basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2010

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

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

2. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

3. Answer ALL the questions in the ANSWER BOOK.

4. You may use a non-programmable calculator.

5. You may use appropriate mathematical instruments.

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

7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.

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

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The type of collision in which kinetic energy is conserved (1)

1.2 The principle which states that each point on a wave front acts as a source of secondary wavelets (1)

1.3 The unit of measure equivalent to one volt per ampere (1)

1.4 The component in a DC electric motor that ensures continuous rotation in one direction by reversing the direction of the current every half-cycle (1)

1.5 The minimum energy needed to eject an electron from a metal surface (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

2.1 An object projected vertically upwards reaches its maximum height and returns to its original point of projection. Ignoring the effects of friction, the direction of the acceleration of the object during its motion is …

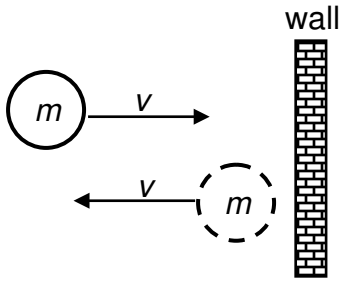
A always vertically downwards.

B first vertically upwards and then vertically downwards.

C first vertically downwards and then vertically upwards.

D always vertically upwards. (2)

2.2 A ball of mass *m* strikes a wall perpendicularly at a speed *v*. Immediately after the collision the ball moves in the opposite direction at the same speed *v*, as shown in the diagram below.



Which ONE of the following represents the magnitude of the change in momentum of the ball?

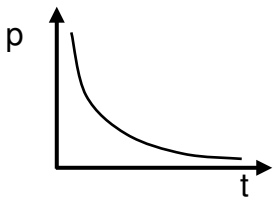
A 0

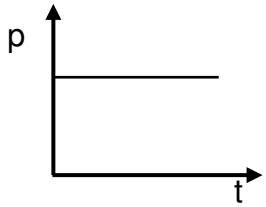
B *mv*

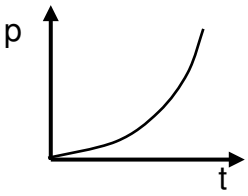
C 2*mv*

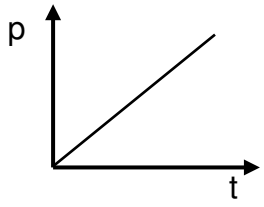
D 3*mv* (2)

2.3 Which ONE of the following momentum versus time graphs best represents the motion of an object that starts from rest and moves in a straight line under the influence of a constant net force?

A


B


C


D


(2)

2.4 Which ONE of the following correctly represents the given types of electromagnetic radiation in order of INCREASING WAVELENGTH?

A Microwaves; infrared; ultraviolet

B Infrared; ultraviolet; X-rays

C Radio waves; infrared; gamma rays

D Ultraviolet; infrared; microwaves (2)

2.5 Which ONE of the following phenomena provides the most conclusive evidence for the wave nature of light?

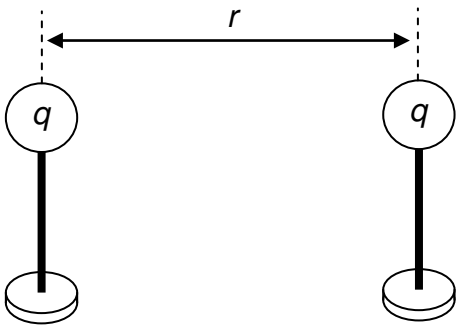
A Photoelectric effect

B Refraction

C Reflection

D Diffraction (2)

2.6 The diagram below represents two small spheres on insulated stands. Each sphere carries a positive charge of magnitude q and is separated by a distance r, as shown. The total electrical potential energy of the system of two charges is U.



The distance between the centres of the spheres is now HALVED.

Which ONE of the following now represents the magnitude of the electrical potential energy of the system of two charges?

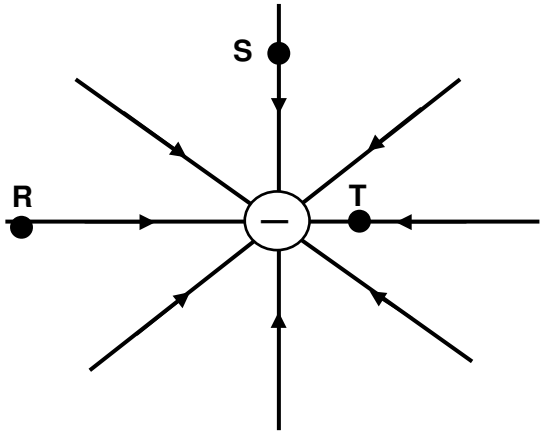
A $\frac{1}{4}U$

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

C $2U$

D $4U$ (2)

2.7 The diagram below represents the electric field pattern around a negative point charge. R, S and T are points at different distances from the negative point charge.



