✓

$= 0,04 \text{ mol}$

$c(\text{CO})_{\text{eq/ ewe}} = c(\text{Br}_2)_{\text{eq/ ewe}}$

$= \frac{n}{V}$

$= \frac{0,04}{2}$

$= 0,02 \text{ mol·dm}^{-3}$

$K_c = \frac{[\text{CO}][\text{Br}_2]}{[\text{COBr}_2]}$ ✓

$0,19 = \frac{(0,02)^2}{[\text{COBr}_2]}$ ✓

$[\text{COBr}_2] = 2,11 \times 10^{-3} \text{ mol·dm}^{-3}$ ✓

6.2.2

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$n(\text{COBr}_2)_{\text{eq/ ewewig}} = cV$	$n(\text{COBr}_2)_{\text{eq/ ewewig}} = cV$
$= 2,11 \times 10^{-3} \times 2$ ✓	$= 2,11 \times 10^{-3} \times 2$ ✓
$= 4,22 \times 10^{-3} \text{ mol}$	$= 4,22 \times 10^{-3} \text{ mol}$
$n(\text{COBr}_2)_{\text{initial/ begin}}$ ✓	$n(\text{COBr}_2)_{\text{initial/ begin}}$ ✓
$= 0,04 + 4,22 \times 10^{-3}$ ✓	$= 0,04 + 4,22 \times 10^{-3}$ ✓
$= 0,044 \text{ mol}$	$= 0,044 \text{ mol}$
% decomposed = $\frac{0,04}{0,044} \times 100$	$m(\text{COBr}_2)_{\text{initial/ begin}} = nM$
$= 90,46\%$ ✓	$= 0,044 \times 188$
	$= 8,27 \text{ g}$
	$m(\text{COBr}_2)_{\text{reacted/ reageer}} = 0,04 \times 188$
	$= 7,52 \text{ g}$
Range/Gebied: 90,46 – 90,9%	% decomposed/ontbind = $\frac{7,52}{8,27} \times 100$
	$= 90,9\%$ ✓

- 6.3 $K_c < 0,19$ (1)
- 6.4 Decreases/Verminder ✓
A decreases in pressure favours the reaction that produces the larger number of moles of gas./'n Afname in druk bevoordeel die reaksie wat die groter aantal mol gas lewer. ✓
The forward reaction will be favoured./Die voorwaartse reaksie sal bevoordeel word. ✓

QUESTION/VRAAG 7

- 7.1 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 Acidic/Suur ✓
pH < 7 ✓ (2)
- 7.2.2
- | OPTION 1/OPSIE 1 | OPTION 2/OPSIE 2 |
|--|---|
| $\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark$
$6 \checkmark = -\log[\text{H}_3\text{O}^+] \checkmark$
$[\text{H}_3\text{O}^+] = 1 \times 10^{-6} \text{ mol}\cdot\text{dm}^{-3}$
$[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14} \checkmark$
$[\text{OH}^-] = 1 \times 10^{-8} \text{ mol}\cdot\text{dm}^{-3} \checkmark$ | $\text{pH} + \text{pOH} = 14 \checkmark$
$6 \checkmark + \text{pOH} = 14$
$\text{pOH} = -\log[\text{OH}^-] \checkmark$
$8 = -\log[\text{OH}^-] \checkmark$
$[\text{OH}^-] = 1 \times 10^{-8} \text{ mol}\cdot\text{dm}^{-3} \checkmark$ |
- (4)
- 7.3
- | OPTION 1/OPSIE 1 | OPTION 2/OPSIE 2 |
|--|--|
| $n(\text{Na}_2\text{CO}_3) = \frac{m}{M} \checkmark$
$= \frac{0,29}{106} \checkmark$
$= 2,74 \times 10^{-3} \text{ mol}$
$n(\text{HCl}) = 2n(\text{Na}_2\text{CO}_3) \checkmark$
$= 5,47 \times 10^{-3} \text{ mol}$
$c(\text{HCl})_{\text{dilute/verduin}} = \frac{n}{V} \checkmark$
$= \frac{5,47 \times 10^{-3}}{0,05} \checkmark$
$= 0,1094 \text{ mol}\cdot\text{dm}^{-3}$
$cV(\text{HCl})_{\text{dilute/verduin}} = cV(\text{HCl})_{\text{conc/gekons}} \checkmark$
$0,1094 \times 500 \checkmark = (\text{HCl})_{\text{conc/gekons}} \times 5 \checkmark$
$\therefore c(\text{HCl})_{\text{conc/gekons}} = 10,94 \text{ mol}\cdot\text{dm}^{-3} \checkmark$ | $n(\text{Na}_2\text{CO}_3) = \frac{m}{M} \checkmark$
$= \frac{0,29}{106} \checkmark$
$= 2,74 \times 10^{-3} \text{ mol}$
$n(\text{HCl}) = 2n(\text{Na}_2\text{CO}_3) \checkmark$
$= 5,47 \times 10^{-3} \text{ mol}$
$\text{In } 50 \text{ cm}^3: \downarrow$
$n(\text{HCl}) = 5,47 \times 10^{-3} \text{ mol}$
$\text{In } 500 \text{ cm}^3: \downarrow$
$n(\text{HCl}) = \frac{500}{50} (5,47 \times 10^{-3}) \checkmark$
$= 0,547 \text{ mol}$
$c(\text{HCl})_{\text{conc/gekons}} = 0,547 \times \frac{1000}{5} \checkmark$
$= 10,94 \text{ mol}\cdot\text{dm}^{-3} \checkmark$ |
- (7)
[17]

QUESTION/VRAAG 8

8. Voltmeter/Multimeter ✓ (1)
- 8.1.2 Anode ✓ (1)
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- 8.1.3 $3\text{Ag}^+(\text{aq}) + \text{Al}(\text{s}) \checkmark \rightarrow 3\text{Ag}(\text{s}) + \text{Al}^{3+}(\text{aq}) \checkmark$ Bal. ✓ (3)
- 8.1.4
- | OPTION 1/OPSIE 1 |
|--|
| $E_{\text{cell}}^0 = E_{\text{reduction}}^0 - E_{\text{oxidation}}^0 \checkmark$
$= +0,80 \checkmark - (-1,66) \checkmark$
$= 2,46 \text{ V} \checkmark$ |
- | OPTION 2/OPSIE 2 |
|--|
| $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s}) \quad 0,80 \text{ V} \checkmark$
$\text{Al}(\text{s}) \rightarrow \text{Al}^{3+}(\text{aq}) + 3\text{e}^- \quad 1,66 \text{ V} \checkmark$
$3\text{Ag}^+(\text{aq}) + \text{Al}(\text{s}) \rightarrow 3\text{Ag}(\text{s}) + \text{Al}^{3+}(\text{aq}) \quad 2,46 \text{ V} \checkmark$ |
- (4)

- 8.2 Platinum/Pt/Carbon/C/Koolstof ✓ (1)
- 8.2.1 Platinum/Pt/Carbon/C/Koolstof ✓ (1)
- 8.2.2 ANY TWO/ENIGE TWEE:
Concentration/Konsentrasie: $1 \text{ mol}\cdot\text{dm}^{-3} \checkmark$
Temperature/Temperatuur: $25^\circ\text{C}/298 \text{ K} \checkmark$
Pressure/Druk: $101,3 \text{ kPa}/1,01 \times 10^5 \text{ Pa}/1 \text{ atm}$ (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 ✓
 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu} \checkmark$
- 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 Ammonia/Ammoniak ✓ (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 $\text{NH}_3 + \text{HNO}_3 \checkmark \rightarrow \text{NH}_4\text{NO}_3 \checkmark$ Bal. ✓ (3)
- 10.2
- 10.2.1
- | OPTION 1/OPSIE 1 | OPTION 2/OPSIE 2 |
|--|---|
| $\text{N} : \text{P} : \text{K}$
$10 : 5 : 15$
$m(\text{fertiliser/kunsmis}) = \frac{30}{100} \times 15$
$= 4,5 \text{ kg}$
$m(\text{P}) = \frac{5}{30} \times 4,5 \checkmark$
$= 0,75 \text{ kg} \checkmark$ | $m(\text{fertiliser/kunsmis}) = \frac{5}{100} \times 15 \checkmark$
$= 0,75 \text{ kg} \checkmark$ |
- (2)
- 10.2.2 %fertiliser/kunsmis = $10 + 5 + 15 = 30\%$
%filler/bindstof = $100 - 30 = 70\%$
 $m(\text{filler/bindstof}) = \frac{70}{100} \times 15 \checkmark$
 $= 10,5 \text{ kg} \checkmark$ (3)
- [14]
- TOTAL/TOTAAL: 150



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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT

GRADE/GRAAD 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

FEBRUARY/MARCH/FEBRUARIE/MAART 2018

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

These marking guidelines consist of 15 pages.
Hierdie nasienriglyne bestaan uit 15 bladsye.

QUESTION 1/VRAAG 1

- 1.1 C ✓✓ (2)
1.2 D ✓✓ (2)
1.3 B ✓✓ (2)
1.4 C ✓✓ (2)
1.5 B ✓✓ (2)
1.6 B ✓✓ (2)
1.7 B ✓✓ (2)
1.8 C ✓✓ (2)
1.9 A ✓✓ (2)
1.10 D ✓✓ (2)

QUESTION 2/VRAAG 2

- 2.1 (1)
2.1.1 A ✓ (1)
2.1.2 B ✓ (1)
2.1.3 D ✓ (1)
2.1.4 D ✓ (1)
2.2 (1)
2.2.1 Butanal/Butanaal ✓ (1)
2.2.2 5-ethyl-6,6-dimethyloctan-3-ol/5-etiel-6,6-dimetieltoktan-3-ol (1)

OR/OF

5-ethyl-6,6-dimethyl-3-octanol/5-etiel-6,6-dimetielt-3-oktanol

Marking criteria/Nasienriglyne:

- Stem, i.e. octan./Stam d.i. oktan. ✓
- Correct functional group, i.e. -ol./Korrekte funksionele groep d.i. -ol. ✓
- Two methyl groups and one ethyl group. ✓
- Twee metielgroepe en een etielgroep. ✓
- Correct numbering of substituents and functional group ✓
- Korrekte nommering van substituenten en funksionele groep.

IF/INDIEN:

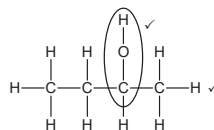
Any error e.g. hyphens omitted and/or incorrect sequence:

Enige fout bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./Maks. 3/4 (4)

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- 2.3 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups on parent chain. ✓
Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituenten/funksionele groepe op die stamketting. (2)

2.4
2.4.1

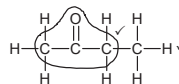
Marking criteria/Nasienriglyne:

- Whole structure correct: 2/2
- Hele struktuur korrek: 2/2
- Only functional group correct/Slegs funksionele groep korrek: Max/Maks.: 1/2

IF/INDIEN:

More than one functional group: 0/2
Meer as een funksionele groep: 0/2 (2)

2.4.2



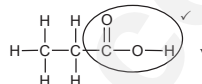
Marking criteria/Nasienriglyne:

- Whole structure correct: 2/2
- Hele struktuur korrek: 2/2
- Only functional group correct/Slegs funksionele groep korrek: Max/Maks.: 1/2

IF/INDIEN:

More than one functional group: 0/2
Meer as een funksionele groep: 0/2 (2)

2.4.3



Marking criteria/Nasienriglyne:

- Whole structure correct: 2/2
- Hele struktuur korrek: 2/2
- Only functional group correct/Slegs funksionele groep korrek: Max/Maks.: 1/2

IF/INDIEN:

More than one functional group: 0/2
Meer as een funksionele groep: 0/2 (2)

[17]

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QUESTION 3/VRAAG 3

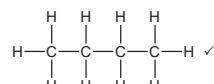
- 3.1 150 kPa ✓ (1)
3.2 (2)
3.2.1 The temperature at which the vapour pressure equals atmospheric/external pressure. ✓✓ (2 or 0)
Die temperatuur waar die dampdruk gelyk is aan atmosferiese/eksterne druk. (2)
3.2.2 55 °C ✓ (1)
3.3 (1)
3.3.1 Z ✓ (1)
3.3.2 • Carboxylic acids have, in addition to London forces and dipole-dipole forces, two sites for hydrogen bonding between molecules. ✓
Karboksielsure het, in toevoeging tot Londonkragte en dipool-dipoolkragte, twee punte vir waterstofbinding tussen molekule.
OR/OF
Carboxylic acids can form dimers due to strong hydrogen bonding between molecules.
Karboksielsure kan dimere vorm as gevolg van sterk waterstofbindings tussen molekule.
• Alcohols have, in addition to London forces and dipole-dipole forces, one site for hydrogen bonding between molecules. ✓
Alkohole het, in toevoeging tot Londonkragte en dipool-dipoolkragte, een punt vir waterstofbinding tussen molekule.
• Ketones has, in addition to London forces, dipole-dipole forces between molecules. ✓
Ketone het, in toevoeging tot Londonkragte, dipool-dipoolkragte tussen molekule.
• Intermolecular forces in carboxylic acids is the strongest./Most energy needed to overcome/break intermolecular forces in ethanoic acid. ✓
Intermolekulêre kragte in karboksielsure is die sterkste./Die meeste energie word benodig om intermolekulêre kragte in karboksielsure te oorkom/breek. (4)
3.3.3 Propanone/Propanoon ✓
OR/OF
Propan-2-one/Propan-2-oon
OR/OF
2-propanone/2-propanoon (1)
[10]