The magnitude of the electric field of the point charge is ...

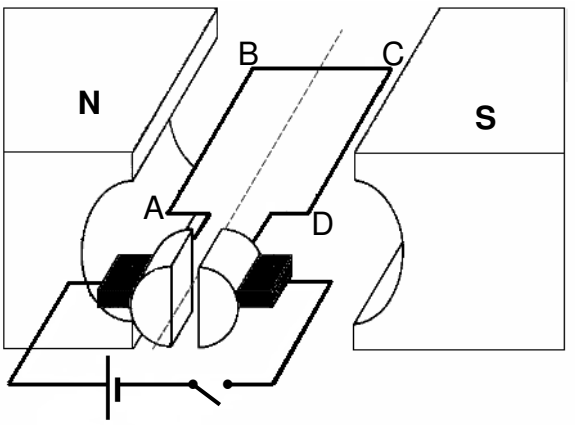
A greatest at point R.

B greatest at point S.

C greatest at point T.

D the same at points R, S and T. (2)

2.8 The simplified diagram of an electric motor is shown below.



When the switch is closed, coil ABCD rotates …

A clockwise.

B anticlockwise.

C clockwise until it reaches the vertical position and then reverses its direction.

D anticlockwise until it reaches the vertical position and then reverses its direction. (2)

2.9 A neon tube lights up when a large external voltage is applied across it.

Which ONE of the following best describes the type of spectrum observed when the gas inside the tube is viewed through a diffraction grating?

A Continuous

B Absorption

C Line emission

D Line absorption (2)

2.10 When a clean metal plate is irradiated with light of sufficient energy, photoelectrons are emitted. The INTENSITY of the light is now increased. This change will …

A increase the number of photoelectrons emitted per second.

B decrease the number of photoelectrons emitted per second.

C increase the kinetic energy of the emitted photoelectrons.

D decrease the kinetic energy of the emitted photoelectrons. (2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

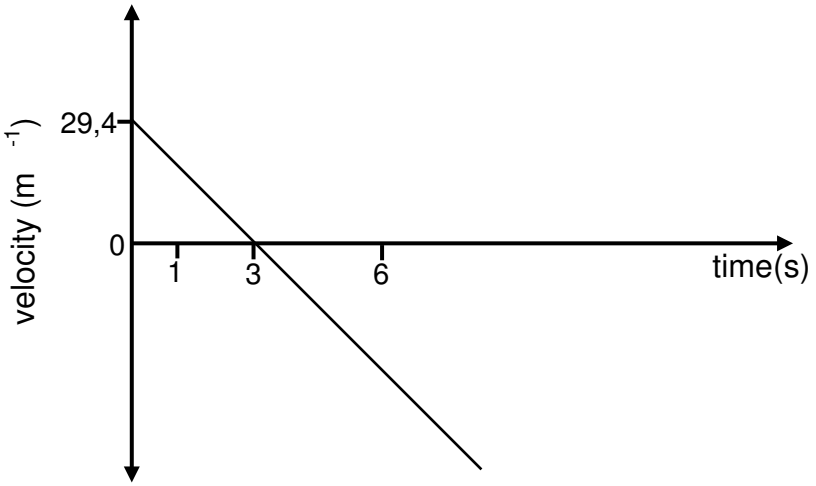
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your numerical answers to TWO decimal places.

QUESTION 3 (Start on a new page.)

A man fires a projectile **X** vertically upwards at a velocity of 29,4 ms $^{-1}$ from the EDGE of a cliff of height 100 m. After some time the projectile lands on the ground below the cliff. The velocity-time graph below (NOT DRAWN TO SCALE) represents the motion of projectile **X**. (Ignore the effects of friction.)



3.1 Use the graph to determine the time that the projectile takes to reach its maximum height. (A calculation is not required.) (1)

3.2 Calculate the maximum height that projectile **X** reaches above the ground. (4)

3.3 Sketch the position-time graph for projectile **X** for the period t = 0 s to t = 6 s. USE THE EDGE OF THE CLIFF AS ZERO OF POSITION.

Indicate the following on the graph:

- The time when projectile **X** reaches its maximum height
- The time when projectile **X** reaches the edge of the cliff (4)

3.4 One second (1 s) after projectile **X** is fired, the man's friend fires a second projectile **Y** upwards at a velocity of 49 m·s^{-1} FROM THE GROUND BELOW THE CLIFF.

The first projectile, **X**, passes projectile **Y** 5,23 s after projectile **X** is fired. (Ignore the effects of friction.)