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QUESTION 4/VRAAG 4

- 4.1 The chemical process in which longer chain hydrocarbon molecules are broken down ✓ to shorter more useful molecules. ✓
Die chemiese proses waarin langer ketting koolwaterstofmolekule afgebreek word in korter meer bruikbare molekule. (2)
4.2 (1)
4.2.1 III ✓ (1)
4.2.2 II ✓ (1)
4.2.3 I ✓ (1)
4.3 (1)
4.3.1 Heat/Light /UV light ✓
Hitte/Lig/UV Lig (1)
4.3.2 P or/of S ✓ (1)
4.3.3 Ethene/Eteen ✓ (1)
4.3.4 C₈H₁₈ ✓✓ (Correct Structural formula/Korrekte struktuurformule : 1/2) (2)
4.3.5

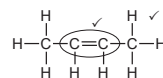


Marking criteria/Nasienriglyne:

- Whole structure correct: 2/2
- Hele struktuur korrek: 2/2
- 4 C atoms in chain:/4 C-atome in ketting: Max/Maks.: 1/2
- Correct condensed formula/Korrekte gekondenseerde formule: 1/2

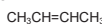
(2)

4.3.6



Marking criteria/Nasienriglyne:

- Whole structure of alkene/haloalkane correct: 2/2
- Hele struktuur van alkeen/haloalkaan korrek: 2/2
- Only functional group correct/Slegs funksionele groep korrek: 1/2
- Correct condensed structure/Korrekte gekondenseerde struktuur: 1/2



(2)

[14]

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QUESTION 5/VRAAG 5

5.1 ONLY ANY ONE OF/ SLEGS ENIGE EEN VAN:

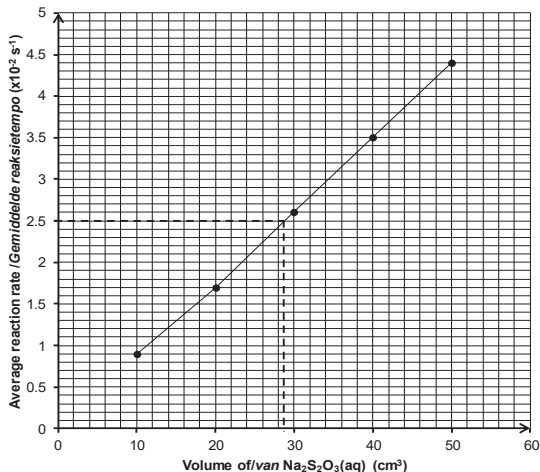
- Change in concentration ✓ of a reactant/product per unit time. ✓
Verandering in konsentrasie van reaktant/produkte per eenheidtyd.
- Rate of change in concentration. ✓ ✓
Tempo van verandering in konsentrasie.
- Change in amount/number of moles/volume/mass of products/reactants per (unit) time./Verandering in hoeveelheid/getal mol/volume/massa van produkte/reaktante 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 reaktante gebruik per (eenheid)tyd.

(2)

5.2 More than/Groter as ✓

Accept/Aanvaar
Equal to/Gelyk aan

(1)

5.3 Graph of average reaction rate versus volume of Na₂S₂O₃(aq)
Grafiek van gemiddelde reaksietempo teenoor volume Na₂S₂O₃(aq)

Marking criteria/Nasienriglyne:

- Any 3 points correctly plotted./Enige 3 punte korrek gestip. ✓
- All (5) points correctly plotted./Alle (5) punte korrek gestip. ✓
- Straight line drawn./Reguitlyn getrek. ✓

(3)

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QUESTION 6/VRAAG 6

6.1

6.1.1 When the equilibrium in a closed system is disturbed, the system will re-establish a new equilibrium by favouring the reaction that will oppose the disturbance. ✓ ✓

Wanneer die ewewig in 'n geslote sisteem versteur word, stel die sisteem 'n nuwe ewewig in deur die reaksie wat die versteuring teenwerk, te bevoordeel.

(2)

6.1.2 Percentage yield increases with an increase in temperature. ✓

- Persentasie opbrengs verhoog met toename in temperatuur.
- Forward reaction is favoured. ✓
- Voorwaartse reaksie word bevoordeel.
- Increase in temperature favours an endothermic reaction. ✓
- Toename in temperatuur bevoordeel die endotermiese reaksie.

(3)

6.1.3 When the pressure increases, the reaction that leads to a decrease in the number of moles will be favoured. ✓ ✓

Wanneer die druk verhoog, word die reaksie wat tot 'n afname in die aantal mol lei, bevoordeel.

Accept/Aanvaar

When the pressure increases, the yield increases ✓ because the equilibrium position shifts to the right. ✓

Wanneer die druk toeneem, neem die opbrengs toe omdat die ewewigsposisie na regs skuif.

(2)

6.1.4 I ✓ ✓

(2)

6.2

Mark allocation/Puntetoekenning

- Substitution of/Vervanging van $36,5 \text{ g mol}^{-1}$ in $n = \frac{m}{M}$. ✓
- Change/Verandering $n(\text{HCl}) = \text{initial/aanvanklik} - \text{equilibrium/ewewig}$. ✓
- USING ratio/GEbruik verhouding: $4 : 1 : 2 : 2$ ✓
- Equilibrium: $n(\text{O}_2) + n(\text{H}_2\text{O}) + n(\text{Cl}_2) = \text{initial} \pm \text{change}$ ✓
- Ewig: $n(\text{O}_2) + n(\text{H}_2\text{O}) + n(\text{Cl}_2) = \text{aanvanklik} \pm \text{verandering}$
- Divide by volume/Gedeel deur volume ($0,2 \text{ dm}^3$) ✓
- Correct K_c expression (formulae in square brackets). ✓
- Korrekke K_c -uitdrukking (formules tussen vierkantthakies).
- Substitution of reactant concentrations/Vervanging van reaktantskonsentrasies. ✓
- Substitution of product concentrations/Vervanging van produk-konsentrasies. ✓
- Final answer/Finale antwoord: $13,966$ to/tot $18,72$ ✓
- Range/Gebied: $13,966$ to/tot $18,72$

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5.4

5.4.1

Marking criteria/Nasienriglyne:

- y axis/y-as: $2,5 \times 10^{-2} \text{ s}^{-1}$ ✓
- Dotted line drawn from the y-axis to the x-axis as shown. ✓
- Stippellyn getrek van y-as na x-as soos getoon.
- $V = 28$ to 30 cm^3 ✓

(3)

5.4.2

Criteria for conclusion/Riglyne vir gevolgtrekking:

- Dependent and independent variables correctly identified. ✓
- Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.
- Relationship between the independent and dependent variables correctly stated./Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.

Examples/Voorbeelde:

- Reaction rate of reaction increases with an increase in concentration/volume of sodium thiosulphate.
Reaksietempo neem toe met 'n toename in konsentrasie/volume van natriumtiosulfaat.
- Reaction rate decreases with a decrease in concentration/volume of sodium thiosulphate.
Reaksietempo neem af met 'n afname in konsentrasie/volume van natriumtiosulfaat.
- Reaction rate is (directly) proportional to concentration/volume of sodium thiosulphate.
Reaksietempo is (direk) eweredig aan konsentrasie/volume van natriumtiosulfaat.

(2)

5.5

- More ($\text{Na}_2\text{S}_2\text{O}_3$) particles per unit volume. ✓
- Meer $\text{Na}_2\text{S}_2\text{O}_3$ -deeltjies per eenheid volume.
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.
- Increase in reaction rate./Toename in reaksietempo. ✓

(3)

5.6

OPTION 1/OPSIE 1

$$n(\text{S})_{\text{produced/gevorm}} = \frac{m}{M}$$

$$= \frac{162}{32} = 0,0506 \text{ mol}$$

$$n(\text{Na}_2\text{S}_2\text{O}_3) = n(\text{S}) = 0,0506 \text{ mol} \checkmark$$

$$n(\text{Na}_2\text{S}_2\text{O}_3) = \frac{m}{M}$$

$$0,0506 = \frac{m}{158} \checkmark$$

$$\therefore m(\text{Na}_2\text{S}_2\text{O}_3) = 7,99 \text{ g} \checkmark$$

$$[\text{Range/Gebied: } 7,90 \text{ to } 8,06]$$

Marking criteria/Nasienriglyne:

- Substitute/Vervang 32 in $n = \frac{m}{M}$ ✓
- Use ratio/Gebruik verhouding: $\text{Na}_2\text{S}_2\text{O}_3 : \text{S} = 1 : 1$ ✓
- Substitute/Vervang 158 in $n = \frac{m}{M}$ ✓
- Final answer/Finale antwoord: $7,90$ to/tot $8,06 \text{ g}$ ✓

OPTION 2/OPSIE 2

$$158 \text{ g} \checkmark \text{Na}_2\text{S}_2\text{O}_3 \rightarrow 32 \text{ g} \checkmark \text{S}$$

$$\therefore x \rightarrow 1,62 \text{ g} \checkmark \text{S}$$

$$x = \frac{158 \times 1,62}{32} = 7,99 \text{ g} \checkmark$$

$$[\text{Range/Gebied: } 7,90 \text{ to } 8,06]$$

(4)

[18]

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OPTION 1/OPSIE 1

	HCl	O ₂	Cl ₂	H ₂ O	
Initial quantity/Aanvange-hoeveelheid (mol)	0,2	0,11	0	0	
Change/Verandering (mol)	0,15 ✓	0,0375	0,075	0,075	ratio ✓ verhouding
Quantity at equilibrium/Hoeveelheid by ewewig (mol)	$\frac{1825}{36,5} = 0,05 \checkmark$	0,0725	0,075	0,075	✓
Equilibrium concentration/Ewigskonsentrasie (mol dm^{-3})	0,25	0,3625	0,375	0,375	Divide by 0,2 ✓ Deel deur 0,2

$$K_c = \frac{[\text{Cl}_2]^2 [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 [\text{O}_2]} = \frac{(0,375)^2 (0,375)^2}{(0,25)^4 (0,3625)} = 13,97 \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte vervanging:Max./Maks. $\frac{8}{9}$ Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{5}{9}$

(9)

OPTION 2/OPSIE 2:

$$n(\text{HCl})_{\text{equilibrium/ewewig}} = \frac{m}{M} = \frac{1825}{36,5} = 0,05 \text{ mol}$$

$$n(\text{HCl})_{\text{reacted/reakeer}} = 0,2 - 0,05 = 0,15 \text{ mol} \checkmark$$

$$\left. \begin{aligned} n(\text{O}_2)_{\text{reacted/reakeer}} &= \frac{1}{4} n(\text{HCl})_{\text{reacted/reakeer}} = \frac{1}{4} \times 0,15 = 0,0375 \text{ mol} \\ n(\text{Cl}_2)_{\text{formed/gevorm}} &= \frac{1}{2} n(\text{HCl})_{\text{reacted/reakeer}} = \frac{1}{2} \times 0,15 = 0,075 \text{ mol} \\ n(\text{H}_2\text{O})_{\text{formed/gevorm}} &= \frac{1}{2} n(\text{HCl})_{\text{reacted/reakeer}} = \frac{1}{2} \times 0,15 = 0,075 \text{ mol} \end{aligned} \right\} \text{Using ratio } \checkmark$$

$$\left. \begin{aligned} n(\text{O}_2)_{\text{equilibrium/ewewig}} &= 0,11 - 0,0375 = 0,0725 \text{ mol} \\ n(\text{Cl}_2)_{\text{equilibrium/ewewig}} &= n(\text{H}_2\text{O})_{\text{equilibrium/ewewig}} = 0,075 \text{ mol} \end{aligned} \right\} \checkmark$$

$$c(\text{O}_2)_{\text{equilibrium/ewewig}} = \frac{n}{V} = \frac{0,0725}{0,2} = 0,3625 \text{ mol dm}^{-3}$$

$$c(\text{Cl}_2)_{\text{equilibrium/ewewig}} = c(\text{H}_2\text{O})_{\text{equilibrium/ewewig}} = \frac{n}{V} = \frac{0,075}{0,2} = 0,375 \text{ mol dm}^{-3} \quad \left. \begin{aligned} &\text{Divide by/} \\ &\text{deel deur } 0,2 \end{aligned} \right\} \checkmark$$

$$K_c = \frac{[\text{H}_2\text{O}]^2 [\text{Cl}_2]^2}{[\text{HCl}]^4 [\text{O}_2]} = \frac{(0,375)^2 (0,375)^2}{(0,25)^4 (0,3625)} = 13,97 \checkmark$$

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. $\frac{5}{9}$

(9)

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CALCULATIONS USING CONCENTRATIONS
BEREKENINGE WAT KONSENTRASIES GEBRUIK**Mark allocation/Punttoekenning**

- Substitution of/Vervanging van $36,5 \text{ g} \cdot \text{mol}^{-1}$ $n = \frac{m}{M}$ ✓
- Initial concentration of reactants/Aanvanklike konsentrasie van reaktante:
 $c(\text{HCl}) = 1,0$ & $c(\text{O}_2) = 0,55 \text{ mol} \cdot \text{dm}^{-3}$ ✓
- Change: $c(\text{HCl}) = 0,75 \text{ mol} \cdot \text{dm}^{-3}$ (initial – equilibrium) ✓
Verandering: $c(\text{HCl}) = 0,75 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik – ewewig)
- USING ratio/GEBRUIK verhouding: $4 : 1 : 2 : 2$ ✓
- Equilibrium/Ewewig: $c(\text{H}_2\text{O}) = c(\text{Cl}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (initial+change) and $c(\text{O}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (initial – change) ✓
Ewewig: $c(\text{H}_2\text{O}) = c(\text{Cl}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik + verandering) en $c(\text{O}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik – verandering)
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules tussen vierkantjies).
- Substitution of reactant concentrations/Vervanging van reaktanskonsentrasies. ✓
- Substitution of product concentrations/Vervanging van produkonsentrasies. ✓
- Final answer/Finale antwoord: $13,97$ ✓
Range/Gebied: $13,966$ to $18,72$

OPTION 3/OPSIE 3

$$n(\text{HCl})_{\text{equilibrium/ewewig}} = \frac{m}{M}$$

$$= \frac{1,825}{36,5}$$

$$= 0,05 \text{ mol}$$

	HCl	O ₂	H ₂ O	Cl ₂	
Initial concentration/ Aanvangskonsentrasie (mol·dm ⁻³)	1,0 ✓	0,55	0	0	Divide by 0,2 ✓ Deel deur 0,2
Change in concentration/ Verandering in konsentrasie (mol·dm ⁻³)	0,75 ✓	0,1875	0,375	0,375	ratio ✓ verhouding
Equilibrium concentration/ Ewewigskonsentrasie (mol·dm ⁻³)	0,25	0,3625	0,375	0,375	✓

$$K_c = \frac{[\text{Cl}_2]^2 [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 [\text{O}_2]} = \frac{(0,375)^2 (0,375)^2}{(0,25)^4 (0,3625)} = 13,97 \quad \checkmark$$

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. $\frac{5}{9}$

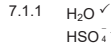
(9)
[18]

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QUESTION 7/VRAAG 7

7.1



(2)

7.1.2

Strong/Sterk ✓
Completely ionised (in water)/Volledig geïoniseer (in water). ✓

(2)

7.2

7.2.1

Marking Criteria/Nasienriglyne

- Formula/Formule: $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b} = \frac{n}{V} \checkmark$
- Substitute/Vervang $0,15 \times 24$ **OR/OF** $0,15 \times 0,024 \checkmark$
- Use/Gebruik 26 cm^3 **OR/OF** $0,026 \text{ dm}^3 \checkmark$
- Use mole ratio/Gebruik molverhouding: $1:2 \checkmark$
- Final answer/Finale antwoord: $0,28 \text{ mol} \cdot \text{dm}^{-3} \checkmark$ ($0,2769 \dots \text{mol} \cdot \text{dm}^{-3}$)

OPTION 1/OPSIE 1

$$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b} \checkmark$$

$$\frac{0,15 \times 24}{c_b \times 26} = \frac{1}{2} \checkmark$$

$$c(\text{NaOH}) = 0,28 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

OPTION 2/OPSIE 2

$$n(\text{H}_2\text{SO}_4) = cV \checkmark$$

$$= (0,15)(0,024) \checkmark$$

$$= 3,6 \times 10^{-3} \text{ mol}$$

$$n(\text{NaOH}) = 2(3,6 \times 10^{-3}) \checkmark$$

$$= 7,2 \times 10^{-3} \text{ mol}$$

$$c = \frac{n}{V}$$

$$= \frac{7,2 \times 10^{-3}}{0,026} \checkmark$$

$$= 0,28 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

(5)

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7.2.2

Marking Criteria/Nasienriglyne

- Calculate/Bereken $n(\text{NaOH})$: $0,02 \times 0,28 \checkmark$
- Calculate/Bereken $n(\text{H}_2\text{SO}_4)$: $0,03 \times 0,15 \checkmark$
- Use ratios/Gebruik molverhouding: $n(\text{H}_2\text{SO}_4) = \frac{1}{2}n(\text{NaOH}) \checkmark$
- $n(\text{H}_2\text{SO}_4)_{\text{excess}} = n(\text{H}_2\text{SO}_4)_{\text{initial}} - n(\text{H}_2\text{SO}_4)_{\text{used}} = 0,0045 - 0,0028 \checkmark$
- Substitute/Vervang $0,05 \text{ dm}^3$ in $c = \frac{n}{V} \checkmark$
- Substitution/Vervang $2 \times 0,034$ in $2[\text{H}_2\text{SO}_4] \checkmark$
- Formula/Formule: $-\log[\text{H}_3\text{O}^+]$ **OR/OF** Substitute/Vervang: $-\log(0,068) \checkmark$
- Final answer: $1,10$ to $1,167 \checkmark$

OPTION 1/OPSIE 1

$$n(\text{NaOH}) = cV$$

$$= 0,02 \times 0,28 \checkmark$$

$$= 0,0056 \text{ mol}$$

$$n(\text{H}_2\text{SO}_4) = 0,03 \times 0,15 \checkmark$$

$$= 0,0045 \text{ mol}$$

$$n(\text{H}_2\text{SO}_4)_{\text{used}} = \frac{1}{2}n(\text{NaOH}) \checkmark$$

$$= 0,0028$$

$$n(\text{H}_2\text{SO}_4)_{\text{excess}} = 0,0045 - 0,0028 \checkmark$$

$$= 0,0017 \text{ mol}$$

$$[\text{H}_2\text{SO}_4] = \frac{n}{V}$$

$$= \frac{0,0017}{0,05} \checkmark$$

$$= 0,034 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_3\text{O}^+] = 2[\text{H}_2\text{SO}_4] \checkmark$$

$$= 2 \times 0,034 \checkmark$$

$$= 0,068 \text{ mol} \cdot \text{dm}^{-3}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] \text{ OR/OF } -\log(0,068) \checkmark$$

$$= 1,17 \checkmark$$

$$(1,167)$$

OPTION 2/OPSIE 2

$$n(\text{NaOH}) = cV$$

$$= 0,02 \times 0,28 \checkmark$$

$$= 0,0056 \text{ mol}$$

$$n(\text{H}_2\text{SO}_4) = 0,03 \times 0,15 \checkmark$$

$$= 0,0045 \text{ mol}$$

$$n(\text{H}_3\text{O}^+) = 2n(\text{H}_2\text{SO}_4) \checkmark$$

$$= 2 \times 0,0045 \checkmark$$

$$= 0,009 \text{ mol}$$

$$n(\text{H}_3\text{O}^+)_{\text{excess}} = 0,009 - 0,0045 \checkmark$$

$$= 0,0045 \text{ mol}$$

$$c(\text{H}_3\text{O}^+) = \frac{n}{V}$$

$$= \frac{0,0045}{0,05} \checkmark$$

$$= 0,09 \text{ mol} \cdot \text{dm}^{-3}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] \text{ OR/OF } -\log(0,068) \checkmark$$

$$= 1,17 \checkmark$$

$$(1,167)$$

(8)
[17]

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QUESTION 8/VRAAG 8

8.1

8.1.1 A substance that loses/donates electrons./'n Stof wat elektrone verloor/skenk.
✓✓ (2 or 0)

(2)

8.1.2

Platinum/Pt ✓

(1)

8.1.3

 $\text{Sn}^{2+}(\text{aq})/\text{tin(II)} \text{ ions/tin(II)-ione} \checkmark$

(1)

8.1.4

 $\text{Pt} | \text{Sn}^{2+}(\text{aq}), \text{Sn}^{4+}(\text{aq}) || \text{Ag}^+(\text{aq}) | \text{Ag(s)}$ **OR/OF** $\text{Pt} | \text{Sn}^{2+}(1 \text{ mol} \cdot \text{dm}^{-3}), \text{Sn}^{4+}(1 \text{ mol} \cdot \text{dm}^{-3}) || \text{Ag}^+(1 \text{ mol} \cdot \text{dm}^{-3}) | \text{Ag(s)}$ **ACCEPT/AANVAAR** $\text{Pt} | \text{Sn}^{2+} | \text{Sn}^{4+} || \text{Ag}^+ | \text{Ag}$

(3)

8.1.5

OPTION 1/OPSIE 1

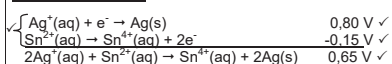
$$E_{\text{cell}}^0 = E_{\text{reduction}}^0 - E_{\text{oxidation}}^0 \checkmark$$

$$= +0,80 \checkmark - (+0,15) \checkmark$$

$$= 0,65 \text{ V} \checkmark$$

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. $E_{\text{cell}}^0 = E_{\text{OA}}^0 - E_{\text{RA}}^0$ followed by correct substitutions./Enige ander formule wat onkonvensionele afkortings gebruik bv. $E_{\text{sel}}^0 = E_{\text{OM}}^0 - E_{\text{RM}}^0$ gevolg deur korrekte vervangings: Max/Maks: $\frac{3}{4}$

OPTION 2/OPSIE 2

(4)

8.2

8.2.1

Magnesium becomes smaller/Brown solid forms/Mg disappears/eaten away/Mg changes colour. ✓
Magnesium word kleiner/Bruin vaste stof vorm/Mg verdwyn/weggevrete/Mg verander van kleur.

(1)

8.2.2

Cu^{2+} is a stronger oxidising agent ✓ (than Mg^{2+}) and will be reduced to Cu. ✓
 Cu^{2+} is 'n sterker oksideermiddel (as Mg^{2+}) en sal na Cu gereduseer word.

OR/OF

Mg is a stronger reducing agent ✓ (than Cu) and will reduce Cu^{2+} to Cu.
Mg is 'n sterker reduseermiddel (as Cu) en sal Cu^{2+} na Cu reduseer.

(3)
[15]

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QUESTION 9/VRAAG 9

- 9.1 The chemical process in which electrical energy is converted to chemical energy. ✓✓
'n Chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.

OR/OF

The use of electrical energy to produce a chemical change.
Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.

- 9.2 B ✓

- 9.3 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}$ ✓✓

Marking criteria/Nasienriglyne

- $\text{Cu} \leftarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$ ($\frac{2}{2}$) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}$ ($\frac{1}{2}$)
 - $\text{Cu} \rightleftharpoons \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$ ($\frac{0}{2}$) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \leftarrow \text{Cu}$ ($\frac{0}{2}$)
 - Ignore if charge omitted on electron./Ignoreer indien lading op elektron weggelaat word.
 - If charge (+) omitted on Cu^{2+} /Indien lading (+) weggelaat op Cu^{2+} .
- Max./Maks.: $\frac{1}{2}$

- 9.4 % purity/suiwerheid = $\frac{m(\text{Cu})}{m(\text{Cu})_{\text{impure/onsuiwer}}} \times 100$
= $\frac{4,4}{5} \times 100$ ✓
= 88% ✓

Marking criteria/Nasienriglyne:

- Substitute/Vervang 4,4 ✓
- Substitute/Vervang 5 ✓
- x 100 ✓
- Final answer/Finale antwoord: 88% ✓

(2)

(1)

(2)

(4)

[9]

QUESTION 10/VRAAG 10

- 10.1
10.1.1 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ ✓ bal ✓

Notes/Aantekeninge:

- Reactants ✓ Products ✓ Balancing ✓
- Reaktanse ✓ Produkte ✓ Balansering ✓
- Ignore if phases are omitted./Ignoreer indien fases uitgelaat word
- Ignore/Ignoreer =
- Marking rule/Nasienreël 3.9

(3)

- 10.1.2 $(\text{NH}_4)_2\text{SO}_4$ ✓

(1)

- 10.1.3 Ostwald process/Ostwaldproses ✓

(1)

- 10.1.4 Ammonium nitrate/Ammoniumnitraat ✓

(1)

- 10.2

- 10.2.1 The ratio of nitrogen (N), phosphorous (P) and potassium (K) in a certain fertiliser. ✓
Die verhouding van stikstof (N), fosfor (P) en kalium (K) in 'n sekere kunsmis.
Accept/Aanvaar: nitrogen, phosphorous and potassium/stikstof, fosfor en kalium.