Calculate the following:

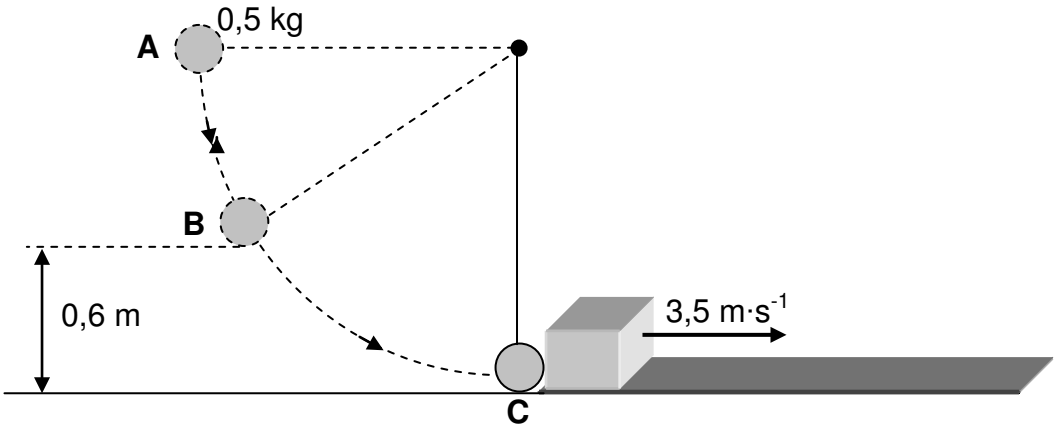
3.4.1 The velocity of projectile **X** at the instant it passes projectile **Y** (5)

3.4.2 The velocity of projectile **X** RELATIVE to projectile **Y** at the instant it passes projectile **Y** (5)

[19]

QUESTION 4 (Start on a new page.)

A steel ball of mass 0,5 kg is suspended from a string of negligible mass. It is released from rest at point **A**, as shown in the sketch below. As it passes through point **B**, which is 0,6 m above the ground, the magnitude of its velocity is 3 m·s^{-1}. (Ignore the effects of friction.)



4.1 Write down the principle of the conservation of mechanical energy in words. (2)

4.2 Calculate the mechanical energy of the steel ball at point **B**. (4)

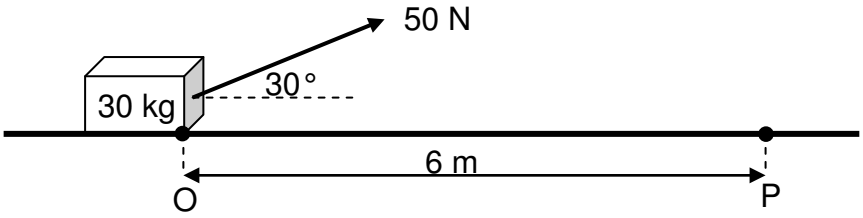
As the steel ball swings through its lowest position at point **C**, it collides with a stationary crate of mass 0,1 kg. Immediately after the collision, the crate moves at a velocity of 3,5 m·s^{-1} to the right.

4.3 Calculate the velocity of the steel ball immediately after the collision. (7)

[13]

QUESTION 5 (Start on a new page.)

A worker pulls a crate of mass 30 kg from rest along a horizontal floor by applying a constant force of magnitude 50 N at an angle of 30° to the horizontal. A frictional force of magnitude 20 N acts on the crate whilst moving along the floor.



5.1 Draw a labelled free-body diagram to show ALL the forces acting on the crate during its motion. (4)

5.2 Give a reason why each of the vertical forces acting on the crate do NO WORK on the crate. (2)

5.3 Calculate the net work done on the crate as it reaches point P, 6 m from the starting point O. (4)

5.4 Use the work-energy theorem to calculate the speed of the crate at the instant it reaches point P. (3)

5.5 The worker now applies a force of the same magnitude, but at a SMALLER ANGLE to the horizontal, on the crate.

How does the work done by the worker now compare to the work done by the worker in QUESTION 5.3? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (No calculations are required.) (2)
[15]

QUESTION 6 (Start on a new page.)

The siren of a burglar alarm system has a frequency of 960 Hz. During a patrol, a security officer, travelling in his car, hears the siren of the alarm of a house and approaches the house at constant velocity. A detector in his car registers the frequency of the sound as 1 000 Hz.