(1)

- 10.2.2 Percentage fertiliser in the bag./Persentasie kunsmis in die sak. ✓

(1)

- 10.2.3 OPTION 1/OPSIE 1:

$$\begin{aligned} \% \text{K} &= \frac{5}{12} \times 22\% \checkmark \\ &= 9,17\% \\ \therefore m(\text{N}) &= \frac{9,17}{100} \times 10 \text{ kg} \checkmark \\ &= 0,92 \text{ kg} \checkmark \end{aligned}$$

- OPTION 2/OPSIE 2:

$$\begin{aligned} m(\text{nutrients/voedingstowwe}): \\ \frac{22}{100} \times 10 &= 2,2 \text{ kg} \\ \downarrow \\ \therefore m(\text{K}) &= \frac{5}{12} \times (2,2) \checkmark \\ &= 0,92 \text{ kg} \checkmark \end{aligned}$$

(4)

[12]

TOTAL/TOTAAL: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

2018

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

These marking guidelines consist of 15 pages.
Hierdie nasienriglyne bestaan uit 15 bladsye.

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QUESTION 1/VRAAG 1

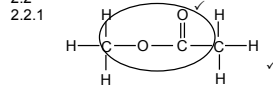
- 1.1 D ✓✓ (2)
1.2 A ✓✓ (2)
1.3 B ✓✓ (2)
1.4 B ✓✓ (2)
1.5 D ✓✓ (2)
1.6 C ✓✓ (2)
1.7 B ✓✓ (2)
1.8 D ✓✓ (2)
1.9 D ✓✓ (2)
1.10 C ✓✓ (2)

[20]

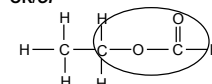
QUESTION 2/VRAAG 2

- 2.1
2.1.1 A ✓ (1)
2.1.2 D ✓ (1)
2.1.3 B ✓ (1)
2.1.4 E ✓ (1)
2.1.5 B ✓ (1)

- 2.2



OR/OF



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/Aanvaar

Any correct arrangement of correct number of atoms
Enige korrekte struktuur met die korrekte aantal atome.

(2)

- 2.2.2 ANY ONE/ENIGE EEN:
Methyl ✓ ethanoate ✓ /metietetanoaat
OR/OF
Ethyl ✓ methanoate ✓ /ietielmetanoaat

(2)

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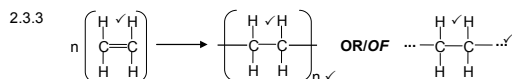
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- 2.3
2.3.1 A large molecule ✓ composed of smaller monomer units covalently bonded to each other in a repeating pattern. ✓
'n Groot molekule ✓ wat uit kleiner monomeer-eenhede bestaan wat kovalent aan mekaar in 'n herhalende patroon gebind is. ✓ (2)

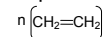
2.3.2 Polyethene ✓
Polieteen

Accept/Aanvaar:

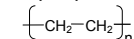
Polyethylene/polythene
Polieteen/poli-etileen/politeen



Accept as reactant/Aanvaar as reaktans:



Accept as product/Aanvaar as produk:



Marking guidelines/Nasienriglyne

- Structure shows TWO C atoms with four bonds (ethene) each and FOUR H atoms./Struktuur toon TWEE C-atome met vier bindings (eteen) elk na VIER H-atome. ✓
- Structure of product / Struktuur van produk. ✓
- Multiple n and brackets correctly shown for reactant and product./Veelvoud n en hakie korrek getoon vir reaktans en produk. ✓

2.4 Hydrolysis/Substitution ✓
Hidrolise/Substitusie

- 2.5 • Use concentrated strong base/NaOH/KOH/LiOH OR ethanolic/alcoholic strong base/NaOH/KOH/LiOH. ✓/Use ethanol instead of water./No water. Gebruik gekonsentreerde sterk basis/NaOH/KOH/LiOH OF etanolie / alkoholiese sterk basis/NaOH/KOH/LiOH /Gebruik etanol in plaas van water./Geen water nie.
• Heat strongly/Verhit sterk ✓

Accept/Aanvaar: Increase temperature/Verhoog temperatuur

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QUESTION 3/VRAAG 3

- 3.1 • **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/momentary dipoles. ✓
Toename in sterkte van intermolekulêre kragte/geïnduseerde dipoolkragte/Londonkragte/dispersiekragte/Van der Waalskragte / momentele dipool.
• **Energy/Energie:**
More energy needed to overcome/break intermolecular forces. ✓
Meer energie benodig om intermolekulêre kragte te oorkom/breek.

OR/OF

- **Structure/Struktuur:**
From 4 C atoms to 1 C atom/bottom to top the chain length/molecular size/molecular structure/molecular mass/surface area decreases. ✓
Van 4 C-atome na 1 C-atoom/onder na bo 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/ Londonkragte/dispersiekragte.
• **Energy/Energie:**
Less energy needed to overcome/break intermolecular forces. ✓
Minder energie benodig om intermolekulêre kragte te oorkom/breek.

- 3.2 • Alkanes have London/dispersion/induced dipole forces. ✓
Alkane het London-/dispersie-/geïnduseerde dipoolkragte.
• Alcohols have hydrogen bonding (in addition to London/dispersion/ induced dipole forces and dipole dipole forces). ✓
Alkohole het waterstofbinding (in toevoeging tot London-/dispersie-/ geïnduseerde dipoolkragte en dipoolkragte).
• Hydrogen bonding are stronger intermolecular forces than London/ dispersion/ induced dipole forces. ✓
Waterstofbindings is sterker intermolekulêre kragte as London-/dispersie-/geïnduseerde dipoolkragte.
OR/OF
More energy needed to overcome/break intermolecular forces in alcohols
Meer energie benodig om intermolekulêre kragte te oorkom/breek in alkohole.
• Alcohols have higher boiling points than alkanes. ✓
Alkohole het hoër kookpunte as die alkane.

3.3 Decrease/Neem af ✓

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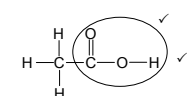
- 3.4 Lower than/Laer as ✓
2-methylpropane/It is more branched/has a smaller surface area/has a shorter chain length (than butane/chain isomer) ✓
2-metielpropaan/Dit is vertak/het 'n kleiner oppervlakte/het 'n korter kettinglengte (as butaan/ketting-isomeer).

OR/OF

Butane/chain isomer is less branched /has larger surface area/longer chain length (than 2-methylpropane).
Butaan/ketting-isomeer is minder vertak/het 'n groter oppervlakte/het 'n langer kettinglengte (as 2-metielpropaan).

QUESTION 4/VRAAG 4

- 4.1
4.1.1 Substitution/halogenation/bromination ✓
Substitusie/halogenering/halogenasie/brominerig/brominasie (1)
- 4.1.2 Elimination/dehydration ✓
Eliminasie/dehidrasie/dehidratering (1)
- 4.1.3 Esterification/condensation ✓
Esterifikasie/verestering/kondensasie (1)
- 4.1.4 Addition/hydrohalogenation/hydrobromination ✓
Addisie/hidrohalogenasie/hidrohalogenering/hidrobrominasie/hidrobromenering (1)
- 4.2
4.2.1 Catalyst/dehydrating agent/speeds up reaction ✓
Katalisator/dehidreermiddel/versnel die reaksie (1)
- 4.2.2 Propyl ✓ ethanoate ✓ /Propieletanoaat (2)



Marking criteria/Nasienriglyne:

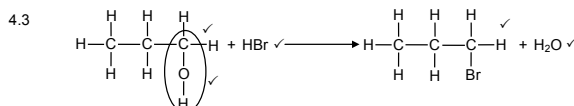
- Whole structure correct 2/2
Hele struktuur korrek:
- Only functional group correct 1/2
Slegs funksionele groep korrek:

IF/INDIEN:

More than one functional group/Meer as een funksionele groep 0/2

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Notes/Aantekeninge:

- Ignore/Ignoreer =
- Accept HBr and H₂O as condensed. /Aanvaar HBr en H₂O as gekondenseerd.
- Any additional reactants and/or products
- Enige addisionele reaktans en/of produkte: Max./Maks. 4/5
- Accept coefficients that are multiples.
Aanvaar koëffisiënte wat veelvoude is.
- Incorrect balancing/Verkeerde balansering: Max./Maks. 4/5
- Molecular/condensed formulae
Molekulêre/gekondenseerde formule: Max./Maks. 2/5

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/reaktans 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/aantal mol/volume/massa van produkte of reaktans per (eenheids)tyd.
 - Amount/number of moles/volume/mass (of products) formed/(reactants) used ✓ per (unit) time. ✓
Hoeveelheid/aantal mol/volume/massa (van produkte) gevorm/(reaktans) gebruik per (eenheids)tyd.
- 5.2
5.2.1 Surface area/State of division ✓
Oppervlakte/Toestand van verdeeldheid (1)
- 5.2.2 **ANY ONE/ENIGE EEN:**
- Amount/mass of magnesium ✓
Hoeveelheid/massa magnesium
 - Concentration of HCl/Acid/Konsentrasie van HCl /suur
 - (Initial) temperature/(Aanvanklike) temperatuur (1)

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5.3

5.3.1

Marking criteria/Nasienriglyne

- Calculate change in $m(\text{Mg})$ or $n(\text{Mg})$ ✓
Bereken verandering in $m(\text{Mg})$ of $n(\text{Mg})$
- Substitute/Vervang $24 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
- Use mol ratio/Gebruik molverhouding: $n(\text{Mg}) = n(\text{H}_2) = 1:1$ ✓
- Substitute/Vervang 25 dm^3 in $n = \frac{V}{V_m}$ ✓
- Final answer/Finale antwoord: $2,5 \text{ dm}^3$ ✓

OPTION 1/OPSIE 1

$$\Delta m(\text{Mg}) = 2,6 - 0,2 \checkmark$$

$$= 2,4 \text{ g}$$

$$n(\text{Mg}_{\text{used/gebruik}}) = \frac{m}{M}$$

$$= \frac{2,4}{24} \checkmark$$

$$= 0,1 \text{ mol}$$

$$n(\text{H}_2) = n(\text{Mg}) = 0,1 \text{ mol} \checkmark$$

$$V(\text{H}_2) = nV_m$$

$$V(\text{H}_2) = (0,1)(25) \checkmark$$

$$= 2,5 \text{ dm}^3 \checkmark$$

OPTION 3/OPSIE 3

$$24 \text{ g Mg} \checkmark \rightarrow 25 \text{ dm}^3 \text{ H}_2$$

$$\therefore 2,4 \text{ g} \checkmark \rightarrow x \text{ dm}^3 \text{ H}_2$$

$$x = \frac{2,4 \times 25}{24} \checkmark$$

$$= 2,5 \text{ dm}^3 \checkmark$$

(5)

5.3.2

Marking criteria/Nasienriglyne

- Substitute/Vervang $2,08 \times 10^{-4}$ in ave rate / *gem. tempo* = $\frac{\Delta n}{\Delta t} \checkmark$
- Substitute/Vervang $10 \times 60 \text{ s}$ (600 s) in ave rate / *gem. tempo* = $\frac{\Delta n}{\Delta t} \checkmark$
- Use mol ratio/Gebruik molverhouding: $n(\text{Mg}) = n(\text{H}_2) = 1:1 \checkmark$
- Substitute/Vervang $24 \text{ g} \cdot \text{mol}^{-1}$ in $m = nM \checkmark$
- Final answer/Finale antwoord: $3 \text{ g} \checkmark$ (Range/Gebied $2,995 - 3,12 \text{ g}$)

$$\text{ave rate / gem. tempo} = \frac{\Delta n}{\Delta t}$$

$$\therefore 2,08 \times 10^{-4} = \frac{\Delta n}{(10 \times 60) - 0} \checkmark$$

$$\therefore \Delta n = 0,125 \text{ mol}$$

$$n(\text{Mg}) = n(\text{H}_2) = 0,125 \text{ mol} \checkmark$$

$$m(\text{Mg}) = nM$$

$$m(\text{Mg}) = 0,125 \times 24 \checkmark$$

$$= 3 \text{ g} \checkmark (2,995 \text{ g})$$

(5)

5.4

- Larger surface area/state of division. ✓
Groter reaksieoppervlak/toestand van verdeeldheid
- More particles (per volume) with correct orientation/Meer deeltjies (per volume) met korrekte oriëntasie. ✓
OR/OF
More contact points/Meer kontakpunte.
- More effective collisions per (unit) time./Frequency of effective collisions increases./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).

(3)
[17]

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QUESTION 6/VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction./Both forward and reverse reactions take place at same rate. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie./Beide voor- en terugwaartse reaksies vind teen dieselfde tempo plaas.
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 reaktante en produkte konstant bly.

(2)

6.2

6.2.1 2 ✓

(1)

6.2.2 1 ✓

(1)

6.2.3 3 ✓

(1)

6.3 POSITIVE MARKING FROM QUESTION 6.2.**POSITIEWE NASIEN VANAF VRAAG 6.2.****Marking criteria/Nasienriglyne:**

- Substitute/Vervang 8 mol in $c = \frac{n}{V} \checkmark$
- Substitute/Vervang 4 mol in $c = \frac{n}{V} \checkmark$
- Substitute/Vervang 12 mol in $c = \frac{n}{V} \checkmark$
- Substitute/Vervang $V = 3 \text{ dm}^3$ in the above THREE formulae/in die bostaande DRIE formules. ✓
- K_c expression/uitdrukking ✓
- Substitution of concentrations into K_c expression ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Final answer/Finale antwoord: $6,75 \checkmark$

OPTION 1/OPSIE 1

$$[A] = \frac{8}{3} = 2,67 \text{ mol} \cdot \text{dm}^{-3}$$

$$[B] = \frac{4}{3} = 1,33 \text{ mol} \cdot \text{dm}^{-3}$$

$$[C] = \frac{12}{3} = 4 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark$$

$$= \frac{(4)^3}{(2,67)^2(1,33)} \checkmark$$

$$= 6,75 \checkmark$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{6}{7}$*

Wrong K_c expression / *Verkeerde K_c -uitdrukking: Max./Maks. $\frac{4}{7}$*

OPTION 2/OPSIE 2

	A	B	C
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	16	8	0
Change (mol) <i>Verandering (mol)</i>	8	4	12
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>	8 ✓	4 ✓	12 ✓
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{8}{3}$	$\frac{4}{3}$	$\frac{12}{3}$

Divide by
deel deur
3 dm³ ✓

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark$$

$$= \frac{(4)^3}{(2,67)^2(1,33)} \checkmark$$

$$= 6,75 \checkmark$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{6}{7}$*

Wrong K_c expression / *Verkeerde K_c -uitdrukking: Max./Maks. $\frac{4}{7}$*

(7)

USING CONCENTRATION/GEbruik KONSENTRASIE
OPTION 3/OPSIE 3

	A	B	C
Initial concentration (mol·dm ⁻³) <i>Aanvangskonsentrasie (mol·dm⁻³)</i>	$\frac{16}{3} = 5,33$	$\frac{8}{3} = 2,67$	0
Change (mol·dm ⁻³) <i>Verandering (mol·dm⁻³)</i>	$\frac{8}{3} = 2,67$	$\frac{4}{3} = 1,33$	$\frac{12}{3} = 4$
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{8}{3} = 2,67 \checkmark$	$\frac{4}{3} = 1,33 \checkmark$	$\frac{12}{3} = 4 \checkmark$

÷3
dm³ ✓

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark$$

$$= \frac{(4)^3}{(2,67)^2(1,33)} \checkmark$$

$$= 6,75 \checkmark$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{6}{7}$*

Wrong K_c expression / *Verkeerde K_c -uitdrukking: Max./Maks. $\frac{4}{7}$*

(7)

6.4 Endothermic/Endotermies ✓

- (An increase in temperature) favours the reverse reaction. ✓
(‘n Toename in temperatuur) bevoordeel die terugwaartse reaksie.
- An increase in temperature favours an endothermic reaction. ✓
‘n Toename in temperatuur bevoordeel ‘n endotermiese reaksie.

(3)
[15]

QUESTION 7/VRAAG 7

- 7.1 Titration/Volumetric analysis ✓
Titrasië/Volumetriese analise (1)
- 7.2 To measure the (exact) volume of acid needed to reach endpoint/to neutralise the base. ✓
Om die (presiese) volume suur te meet wat benodig word om die eindpunt te bereik/om die basis te neutraliseer. (1)
- 7.3 Acids produce hydrogen ions (H^+)/hydronium ions (H_3O^+) in solution/when dissolved in water. ✓✓
Sure vorm waterstofione(H^+)/hydroniumione (H_3O^+) in oplossing/wanneer opgelos in water.
- IF/INDIEN:**
Acids produce hydrogen ions (H^+)/hydronium ions (H_3O^+). ✓
Sure vorm waterstofione(H^+)/hydroniumione (H_3O^+).
- 7.4 H_2SO_4 ionises completely./ H_2SO_4 ioniseer volledig. ✓ (1)
- 7.5 Blue to yellow/Blou na geel ✓ (1)

Marking guidelines/Nasienriglyne:

- Formula/Formule: $C = \frac{n}{V} / n = cV / \frac{C_a \times V_a}{C_b \times V_b} = \frac{n_a}{n_b}$ ✓
- Substitution of/Vervanging van: $(0,1)(25)/(0,1)(0,025)$ ✓
- Use mol ratio/Gebruik molverhouding: $n_a : n_b = 1 : 2$ ✓
- Final answer/Finale antwoord: $12,5 \text{ cm}^3 / 0,0125 \text{ dm}^3$ ✓

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$\frac{C_a V_a}{C_b V_b} = \frac{n_a}{n_b}$ ✓ $\frac{(0,1)V_a}{(0,1)(25)} = \frac{1}{2}$ ✓ $\therefore V_a = 12,5 \text{ cm}^3$ ✓	$C_b = \frac{n}{V}$ ✓ $0,1 = \frac{n}{0,025}$ ✓ $n_b = 2,5 \times 10^{-3} \text{ mol}$ ✓ $n_a = \frac{1}{2} n_b = \frac{1}{2} (2,5 \times 10^{-3})$ ✓ $= 1,25 \times 10^{-3} \text{ mol}$ ✓ $C_a = \frac{n}{V}$ ✓ $0,1 = \frac{1,25 \times 10^{-3}}{V}$ ✓ $\therefore V_a = 0,0125 \text{ dm}^3 / 12,5 \text{ cm}^3$ ✓

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7.7 POSITIVE MARKING FROM QUESTION 7.6.
POSITIEWE NASIEN VANAF VRAAG 7.6.

Marking guidelines/Nasienriglyne:

- Formula/Formule: $c = \frac{n}{V}$ ✓
- Substitution of/Vervanging van: $(0,1)(0,005)/0,0175$ in $n = cV$ ✓
- Substitute/Vervang $V = 0,0425 \text{ dm}^3$ ✓
- Use/Gebruik $[H_3O^+] : [H_2SO_4] = 2 : 1$ ✓
- Formula/Formule: $pH = -\log[H_3O^+]$ ✓
- Substitute/Vervang $[H^+]$ ✓
- Final answer/Finale antwoord: 1,63 ✓

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$n_{a(\text{excess/oormaat})} = cV$ ✓ $= (0,1)(0,005)$ ✓ $= 5 \times 10^{-4} \text{ mol}$ ✓ $C_a = \frac{n}{V}$ ✓ $= \frac{5 \times 10^{-4}}{4,25 \times 10^{-2}}$ ✓ $= 1,18 \times 10^{-2} \text{ mol} \cdot \text{dm}^{-3}$ ✓ $c(H^+) = 2C_a$ ✓ $= 2(1,18 \times 10^{-2})$ ✓ $= 2,36 \times 10^{-2} \text{ mol} \cdot \text{dm}^{-3}$ ✓ $pH = -\log[H_3O^+]$ ✓ $= -\log(2,36 \times 10^{-2})$ ✓ $= 1,63$ ✓	$n_{a(\text{final/finale})} = cV$ ✓ $= (0,1)(0,0175)$ ✓ $= 1,75 \times 10^{-3} \text{ mol}$ ✓ $n_{a(\text{exs/oor})} = n_{a(\text{final/finale})} - n_{a(\text{react/reaageer})}$ ✓ $= 1,75 \times 10^{-3} - 1,25 \times 10^{-3}$ ✓ $= 5 \times 10^{-4} \text{ mol}$ ✓ $C_a = \frac{n}{V}$ ✓ $= \frac{5 \times 10^{-4}}{4,25 \times 10^{-2}}$ ✓ $= 1,18 \times 10^{-2} \text{ mol} \cdot \text{dm}^{-3}$ ✓ $c(H^+) = 2C_a$ ✓ $= 2(1,18 \times 10^{-2})$ ✓ $= 2,36 \times 10^{-2} \text{ mol} \cdot \text{dm}^{-3}$ ✓ $pH = -\log[H_3O^+]$ ✓ $= -\log(2,36 \times 10^{-2})$ ✓ $= 1,63$ ✓

OPTION 3/OPSIE 3

$n_{a(\text{excess/oormaat})} = cV$ ✓
 $= (0,1)(0,005)$ ✓
 $= 5 \times 10^{-4} \text{ mol}$ ✓
 $n(H^+) = 2n_{a(\text{excess/oormaat})}$ ✓
 $= 2(5 \times 10^{-4})$ ✓
 $= 1 \times 10^{-3} \text{ mol}$ ✓
 $C(H^+) = \frac{n}{V}$ ✓
 $= \frac{1 \times 10^{-3}}{4,25 \times 10^{-2}}$ ✓
 $= 2,36 \times 10^{-2} \text{ mol} \cdot \text{dm}^{-3}$ ✓
 $pH = -\log[H_3O^+]$ ✓
 $= -\log(2,36 \times 10^{-2})$ ✓
 $= 1,63$ ✓

[17]

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QUESTION 8/VRAAG 8

- 8.1 Galvanic (cell)/Voltaic (cell) ✓
Galvaniese (sel)/Voltaiese (sel) (1)
- 8.1.2 Indicates phase boundary/Interphase /phase separator ✓
Dui faseskeiding aan/Interfase /fase onderskeier (1)
- 8.1.3 $Fe^{2+} \rightarrow Fe^{3+} + e^-$ ✓✓

Notes/Aantekeninge

- $Fe^{3+} + e^- \leftarrow Fe^{2+}$ ($\frac{2}{2}$) $Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ ($\frac{0}{2}$)
 $Fe^{2+} = Fe^{3+} + e^-$ ($\frac{1}{2}$) $Fe^{3+} + e^- \rightarrow Fe^{2+}$ ($\frac{0}{2}$)
- Ignore if charge on electron is omitted./Ignoreer indien lading op elektron uitgelaat is.
- If a charge of an ion is omitted e.g. $Fe^{2+} \rightarrow Fe^{3+} + e^-$ /Indien lading opioon uitgelaat is bv. $Fe^{2+} \rightarrow Fe^{3+} + e^-$ Max./Maks: $\frac{1}{2}$

OPTION/OPSIE 1

$E_{cell}^0 = E_{reduction}^0 - E_{oxidation}^0$ ✓
 $0,03 \text{ V} = E_{Fe^{3+}/Fe^{2+}}^0 - (0,77 \text{ V})$ ✓
 $E_{Fe^{3+}/Fe^{2+}}^0 = 0,80 \text{ (V)}$ ✓
X = Silver / Ag ✓

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. $E_{cell}^0 = E_{ox}^0 - E_{red}^0$, followed by correct substitutions./Enige ander formule wat onkonvensionele afkortings gebruik bv. $E_{cell}^0 = E_{ox}^0 - E_{red}^0$ gevolg deur korrekte vervangings: Max./Maks: $\frac{4}{5}$

OPTION/OPSIE 2

✓ $X^+(aq) + e^- \rightarrow X(s)$ 0,80 (V) ✓
 $Fe^{2+}(s) \rightarrow Fe^{3+}(aq) + e^-$ 0,77 (V) ✓
 $X(aq) + Fe^{2+}(aq) \rightarrow X(s) + Fe^{3+}(aq)$ 0,03 (V) ✓
X = Silver/Ag/Silwer ✓

- 8.2 Pt ✓ (1)
- 8.2.1 Pt ✓ (1)
- 8.2.2 Iron(III) (ions)/Ferric ions ✓
Yster(III)-(ione)/Ferri ione (1)
- 8.2.3 $2Fe^{3+} + Cu \rightarrow 2Fe^{2+} + Cu^{2+}$ ✓ Bal. ✓

Notes/Aantekeninge

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse Produkte Balansering
- Ignore phases./Ignoreer fases.
- Ignore double arrows./Ignoreer dubbelpyle.
- Marking rule 6.3.10/Nasienreeël 6.3.10.