6.1 Name the phenomenon that explains the change in the observed frequency. (1)

6.2 Calculate the speed at which the patrol car approaches the house. Use the speed of sound in air as 340 $m \cdot s^{-1}$. (4)

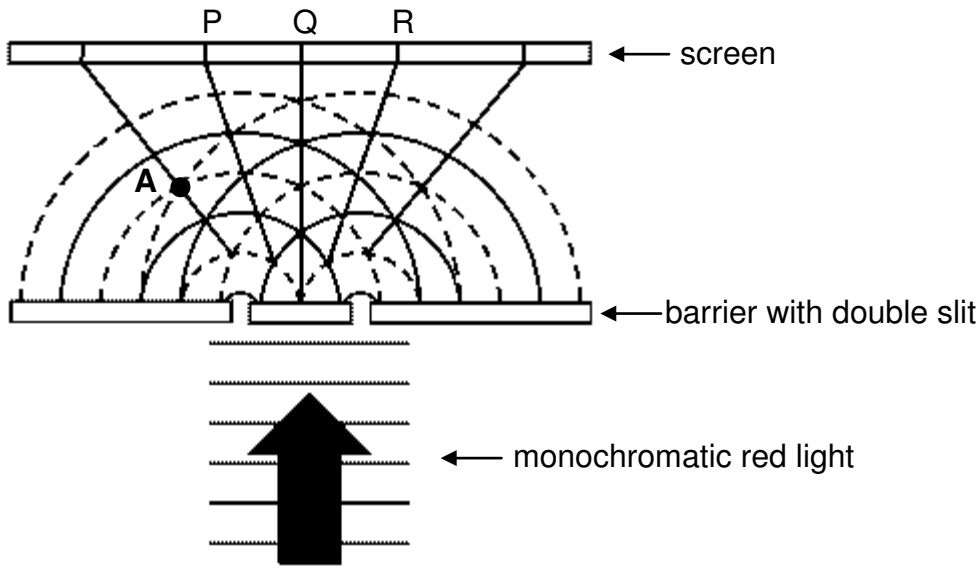
6.3 If the patrol car had approached the house at a higher speed, how would the detected frequency have compared to the first observed frequency of 1 000 Hz? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

[6]

QUESTION 7 (Start on a new page.)

Monochromatic red light passes through a double slit, as shown in the diagram below. Circular wave fronts, advancing towards the screen, are shown between the slits and the screen as dotted lines and solid lines. The solid lines represent crests and the dotted lines troughs.

Interference of the circular wave fronts results in an interference pattern observed on the screen. **P**, **Q** and **R** represent the centres of different bands in the interference pattern.



7.1 Define the term *interference*. (2)

7.2 What type of interference takes place at point **A**? Give a reason for the answer. (2)

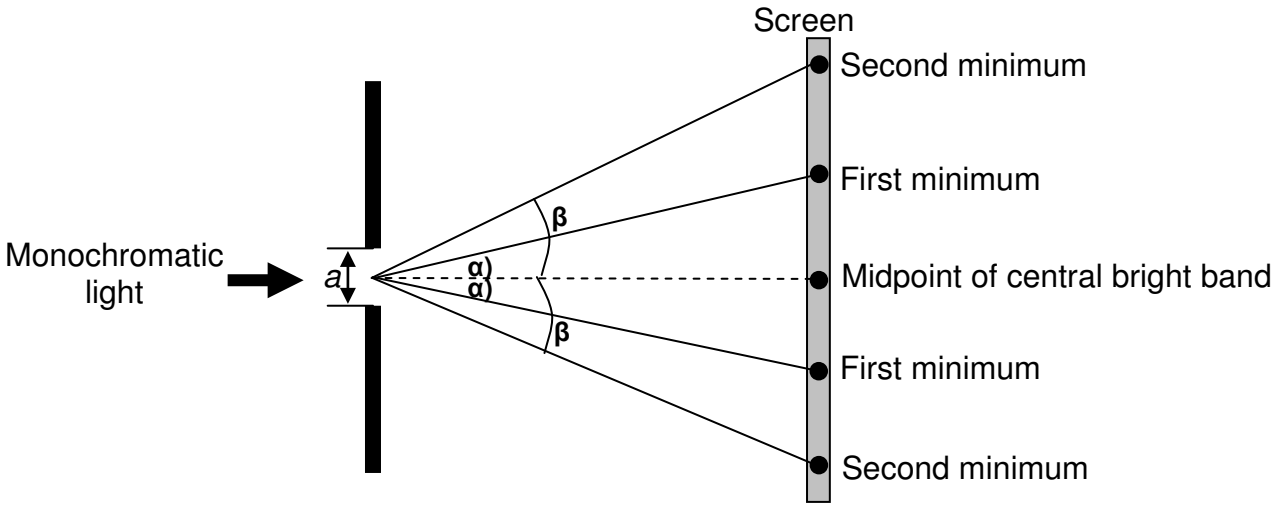
7.3 Is band **P** a dark band or a red band? Refer to the type of interference involved to explain how you arrived at the answer. (3)

[7]

QUESTION 8 (Start on a new page.)

The relationship between the degree of diffraction of light and slit width is investigated.

Monochromatic light of wavelength 410 nm is passed through a single slit at a *fixed distance* from a screen. The angles at which the first minimum (α) and the second minimum (β) occur are measured.



The experiment is repeated using the same light source but a slit of different width.

The results obtained from the two experiments are represented in the table below.

	ANGLE OF 1ST MINIMUM (α)	**ANGLE OF 2ND MINIMUM (β)**
Slit 1	10°	20°
Slit 2	5°	10°

8.1 Define the term *diffraction*. (2)

8.2 For this investigation, name the following:

8.2.1 Dependent variable (1)

8.2.2 Independent variable (1)

8.3 Which ONE of **Slit 1** or **Slit 2** is the narrower slit? Explain the answer. (2)

8.4 Use the data in the table to calculate the width of **Slit 2**. (4)
[10]

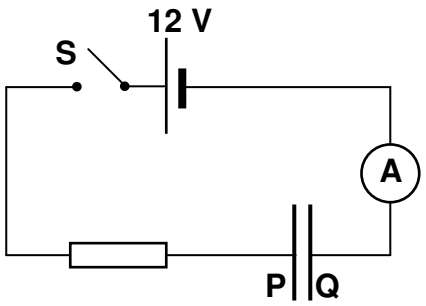
QUESTION 9 (Start on a new page.)

A certain parallel plate capacitor consists of two plates, each of dimension 15 mm by 20 mm, separated by a distance of 1,5 mm. The space between the plates is occupied by air.

9.1 Define the term *capacitance*, in words. (2)

9.2 Calculate the capacitance of this capacitor. (5)

The circuit diagram below shows the ABOVE CAPACITOR, initially uncharged, connected in series to a resistor, an ammeter of negligible resistance and a source with an emf of 12 V. The internal resistance of the battery is negligible.



Switch **S** is now closed.

9.3 Draw a sketch graph of current versus time to show how the ammeter reading changes with time as the capacitor charges. (2)

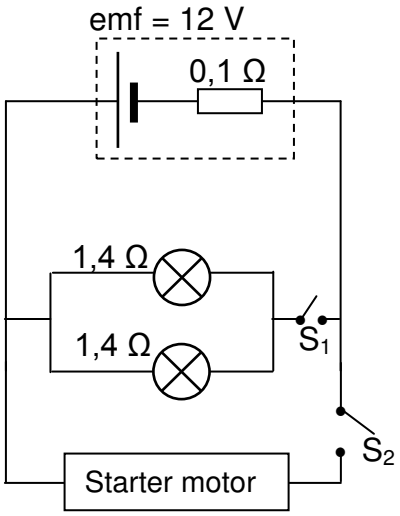
The capacitor is now fully charged.

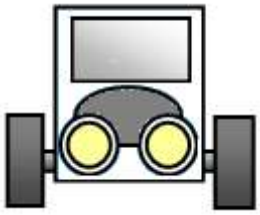
9.4 Calculate the magnitude of the charge on each plate of the capacitor. (3)

9.5 One of the molecules in the air between the plates of the capacitor becomes ionised. This ion carries a charge of $+3,2 \times 10^{-19}$ C. Calculate the magnitude of the electrostatic force experienced by this ion between the plates. (5)
[17]

QUESTION 10 (Start on a new page.)

The headlights of a car are connected in parallel to a 12 V battery, as shown in the simplified circuit diagram below. The internal resistance of the battery is 0,1 Ω and each headlight has a resistance of 1,4 Ω. The starter motor is connected in parallel with the headlights and controlled by the ignition switch, **S_2**. The resistance of the connecting wires may be ignored.





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

10.2 With only switch **S_1** closed, calculate the following:

10.2.1 Effective resistance of the two headlights (3)

10.2.2 Potential difference across the two headlights (4)

10.2.3 Power dissipated by one of the headlights (3)

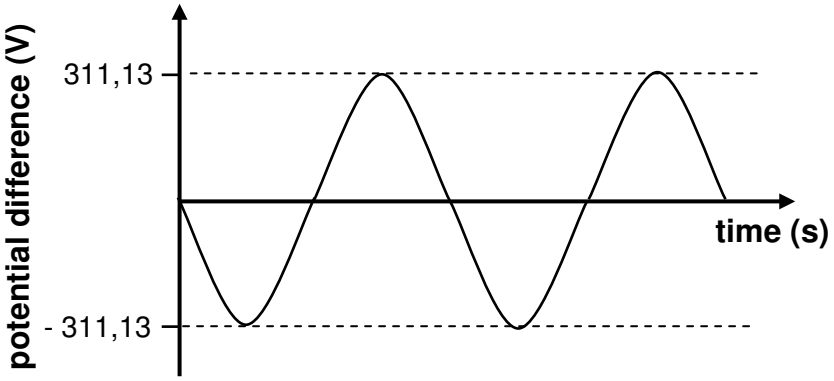
10.3 Ignition switch **S_2** is now closed (whilst **S_1** is also closed) for a short time and the starter motor, with VERY LOW RESISTANCE, rotates.