(3)

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Please turn over/Blaai om asseblief

QUESTION 9/VRAAG 9

- 9.1 Electrolyte/Elektroliet ✓ (1)
- 9.1.1 Conduct electricity/Carry charges ✓
Gelei elektrisiteit/Dra ladinge. (1)
- 9.2 $Cu(NO_3)_2$ ✓ (1)
- 9.3 Iron rod/Ysterstaaf ✓
Reduction takes place./Reduksie vind plaas. ✓ (2)
- 9.4 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓

Notes/Aantekeninge

- $Cu^{2+} + 2e^- \leftarrow Cu$ ($\frac{2}{2}$) $Cu^{2+} + 2e^- \rightleftharpoons Cu$ ($\frac{0}{2}$)
 $Cu = Cu^{2+} + 2e^-$ ($\frac{1}{2}$) $Cu^{2+} + 2e^- \rightarrow Cu$ ($\frac{0}{2}$)
- Ignore if charge on electron is omitted./Ignoreer indien lading op elektron uitgelaat is.
- If a charge of an ion is omitted e.g. $Cu \rightarrow Cu^{2+} + 2e^-$ /Indien lading opioon uitgelaat is bv. $Cu \rightarrow Cu^{2+} + 2e^-$ Max./Maks: $\frac{1}{2}$

- 9.5 Copper(II) (ions)/ Cu^{2+} ✓ and silver (ions)/ Ag^+ ✓
Koper(II)-(ione) / Cu^{2+} en silwer-(ione) / Ag^+
- Accept/Aanvaar**
Cu (ions) and Ag (ions) (Ions are stated in the question.)
Cu-(ione) en Ag-(ione) (Ione word in vraag genoem.) (2)
- 9.5.2 Ag^+ /silver(I) ions is a stronger oxidising agent ✓ than Cu^{2+} /Copper(II) ions and will be reduced (more readily) ✓ to form silver/Ag on the iron rod.
 Ag^+ /silver(I) ione is 'n sterker oksideermiddel' as Cu^{2+} /Copper(II) ione en sal (meer gereedelik) gereduseer word om silwer/Ag op die ysterstaaf te vorm. (2)

[11]

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QUESTION 10/VRAAG 10

- 10.1 (Catalytic) oxidation (of ammonia)/(Katalitiese) oksidasie (van ammoniak) ✓ (1)
- 10.1.1 Neutralisation/acid-base reaction ✓
Neutralisasie/suur-basisreaksie (1)
- 10.2 Nitrogen/N₂/Stikstof ✓ (1)
- 10.2.1 NO₂/nitrogen dioxide/Stikstofdoksied ✓ (1)
- 10.2.2 Nitric acid/HNO₃/Salpetersuur ✓ (1)
- 10.3 2NH₃ + H₂SO₄ ✓ → (NH₄)₂SO₄ ✓ Bal. ✓

Notes/Aantekeninge:

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse Produkte Balansering
- Ignore double arrows./Ignoreer dubbelpyle.
- Marking rule 6.3.10./Nasienreël 6.3.10.

(3)

- 10.3.2 4NH₃ + 5O₂ ✓ → 4NO + 6H₂O ✓ Bal. ✓

Notes / Aantekeninge:

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse Produkte Balansering
- Ignore double arrows./Ignoreer dubbelpyle.
- Marking rule 6.3.10./Nasienreël 6.3.10.

(3)

- 10.4 % N = $\frac{28}{80} \times 100$
= 35% ✓

(3)

[14]

TOTAL/TOTAAL: 150

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basic education

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Basic Education
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GRADE/GRAAD 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2018

MARKING GUIDELINE/NASIENRIGLYN

MARKS/PUNTE: 150

These marking guidelines consist of 18 pages.
Hierdie nasienriglyne bestaan uit 18 bladsye.

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Please turn over/Blaai om asseblief

QUESTION 1/VRAAG 1

- 1.1 C ✓✓ (2)
- 1.2 C ✓✓ (2)
- 1.3 C ✓✓ (2)
- 1.4 A ✓✓ (2)
- 1.5 D ✓✓ (2)
- 1.6 B ✓✓ (2)
- 1.7 B ✓✓ (2)
- 1.8 D ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 B ✓✓ (2)

[20]

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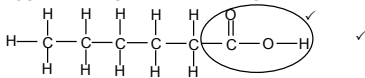
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QUESTION 2/VRAAG 2

- 2.1 **ANY ONE/ENIGE EEN:**
- (Alcohol/ethanol) is flammable/catches fire easily. ✓
(Alkohol/etanol) is vlambaar/slaan maklik aan die brand.
 - To heat it evenly./Om dit eweredig te verhit.
 - Water bath is used for low heat/low temperature./Waterbad word gebruik vir lae hitte/lae temperatuur.
 - Alcohol/ethanol will evaporate too quickly./ (Alkohol/etanol) sal te vinnig verdamp.
- Accept/Aanvaar:**
(Alcohol/ethanol) is volatile./ (Alkohol/etanol) is vlugtig. (1)
- 2.2
- 2.2.1 Esterification/condensation ✓
Verestering/esterifikasie/kondensasie (1)
- 2.2.2 H₂SO₄ ✓ (1)
- 2.2.3 Esters ✓ (1)
- 2.3 $M(\text{ester}) = \frac{144}{72} = 2$
 $M(\text{C}_4\text{H}_8\text{O}) = 72$ ✓
∴ 2 x C₄H₈O = C₈H₁₆O₂ ✓
- Marking guidelines/Nasienriglyne**
- If only answer given, award 2 marks on final answer./Indien slegs antwoord gegee, ken 2 punte toe vir finale antwoord.
 - If 72 g·mol⁻¹ calculated without substituting, no mark is awarded./Indien 72 g·mol⁻¹ bereken is sonder om te vervang word geen punt toegeken nie.
- (2)
- 2.4 Ethyl ✓ hexanoate ✓
Etielheksanoaat
- Note/Aantekening**
Accept any other ethyl ESTER from QUESTION 2.3.
Aanvaar enige ander etiel ESTER vanaf VRAAG 2.3. (2)

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2.5 POSITIVE MARKING FROM QUESTION 2.4.
POSITIEWE NASIEN VANAF VRAAG 2.4.

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/Aanvaar -OH as condensed/gekondenseerd.
- IF/INDIEN**
- More than one functional group/wrong functional group/Meer as een funksionele groep/foutiewe funksionele groep: $\frac{0}{2}$
- If condensed structural formulae used/Indien gekondenseerde struktuur-formules gebruik: Max/Maks.: $\frac{1}{2}$

(2)
[10]

QUESTION 3/VRAAG 3

3.1 Marking guidelines/Nasienriglyne

If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark./Indien enige van die onderstreepte frases in die korrekte konteks uitgelaat is, trek 1 punt af.

The temperature at which the vapour pressure of a substance equals atmospheric/external pressure.
Die temperatuur waar die dampdruk van 'n stof gelyk is aan atmosferiese/eksterne druk.

(2)

3.2

3.2.1 Carboxyl (group)/karboksiel(groep) ✓

Accept/Aanvaar

Carboxylic/Karboksiel

(1)

3.2.2 Propanoic acid/propanoësuur ✓

(1)

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3.4.3 Marking guidelines/Nasienriglyne

- BOTH have hydrogen bonding./BEIDE het waterstofbindings. ✓
- Compare number of sites for hydrogen bonding./Vergelyk aantal punte vir waterstofbinding. ✓
- Compare strength of IMFs./Vergelyk sterkte van IMKe. ✓
- Compare energy required./Vergelyk energie benodig. ✓

- Both compounds **X** and **B** have (in addition to London forces and dipole-dipole forces) hydrogen bonding./Beide verbindings **X** en **B** het waterstofbindings (behalwe Londonkragte en dipool-dipoolkragte). ✓
- Compound **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol has one site for hydrogen bonding and compound **B**/ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding OR **B**/ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding. ✓
Verbinding **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol het een punt vir waterstofbindings en verbinding **B**/etanoësuur/karboksiesuur het twee/meer punte vir waterstofbindings. OF **B**/etanoësuur/karboksiesuur het twee/meer punte vir waterstofbindings.
- Intermolecular forces in compound **B**/ethanoic acid/carboxylic acid are stronger than intermolecular forces in compound **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol. ✓
Intermolekulêre kragte in verbinding **B**/etanoësuur/karboksiesuur is sterker as die intermolekulêre kragte in verbinding **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol.

OR/OF

- Intermolecular forces in compound **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol are weaker than intermolecular forces in compound **B**/ethanoic acid/carboxylic acid./Intermolekulêre kragte in verbinding **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol is swakker as intermolekulêre kragte in verbinding **B**/etanoësuur/karboksiesuur.
- More energy is needed to overcome/break intermolecular forces in compound **B**/ethanoic acid/carboxylic acid than in compound **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol. ✓
Meer energie word benodig om intermolekulêre kragte in verbinding **B**/etanoësuur as in verbinding **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol te oorkom/breek.
- OR/OF
Less energy is needed to overcome/break intermolecular forces in compound **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol than in compound **B**/ethanoic acid/carboxylic acid.
Minder energie word benodig om intermolekulêre kragte in verbinding **X**/CH₃CH₂CH₂OH/propan-1-ol/alcohol te oorkom/breek as in verbinding **B**/etanoësuur/karboksiesuur.

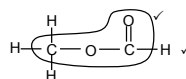
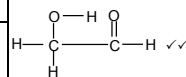
(4)

[15]

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3.2.3

ACCEPT/AANVAAR
(2 or/0)

Marking criteria/Nasienriglyne

- Whole structure correct: $\frac{2}{2}$
Hele struktuur korrek: $\frac{2}{2}$
- Only functional group correct: $\frac{1}{2}$
Slegs funksionele groep korrek: Max/Maks.: $\frac{1}{2}$
- IF/INDIEN**
- More than one functional group/wrong functional group/Meer as een funksionele groep/foutiewe funksionele groep: $\frac{0}{2}$
- If condensed structural formulae used/Indien gekondenseerde struktuur-formules gebruik: Max/Maks.: $\frac{1}{2}$

(2)

3.3

A ✓

- Lowest boiling point./Shortest chain length. ✓
Laagste kookpunt./Kortste kettinglengte.

(2)

3.4

3.4.1 The same molecular mass/molecular size. ✓

Dieselfde molekulêre massa/molekulêre grootte.

(1)

3.4.2

Primary/Primêre ✓

- (A series of organic) compounds in which one member differs from the next by a CH₂ group./('n Reeks organiese) verbindings wat deur dieselfde algemene formule/funksionele groep beskryf kan word. (2 of 0)
- OR/OF
(A series of organic) compounds in which one member differs from the next by a CH₂ group./('n Reeks organiese) verbindings waarin een lid van die volgende verskil met 'n CH₂-groep. (2 or/0 of 0)
- OH group is bonded to a C atom bonded to one other C atom. ✓
-OH-groep is gebind aan 'n C-atoom wat aan een ander C-atoom gebind is.
- OR/OF
-OH group is bonded to a C atom that has two H atoms.
-OH-groep is gebind aan 'n C-atoom wat twee H-atome bevat.

(2)

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QUESTION 4/VRAAG 4

4.1

4.1.1 (A series of organic) compounds that can be described by the same general formula/function group. ✓✓ (2 or 0)
(('n Reeks organiese) verbindings wat deur dieselfde algemene formule/funksionele groep beskryf kan word. (2 of 0))

OR/OF

(A series of organic) compounds in which one member differs from the next by a CH₂ group./('n Reeks organiese) verbindings waarin een lid van die volgende verskil met 'n CH₂-groep. (2 or/0 of 0))

(2)

4.1.2

Substitution/halogenation/bromination ✓
Substitusie/halogenasie/halogenering/brominasie/brominerig

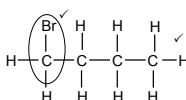
(1)

4.1.3

HBr ✓

(1)

4.1.4



Marking criteria/Nasienriglyne

- Br on first C atom/Br op eerste C-atoom: Max/Maks.: $\frac{1}{2}$
- Whole structure correct/Hele struktuur korrek: $\frac{2}{2}$
- IF/INDIEN:**
Br₂ but rest of structure correct/Br₂ maar res van struktuur korrek: $\frac{1}{2}$

(2)

4.1.5

C₅H₁₂ + 8O₂ → 5CO₂ + 6H₂O ✓ Bal ✓

Marking guidelines/Nasienriglyne

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse ✓ Produkte ✓ Balansering ✓
- Ignore double arrows and phases./Ignoreer dubbelpyle en fases.
- Marking rule 6.3.10/Nasienreeël 6.3.10.
- If condensed structural formulae used/Indien gekondenseerde struktuur-formules gebruik: Max/Maks.: $\frac{2}{3}$

(3)

4.1.6

Marking guidelines/Nasienriglyne

If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark./Indien enige van die onderstreepte frases in die korrekte konteks uitgelaat is, trek 1 punt af.

The (chemical) process in which longer chain hydrocarbons/longer chain alkanes are broken down to shorter/more useful hydrocarbons/molecules/chains/alkanes and alkenes.
Die (chemiese) proses waarin langketting koolwaterstowwe/langketting-alkane afgebreek word in korter/meer bruikbare koolwaterstowwe/molekule/kettings/alkane en alkenes.

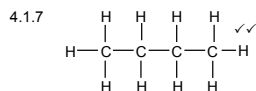
(2)

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**Marking guidelines/Nasienriglyne**

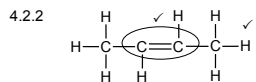
- One or more H atoms omitted/Een of meer H-atome uitgelaat: Max/Maks: $\frac{1}{2}$
- Condensed or semi-structural formula: Gekondenseerde of semi-struktuur-formule: Max/Maks: $\frac{1}{2}$

(2)

4.2
4.2.1 Butan-2-ol ✓✓ **OR/OF** 2-butanol ✓✓

IF/INDIEN:Butanol or/of butan-1-ol $\frac{1}{2}$

(2)

**Marking criteria/Nasienriglyne**

- Only functional group correct/Slegs funksionele groep korrek: Max/Maks: $\frac{1}{2}$
- Whole structure correct: Hele struktuur korrek: $\frac{2}{2}$

(2)

[17]

QUESTION 5/VRAAG 5

5.1 Temperature/Temperatuur ✓

(1)

5.2 **NOTE/LET WEL**
Give the mark for per unit time only if in context of reaction rate.
Gee die punt vir per eenheid tyd slegs indien in konteks met reaksietempo.