How will the brightness of the headlights be affected while switch **S_2** is closed? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Fully explain how you arrived at the answer. (4)
[16]

QUESTION 11 (Start on a new page.)

The output of an AC generator is shown in the graph below.



A light bulb with an average power rating of 100 W is connected to this generator.

11.1 Calculate the following:

11.1.1 rms potential difference across the light bulb (3)

11.1.2 Peak current (I_{max}) through the light bulb (5)

11.2 The AC generator is replaced with a DC generator. Draw the graph of potential difference versus time for the output of the DC generator. (No numerical values are expected on the axes.) (2)

[10]

QUESTION 12 (Start on a new page.)

Sunlight is a major source of ultraviolet light.

12.1 Overexposure to ultraviolet light could have harmful effects on humans. State ONE of these harmful effects on humans. (1)

12.2 Medical practitioners expose surgery equipment to ultraviolet light. Give a reason for doing this. (1)

A certain metal has a work function of $3,84 \times 10^{-19}$ J. The surface of the metal is irradiated with ultraviolet light of wavelength 200 nm causing photoelectrons to be emitted.

12.3 Calculate the energy of a photon of ultraviolet light. (4)

12.4 Calculate the maximum velocity of the emitted photoelectrons. (4)

12.5 Will photoelectrons be emitted from the surface of this metal if it is irradiated with X-rays? Give a reason for the answer. (2)

[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}$ $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ $J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}$ $N \cdot m^{2} \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}$ kg
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}$ $F \cdot m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

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

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

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

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2010

MEMORANDUM

MARKS: 150

This memorandum consists of 23 pages.

NOTE: Marking rule 1.5 was changed according to decisions taken at the memorandum discussion, 17-18 November 2010.

Learning Outcomes and Assessment Standards		
LO 1	**LO 2**	**LO 3**
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables.	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge.	**AS 12.3.1:** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims.
AS 12.1.2: Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations.	**AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words.	**AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications.
AS 12.1.3: Select and use appropriate problem-solving strategies to solve (unseen) problems.	**AS 12.2.3:** Apply scientific knowledge in everyday life contexts.	**AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally.
AS 12.1.4: Communicate and defend scientific arguments with clarity and precision.		

GENERAL GUIDELINES

1. CALCULATIONS

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

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

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

1.4 If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark**.

1.5 When **no formula** is given, marks will be **forfeited** for **zero substitutions** not shown. Other substitutions and a correct answer will be credited.

1.6 **No penalisation if zero substitutions are omitted** in calculations where **correct formula** / principle is given correctly.

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

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

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

1.10 All calculations, when not specified in the question, must be done to two decimal places.

2. UNITS

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question or sub-question**.

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

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

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

3. GENERAL

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

3.2 For marking purposes, alternative symbols (s,u,t, etc.) will also be accepted

3.3 Separate compound units with a multiplication dot, not a full stop, for example, $m \cdot s^{-1}$.
For marking purposes $m.s^{-1}$ and m/s will also be accepted.

4. POSITIVE MARKING

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

4.1 **Sub-question to sub-question:** When a certain variable is calculated in one sub-question (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent sub-questions.

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

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

4.4 Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.

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

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

SECTION A

QUESTION 1

1.1	Elastic ✓	[12.2.1]	(1)
1.2	Huygens' (principle) ✓	[12.2.1]	(1)
1.3	ohm / Ω ✓	[12.2.1]	(1)
1.4	(Split-ring) commutator ✓	[12.2.1]	(1)
1.5	Work function ✓	[12.2.1]	(1)
			[5]

QUESTION 2

2.1	A ✓✓	[12.2.3]	(2)
2.2	C ✓✓	[12.1.2]	(2)
2.3	D ✓✓	[12.2.3]	(2)
2.4	D ✓✓	[12.2.2]	(2)
2.5	D ✓✓	[12.2.1]	(2)
2.6	C ✓✓	[12.2.2]	(2)
2.7	C ✓✓	[12.2.2]	(2)
2.8	B ✓✓	[12.1.2]	(2)
2.9	C ✓✓	[12.2.1]	(2)
2.10	A ✓✓	[12.2.2]	(2)
			[20]

TOTAL SECTION A: 25

SECTION B

QUESTION 3

3.1 3 seconds / 3 s ✓ [12.1.2] (1)

3.2

Accept the equations:	
v = u + at	$s = ut + \frac{1}{2}at^2$
$s = \left(\frac{v + u}{2}\right)t$	$v^2 = u^2 + 2as$

OPTION 1

Area between graph and time axis
Δy = (area of triangle)/ ½ bh ✓
= ½ (3)(29,4) ✓
= 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓

OPTION 2

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

$= \left(\frac{0 + 29,4}{2}\right)3$ ✓ $= \left(\frac{29,4 + 0}{2}\right)3$

= 44,1 m (43,22m)

Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓(143,22m)

OPTION 3

From edge of cliff to max height
(Upward positive)
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
∴ $0^2 = 29,4^2 + 2(-9,8)\Delta y$ ✓
∴ Δy = 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m✓

From edge of cliff to max height)
(Downward positive)
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
∴ $0^2 = (-29,4)^2 + 2(9,8)\Delta y$ ✓
∴ Δy = - 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m✓

OPTION 4

From edge of cliff to max height
(Upward positive)

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

= (29,4)(3) + ½(-9,8)(3)^2 ✓

= 44,1 m

Maximum height above ground:

100 +✓ 44,1 = 144,1 m ✓(143,2 m)

From edge of cliff to max height)
(Downward positive)

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

= (-29,4)(3) + ½(9,8)(3)^2 ✓

= - 44,1 m

Maximum height above ground:

100 +✓ 44,1 = 144,1 m ✓

OPTION 5

From max height to edge of cliff
Downward positive

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

(29,4)^2 = 0^2 + 2(9,8)Δy ✓

∴ Δy = 44,1 m

Maximum height above ground:

100 +✓ 44,1 = 144,1 m✓

OPTION 6

From max height to edge of cliff
Downward positive

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

= (0)(3) + ½(9,8)(3)^2 ✓

= 44,1 m

Maximum height above ground:

100 +✓ 44,1 = 144,1 m ✓

OPTION 7

$E_{mech\ (edge\ of\ cliff)} = E_{mech\ (max\ height)}$

$(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ } ✓ any equation

$m(gh + ½ v^2)_A = m(gh + ½ v^2)_B$

(9,8)(100)+ ½ (29,4)^2 ✓= (9,8)h + 0 ✓

h = 144,1 m ✓

OPTION 8

$W_{net} = \Delta E_k$

$mghcos\theta = ½ m(v_f^2 - v_i^2)$ } ✓any equation

$m(ghcos\theta) = ½m(v_f^2 - v_i^2)$

(9,8)hcos180^o = ½ (0^2 - (29,4)^2) ✓

h = 44,1 m (43,22m)

Maximum height above ground:

100 +✓ 44,1 = 144,1 m ✓

OPTION 9

$E_{mech\ (edge\ of\ cliff)} = E_{mech\ (max\ height)}$

$(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ } any equation

$m(gh + ½ v^2)_A = m(gh + ½ v^2)_B$

0 + ½ (29,4)^2 = (9,8)h + 0 ✓

h = 44,1 m

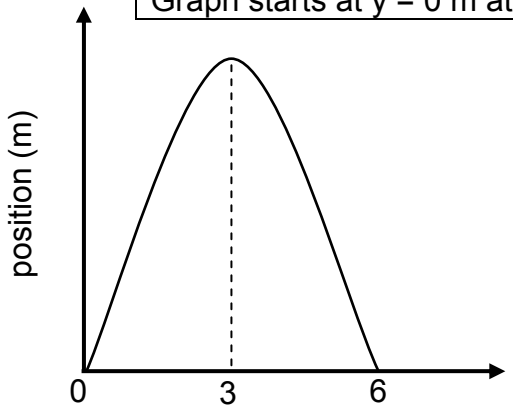
Maximum height above ground:

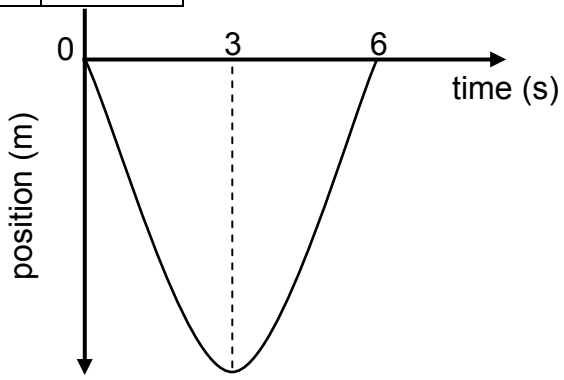
100 +✓ 44,1 = 144,1 m ✓

[12.1.2]
[12.2.3] (4)

3.3

Checklist: Criteria for graph	Marks
Correct shape	✓
t = 3 s at maximum height	✓
t = 6 s at y = 0 m	✓
Graph starts at y = 0 m at t = 0 s	✓





[12.1.2] (4)

3.4.1

OPTION 1:
Upward positive:
$v_f = v_i + a\Delta t$ ✓
$= \underline{29,4}$✓ + $\underline{(-9,8)(5,23)}$ ✓
$= -21,85\ m\cdot s^{-1}$ ✓downwards ✓
OR
$v_f = 21,85\ m\cdot s^{-1}$ ✓downwards✓