ANY ONE/ENIGE EEN

- Change in concentration ✓ of products/reactants per (unit) time. Verandering in konsentrasie van produkte/reaktante per (eenheid) tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time. Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktante per (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time. Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktante gebruik per (eenheid) tyd.
- Rate of change in concentration/amount/number of moles/volume/mass. Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/volume/massa. ✓✓ (2 or/of 0)

(2)

5.3 14 (min) ✓✓

(2)

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5.4

5.4.1 Graph/grafiek **B** ✓
(Experiment 3) has the highest (acid) concentration/more particles/higher number of moles. ✓
(Eksperiment 3) het die hoogste (suur)konsentrasie/meer deeltjies/groter aantal mol.

(2)

5.4.2

(Graph/grafiek) **C** ✓
(Experiment 5) is at highest temperature/more particles with sufficient kinetic energy/HCl is at 35°C ✓
(Eksperiment 5) is by die hoogste temperatuur/meer deeltjies met genoeg kinetiese energie/HCl is by 35°C.

(2)

5.5

5.5.1 Speeds up the reaction./Increases the reaction rate./Provides alternate pathway./Lowers the (net) activation energy. ✓
Versnel die reaksie./Verhoog die reaksietempo./Verskaf alternatiewe roete./Verlaag die (netto) aktiveringsenergie.

(1)

5.5.2

Equal to/Gelyk aan ✓

(1)

5.6

$$n(\text{Zn}) = \frac{m}{M}$$

$$= \frac{15}{65}$$

$$= 0,023 \text{ mol}$$

$$\text{rate/tempo} = -\frac{\Delta n}{\Delta t}$$

$$= -\frac{0 - 0,023}{14 - 0}$$

$$= 1,65 \times 10^{-3} \text{ (mol} \cdot \text{min}^{-1}\text{)}$$

Marking guidelines/Nasienriglyne

- Substitute/vervang 65 g·mol⁻¹ in $n = \frac{m}{M}$ ✓
- Substitute change in mol to calculate rate./Vervang verandering in mol om tempo te bereken. ✓
- Substitute change in time to calculate rate./Vervang verandering in tyd om tempo te bereken. ✓
- Final answer/Finale antwoord: $1,65 \times 10^{-3} \text{ mol} \cdot \text{min}^{-1}$ ✓
- Range/Gebied: $1,43 \times 10^{-3}$ to/tot $1,65 \times 10^{-3} \text{ (mol} \cdot \text{min}^{-1}\text{)}$

Notes/Aantekeninge

- Ignore if zeros omitted in calculation of reaction rate./Ignoreer indien nulle uitgelaat in berekening van reaksietempo.
- Accept negative answer i.e. $-1,65 \times 10^{-3} \text{ mol} \cdot \text{min}^{-1}$ /Aanvaar negatiewe antwoord d.i. $-1,65 \times 10^{-3} \text{ mol} \cdot \text{min}^{-1}$.

(4)

[15]

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QUESTION 6/VRAAG 6

6.1 When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium ✓ by favouring the reaction that will cancel/oppose the disturbance. ✓
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n (nuwe) ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

(2)

6.2 Endothermic/Endotermies ✓

- Decrease in temperature favours the exothermic reaction. ✓
Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The reverse reaction is favoured./Die terugwaartse reaksie word bevoordeel. ✓
OR/OF
Number of moles/amount/concentration of N₂O₄/colourless gas increases. Aantal mol/hoeveelheid/konsentrasie van N₂O₄/kleurlose gas neem toe.
OR/OF
Number of moles/amount of NO₂/brown gas decreases./Aantal mol/hoeveelheid NO₂/bruin gas neem af.

(3)

6.3
6.3.1 Increases/Verhoog ✓

(1)

6.3.2 Remains the same/Bly dieselfde ✓

(1)

6.3.3 Increases/Verhoog ✓

(1)

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**6.4 CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBUIK****Marking guidelines/Nasienriglyne**

- $\Delta n(\text{N}_2\text{O}_4) = 20\%$ of van $x/0,2x$. ✓
- USE ratio/GEbruik verhouding: N₂O₄ : NO₂ : = 1 : 2. ✓
- $n(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = n(\text{N}_2\text{O}_4)_{\text{initial/begin}} - \Delta n(\text{N}_2\text{O}_4)$. ✓
 $n(\text{NO}_2)_{\text{eq/ewe}} = n(\text{NO}_2)_{\text{initial/begin}} + \Delta n(\text{NO}_2)$. ✓
- Divide equilibrium moles by 2 dm³/Deel ewewigsmol deur 2 dm³. ✓
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkanties).
- Substitution of K_c value/Vervanging van K_c-waarde. ✓
- Substitution of concentrations into correct K_c expression. ✓
Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/Finale antwoord: 1,6 (mol) ✓

OPTION 1/OPSIE 1

	N ₂ O ₄	NO ₂	
Initial amount (moles) Aanvangshoeveelheid (mol)	x	0	
Change in amount (moles) Verandering in hoeveelheid (mol)	0,2x ✓	0,4x	ratio ✓ verhouding
Equilibrium amount (moles) hoeveelheid (mol)	0,8x	0,4x	✓
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,4x	0,2x	Divide by 2 dm ³ ✓

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$$

$$0,16 = \frac{(0,2x)^2}{(0,4x)}$$

$$x = 1,6 \text{ (mol)} \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{8}$

OPTION 2/OPSIE 2

$$\Delta n(\text{N}_2\text{O}_4) = \frac{20}{100} x \checkmark = 0,2x$$

$$\Delta n(\text{NO}_2) = 2\Delta n(\text{N}_2\text{O}_4) = 0,4x \checkmark$$

$$n(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = x - 0,2x = 0,8x \text{ AND } n(\text{NO}_2)_{\text{eq/ewe}} = 0 + 0,4x \checkmark$$

$$c(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = \frac{0,8x}{2} = 0,4x \checkmark$$

$$c(\text{NO}_2)_{\text{eq/ewe}} = \frac{0,4x}{2} = 0,2x \checkmark$$

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$$

$$0,16 = \frac{(0,2x)^2}{(0,4x)}$$

$$x = 1,6 \text{ (mol)} \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{8}$

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CALCULATIONS USING CONCENTRATION

BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking guidelines/Nasienriglyne

- Initial $n(\text{N}_2\text{O}_4)/x$ divide by 2 dm^3 . ✓
- Aanvanklike $n(\text{N}_2\text{O}_4)/x$ gedeel deur 2 dm^3 . ✓
- $\Delta c(\text{N}_2\text{O}_4) = 20\%$ of initial concentration/0,1x. ✓
- USE ratio/GEBRUIK verhouding: $c(\text{N}_2\text{O}_4) : c(\text{NO}_2) = 1 : 2$. ✓
- $c(\text{N}_2\text{O}_4)_{\text{eq}} = c(\text{N}_2\text{O}_4)_{\text{initial}} - \Delta c(\text{N}_2\text{O}_4)$. ✓
- $c(\text{NO}_2)_{\text{eq}} = c(\text{NO}_2)_{\text{initial}} + \Delta c(\text{NO}_2)$. ✓
- Correct K_c expression (formulas in square brackets). ✓
- Korrekte K_c uitdrukking (formules in vierkantakies). ✓
- Substitution of K_c value/Vervanging van K_c -waarde. ✓
- Substitution of concentrations into K_c expression. ✓
- Vervanging van konsentrasies in K_c -uitdrukking. ✓
- Final answer/Finale antwoord: $1,6 \text{ (mol)}$ ✓

OPTION 3/OPSIE 3

	N_2O_4	NO_2	
Initial concentration (mol·dm ⁻³) Aanvanklike konsentrasie (mol·dm ⁻³)	$\frac{x}{2} = 0,5x$	0	Divide by 2 dm^3 ✓
Change (mol·dm ⁻³) Verandering (mol·dm ⁻³)	$0,1x$ ✓	$0,2x$	ratio ✓ verhouding
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	$0,4x$	$0,2x$	✓

$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$ ✓
 $0,16 = \frac{(0,2x)^2}{0,4x}$ ✓
 $x = 1,6 \text{ (mol)}$ ✓

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{6}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{5}{8}$

(8)
[16]

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QUESTION 7/VRAAG 7

7.1

7.1.1 An acid is a proton donor. ✓✓
'n Suur is 'n protondonor/skenker.

(2)

7.1.2 H_2O ✓

(1)

7.1.3 HSO_4^- ✓✓

(2)

7.2

7.2.1 Reaction of a salt with water/ H_2O . ✓✓
Reaksie van 'n sout met water/ H_2O .

Accept/Aanvaar

Reaction of cations or anions with water
Reaksie van katione of anione met water

(2)

7.2.2 $\text{CO}_3^{2-}(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_2\text{CO}_3(\text{aq}) + 2\text{OH}^-(\text{aq})$ ✓
OR/OF $\text{CO}_3^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HCO}_3^-(\text{aq}) + \text{OH}^-(\text{aq})$

Accept/Aanvaar:

 $\text{CaCO}_3(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_2\text{CO}_3(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq})$

- The formation of $\text{OH}^-(\text{aq})$ neutralises the excess acid. ✓
- Die vorming van $\text{OH}^-(\text{aq})$ neutraliseer die oormaat suur.

Marking guidelines/Nasienriglyne

- Reactants ✓ Products ✓
Reaktanse Produkte
- The formation of $\text{OH}^-(\text{aq})$ neutralises the excess acid. ✓
Die vorming van $\text{OH}^-(\text{aq})$ neutraliseer die oormaat suur.
- Ignore single arrows and phases./Ignoreer enkelpyle en fases.
- Marking rule 6.3.10/Nasienreël 6.3.10.
- Ignore balancing./Ignoreer balansering.

(3)

7.3

7.3.1 $\text{pH} = -\log[\text{H}_3\text{O}^+]$ ✓
 $5 = -\log[\text{H}_3\text{O}^+]$ ✓
 $[\text{H}_3\text{O}^+] = 1 \times 10^{-5} \text{ mol·dm}^{-3}$ ✓

(3)

7.3.2 POSITIVE MARKING FROM QUESTION 7.3.1.
POSITIEWE NASIEN VAN VRAAG 7.3.1.

Marking guidelines/Nasienriglyne

- Any formula/Enige formule: $c = \frac{n}{V} / n = \frac{m}{M} \cdot \frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b} / c = \frac{m}{MV}$ ✓
- Substitute/vervang $V = 4 \times 10^3 \text{ dm}^3$ ✓
- Calculate $n_a(\text{reacted}) = n_a(\text{initial}) - n_a(\text{final})$ ✓✓
- Bereken $n_a(\text{reageer}) = n_a(\text{begin}) - n_a(\text{final})$ ✓✓
- Use/Gebruik $n(\text{CaO}) : n(\text{H}_3\text{O}^+) = 1:2$ ✓
- Substitution of/Vervanging van 56 g·mol^{-1} ✓
- Final answer/Finale antwoord: $m = 1,08 \times 10^6 \text{ g}$ to/for $1,09 \times 10^6 \text{ g}$ ✓

IF final answer is negative./INDIEN finale antwoord negatief is Max./Maks: $\frac{6}{7}$

OPTION 1/OPSIE 1

$$c(\text{H}_3\text{O}^+)_{\text{initial}} = \frac{n}{V} \checkmark$$

$$1 \times 10^{-5} = \frac{n}{4 \times 10^3} \checkmark$$

$$n_a = 4 \times 10^4 \text{ mol}$$

$$n(\text{H}_3\text{O}^+)_{\text{react/rea}} = 4 \times 10^4 - 1,26 \times 10^3 \checkmark \checkmark$$

$$= 3,87 \times 10^4 \text{ mol}$$

$$n(\text{CaO}) = \frac{1}{2}n(\text{H}_3\text{O}^+) \checkmark$$

$$= \frac{1}{2} \times 3,87 \times 10^4 \checkmark$$

$$= 1,94 \times 10^4 \text{ mol}$$

OPTION 2/OPSIE 2

$$c(\text{H}_3\text{O}^+)_{\text{fin}} = \frac{n}{V} \checkmark$$

$$= \frac{126 \times 10^3}{4 \times 10^3} \checkmark$$

$$= 3,15 \times 10^{-7} \text{ mol·dm}^{-3}$$

$$c(\text{H}_3\text{O}^+)_{\text{rea}} = 1 \times 10^{-5} - 3,15 \times 10^{-7} \checkmark \checkmark$$

$$= 9,69 \times 10^{-6} \text{ mol·dm}^{-3}$$

$$n(\text{H}_3\text{O}^+)_{\text{rea}} = cV$$

$$= (9,69 \times 10^{-6})(4 \times 10^3) \checkmark$$

$$= 3,87 \times 10^4 \text{ mol}$$

$$n(\text{CaO}) = \frac{1}{2}n(\text{H}_3\text{O}^+) \checkmark$$

$$= \frac{1}{2} \times 3,87 \times 10^4 \checkmark$$

$$= 1,94 \times 10^4 \text{ mol}$$

OR/OF

$$n(\text{CaO}) = \frac{m}{M}$$

$$1,94 \times 10^4 = \frac{m}{56} \checkmark$$

$$\therefore m = 1,09 \times 10^6 \text{ g} \checkmark$$

$$1 \text{ mol} : 56 \text{ g} \checkmark$$

$$1,94 \times 10^4 \text{ mol} : m$$

$$\therefore m = 1,09 \times 10^6 \text{ g} \checkmark$$

OPTION 3/OPSIE 3

$$c(\text{H}_3\text{O}^+)_{\text{fin}} = \frac{n}{V} \checkmark$$

$$= \frac{126 \times 10^3}{4 \times 10^3} \checkmark$$

$$= 3,15 \times 10^{-7} \text{ mol·dm}^{-3}$$

$$c(\text{H}_3\text{O}^+)_{\text{rea}} = 1 \times 10^{-5} - 3,15 \times 10^{-7} \checkmark \checkmark$$

$$= 9,69 \times 10^{-6} \text{ mol·dm}^{-3}$$

$$c(\text{CaO}) = \frac{1}{2}c(\text{H}_3\text{O}^+) \checkmark = 4,845 \times 10^{-6} \text{ mol·dm}^{-3}$$

$$c = \frac{m}{MV} \therefore 4,845 \times 10^{-6} = \frac{m}{56(4 \times 10^3)} \therefore m = 1,09 \times 10^6 \text{ g} \checkmark$$

(7)
[10]

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QUESTION 8/VRAAG 8

8.1

8.1.1 Loss of electrons./Verlies aan elektrone. ✓✓ (2 or/of 0)

(2)

8.1.2 $\text{Fe} \rightarrow \text{Fe}^{3+} + 3\text{e}^-$ ✓✓

Marking guidelines/Nasienriglyne

- $\text{Fe} = \text{Fe}^{3+} + 3\text{e}^-$ $\frac{1}{2}$ $\text{Fe}^{3+} + 3\text{e}^- = \text{Fe}$ $\frac{0}{2}$
- $\text{Fe}^{3+} + 3\text{e}^- \leftarrow \text{Fe}$ $\frac{2}{2}$ $\text{Fe}^{3+} + 3\text{e}^- \rightarrow \text{Fe}$ $\frac{0}{2}$
- Ignore if charge omitted on electron./Ignoreer indien lading weggelaat op elektron.
- If charge (+) omitted on Fe^{3+} /Indien lading (+) weggelaat op Fe^{3+} .
- Example/Voorbeeld: $\text{Fe} \rightarrow \text{Fe}^{3+} + 3\text{e}^-$ ✓ Max./Maks: $\frac{1}{2}$

(2)

8.1.3 Reducing agent/Reduseermiddel ✓

(1)

8.1.4 Fe is a stronger reducing agent ✓ than Cu ✓ and (Fe) will be oxidised ✓
(to Fe^{3+})./Fe is 'n sterker reduseermiddel as Cu en (Fe) sal geoksideer word
(na Fe^{3+}).

OR/OF

Cu is a weaker reducing agent ✓ than Fe ✓ and (Cu) will not be oxidised ✓
(to Cu^{2+})./Cu is 'n swakker reduseermiddel as Fe en (Cu) sal nie geoksideer
word nie (na Cu^{2+}).

(3)

8.1.5 $\text{Zn}/\text{Zn} \checkmark$

Stronger reducing agent (than Fe)./Sterker reduseermiddel (as Fe). ✓

OR/OF

Zn will undergo oxidation (before Fe)./Zn sal oksidasie (voor Fe) ondergaan.

OR/OF

Cu is a weaker reducing agent (than Fe)./Cu is 'n swakker reduseermiddel
(as Fe).

(2)

8.2

8.2.1 $3\text{Cu}^{2+} + 2\text{Fe} \rightarrow 3\text{Cu} + 2\text{Fe}^{3+}$ ✓ Bal. ✓

Marking guidelines/Nasienriglyne

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse Produkte Balansering
- Ignore double arrows./Ignoreer dubbelpyle.
- Marking rule 6.3.10/Nasienreël 6.3.10.

(3)

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8.2.2	OPTION 1/OPSIE 1 $E_{\text{cell}}^{\circ} = E_{\text{reduction}}^{\circ} - E_{\text{oxidation}}^{\circ}$ $= 0,34 \checkmark - (-0,06) \checkmark$ $= 0,40 \text{ V} \checkmark$	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. $E_{\text{cell}}^{\circ} = E_{\text{ox}}^{\circ} - E_{\text{red}}^{\circ}$ followed by correct substitutions./Enige ander formule wat onkonvensionele afkortings gebruik bv. $E_{\text{cell}}^{\circ} = E_{\text{ox}}^{\circ} - E_{\text{red}}^{\circ}$ gevolg deur korrekte vervangings: $\frac{3}{4}$
	OPTION 2/OPSIE 2 $\text{Cu}^{2+} + 2e^{-} \rightarrow \text{Cu} \checkmark$ $\text{Fe} \rightarrow \text{Fe}^{3+} + 3e^{-} \checkmark$ $3\text{Cu}^{2+} + 2\text{Fe} \rightarrow 3\text{Cu} + 2\text{Fe}^{3+}$ $E^{\circ} = 0,34 \text{ V} \checkmark$ $E^{\circ} = 0,06 \text{ V} \checkmark$ $E^{\circ} = +0,40 \text{ V} \checkmark$	

(4)
[17]

QUESTION 9/VRAAG 9

- 9.1 A cell in which electrical energy is converted to chemical energy. ✓✓ (2 or 0)
 'n Sel waarin elektriese energie omgeskakel word na chemiese energie. (2 of 0)

OR/OF

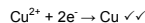
A cell in which electrical energy/electricity is used to obtain a chemical change/reaction. (2 or 0)
 'n Sel waarin elektriese energie/elektrisiteit gebruik word om 'n chemiese verandering/reaksie te veroorsaak. (2 of 0)

(2)

- 9.2 Any soluble copper(II) salt e.g./Enige oplosbare koper(II)-sout bv.
 $\text{CuSO}_4/\text{Cu}(\text{NO}_3)_2/\text{CuCl}_2 \checkmark$

(1)

- 9.3 B ✓



Marking guidelines/Nasienriglyne

- $\text{Cu} \leftarrow \text{Cu}^{2+} + 2e^{-}$ ($\frac{2}{2}$) $\text{Cu} \rightleftharpoons \text{Cu}^{2+} + 2e^{-}$ ($\frac{0}{2}$)
- $\text{Cu}^{2+} + 2e^{-} \rightleftharpoons \text{Cu}$ ($\frac{1}{2}$) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2e^{-}$ ($\frac{0}{2}$)
- Ignore if charge on electron is omitted./Ignoreer indien lading op elektron uitgelaat is.
- If a charge of an ion is omitted e.g. $\text{Cu}^{2+} + 2e^{-} \rightarrow \text{Cu}$ /Indien lading op ioon uitgelaat is bv. $\text{Cu}^{2+} + 2e^{-} \rightarrow \text{Cu}$ Max./Maks: $\frac{1}{2}$

(3)

- 9.4 Platinum/Pt ✓ AND/EN silver/Ag/silver ✓

(2)

[8]

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QUESTION 10/VRAAG 10

- 10.1
 10.1.1 Haber (process)/Haber(proses) ✓ (1)
 10.1.2 Ostwald (process)/Ostwald(proses) ✓ (1)
 10.2
 10.2.1 Ammonium nitrate/Ammoniumnitraat/ $\text{NH}_4\text{NO}_3 \checkmark$ (1)
 10.2.2 Iron/iron oxide/Fe/FeO ✓
 Yster/ysterskied/Fe/FeO (1)
 10.3 $2\text{NH}_3 + \text{H}_2\text{SO}_4 \checkmark \rightarrow (\text{NH}_4)_2\text{SO}_4 \checkmark$ Bal ✓ (3)

Marking guidelines/Nasienriglyne

- Reactants ✓ Products ✓ Balancing ✓
- Reaktanse ✓ Produkte ✓ Balansering
- Ignore double arrows./Ignoreer dubbelpyle.
- Marking rule 6.3.10./Nasienreël 6.3.10.

10.4	Marking guidelines/Nasienriglyne - Any ONE molar mass correct/Enige EEN molêre massa korrek: $80 \text{ g mol}^{-1}/164 \text{ g mol}^{-1}/74,5 \text{ g mol}^{-1} \checkmark$ $m(\text{N}) = 7 \text{ (kg)}$ OR/OF 0,14 ✓ $m(\text{P}) = 2,27 \text{ (kg)}$ OR/OF 0,045 ✓ $m(\text{K}) = 9,42 \text{ (kg)}$ OR/OF 0,188 ✓ - Final answer/Finale antwoord: 3 : 1 : 4 ✓	ACCEPT/AANVAAR: 3,08 : 1 : 4,15 OR/OF 7 : 2,27 : 9,42
	OPTION 1/OPSIE 1 NH_4NO_3 : $80 \text{ g} \checkmark \rightarrow 28 \text{ g N}$ $20 \text{ kg} \rightarrow \frac{28}{80} \times 20$ $\therefore m(\text{N}) = 7 \text{ kg} \checkmark$ Na_3PO_4 : $164 \text{ g} \rightarrow 31 \text{ g P}$ $12 \text{ kg} \rightarrow \frac{31}{164} \times 12$ $\therefore m(\text{P}) = 2,27 \text{ kg} \checkmark$ KCl : $74,5 \text{ g} \rightarrow 39 \text{ g K}$ $18 \text{ kg} \rightarrow \frac{39}{74,5} \times 18$ $\therefore m(\text{K}) = 9,42 \text{ kg} \checkmark$ $\therefore \text{N} : \text{P} : \text{K}$ $7 : 2,27 : 9,42$ $3 : 1 : 4 \checkmark$	OPTION 2/OPSIE 2 $n(\text{NH}_4\text{NO}_3) = \frac{m}{M}$ $= \frac{20\,000}{80} = 250 \text{ mol}$ $n(\text{N}) = 2n(\text{NH}_4\text{NO}_3) = 500 \text{ mol}$ $m(\text{N}) = 500 \times 14$ $= 7\,000 \text{ g} = 7 \text{ kg} \checkmark$ $n(\text{Na}_3\text{PO}_4) = \frac{12\,000}{164} = 73,17 \text{ mol}$ $m(\text{P}) = 73,17 \times 31$ $= 2\,268 \text{ g} = 2,27 \text{ kg} \checkmark$ $n(\text{KCl}) = \frac{18\,000}{74,5} = 241,61 \text{ mol}$ $m(\text{K}) = 241,61 \times 39$ $= 9\,423 \text{ g} = 9,42 \text{ kg} \checkmark$ $\therefore \text{N} : \text{P} : \text{K}$ $7 : 2,27 : 9,42$ $3 : 1 : 4 \checkmark$

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OPTION 3/OPSIE 3 NH_4NO_3 : %N = $\frac{28}{80} \times 100 = 35\%$ $m(\text{N}) = \frac{35}{100} \times 20 = 7 \text{ kg} \checkmark$ Na_3PO_4 : $\%P = \frac{31}{164} \times 100 = 18,9\%$ $m(\text{N}) = \frac{18,9}{100} \times 12 = 2,27 \text{ kg} \checkmark$ KCl : $\%K = \frac{39}{74,5} \times 100 = 52,34\%$ $m(\text{K}) = \frac{52,34}{100} \times 18 = 9,42 \text{ kg} \checkmark$ $\therefore \text{N} : \text{P} : \text{K} = 7 : 2,27 : 9,42$ $= 3 : 1 : 4 \checkmark$	OPTION 4/OPSIE 4 NH_4NO_3 : $\%N = \frac{28}{80} \times 100 = 35\%$ Na_3PO_4 : $\%P = \frac{31}{164} \times 100 = 18,9\%$ KCl : $\%K = \frac{39}{74,5} \times 100 = 52,34\%$ N : $\frac{20}{50} \times 35 = 0,14 \checkmark$ P : $\frac{12}{50} \times 18,9 = 0,045 \checkmark$ K : $\frac{18}{50} \times 52,34 = 0,188 \checkmark$ $\text{N} : \text{P} : \text{K} = 0,14 : 0,045 : 0,188$ $= 3 : 1 : 4 \checkmark$
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(5)

[12]

TOTAL/TOTAAL: 150

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