Downward positive:
$v_f = v_i + a\Delta t$ ✓
$= \underline{-29,4}$ ✓+ $\underline{(9,8)(5,23)}$ ✓
$= 21,85\ m\cdot s^{-1}$ ✓downwards ✓

OPTION 2
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= 29,4\ (5,23) + ½\ (-9,8)(5,23)^2$
$= 19,73$ m

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$
$= \underline{29,4^2}$ ✓+ $\underline{2(-9,8)(19,73)}$ ✓
$\therefore v_f = 21,85\ m\cdot s^{-1}$ ✓downwards ✓

Downward positive:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (-29,4)(5,23) + ½\ (9,8)(5,23)^2$
$= -19,73$ m

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$
$= \underline{(-29,4)^2}$ ✓+ $\underline{2(9,8)(-19,73)}$ ✓
$\therefore v_f = 21,85\ m\cdot s^{-1}$ ✓downwards ✓

POSITIVE MARKING FROM 3.1

OPTION 3 (Downward motion only)
Downward positive:
Time for downward motion:
(5,23 – 3)✓ = 2,23 s

$v_f = v_i + a\Delta t$ ✓
$= \underline{0 + (9,8)(2,23)}$ ✓
$= 21,85\ m\cdot s^{-1}$ ✓downwards ✓

OPTION 4
Downward positive:
Time for downward motion:
(5,23 – 3)✓ = 2,23 s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{(0)(2,23) + ½\ (9,8)(2,23)^2}$
$= 24,36721$ m

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$
$= \underline{(0)^2 + 2(9,8)(24,36721)}$ ✓
$\therefore v_f = 21,85\ m\cdot s^{-1}$ ✓downwards ✓

[12.2.3] (5)

3.4.2 **POSITIVE MARKING FROM QUESTION 3.4.1**

OPTION 1
Upward positive:

$\Delta t = (5,23 – 1)$ ✓ = 4,23 s

$v_f = v_i + a\Delta t$ ✓
$= \underline{49 + (-9,8)(4,23)}$ ✓
$v_f = 7,55\ m\cdot s^{-1}$ upwards

$\Delta v_{XY} = v_X - v_Y$ (vector difference)
$= -21,85 - 7,55$
$= -29,40\ m\cdot s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40\ m\cdot s^{-1}$✓ downwards✓

$v_{XY} = v_{XG} + v_{GY}$
$= -21,85 + (-7,55)$
$= -29,40\ m\cdot s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40\ m\cdot s^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$-21,85 = v_{XY} + (7,55)$
$= -29,40\ m\cdot s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40\ m\cdot s^{-1}$ ✓downwards✓

Downward positive:

$\Delta t = (5,23 - 1)$ ✓ $= 4,23$ s

$v_f = v_i + a\Delta t$ ✓
$= \underline{-49 + (9,8)(4,23)}$ ✓
$= -7,55 \text{ m·s}^{-1}$
$v_f = 7,55 \text{ m·s}^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= 21,85 + (7,55)$
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= 21,85 - (- 7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$21,85 = v_{XY} + (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

OPTION 2

Upward positive:

$\Delta t = (5,23 - 1)$✓ $= 4,23$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= 49(4,23) + ½ (-9,8)(4,23)^2$
$= 119,59$ m (upwards)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both equations)
$= \underline{(49)^2 + 2(-9,8)(119,59)}$ ✓
$\therefore v_f = 7,55 \text{ m·s}^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= -21,85 + (-7,55)$
$= -29,40 \text{ m·s}^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= -21,85 - 7,55$
$= -29,40 \text{ m·s}^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$-21,85 = v_{XY} + (7,55)$
$= -29,40 \text{ m·s}^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

Downward positive:

$\Delta t = (5,23 - 1)$✓ $= 4,23$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (-49)(4,23) + ½ (9,8)(4,23)^2$
$= -119,59$ m (upwards)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both equations)
$= \underline{(-49)^2 + 2(9,8)(-119,59)}$ ✓
$\therefore v_f = 7,55 \text{ m·s}^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= 21,85 + (7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= 21,85 - (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$21,85 = v_{XY} + (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

[12.1.3] (5)
[19]

QUESTION 4

.1 The sum of the kinetic and (gravitational) potential energy is conserved / constant / remains the same / does not change✓
in an isolated / closed / system / no external work done / only conservative forces act on the system.✓

OR
The (total) mechanical energy is conserved/ constant✓
in an isolated system.✓

[12.2.1] (2)

4.2

OPTION 1
$E_{mech} = U + K$ or $E_p + E_k$
$= mgh + ½ mv^2$ ✓(any formulae)
$= (0,5)(9,8)(0,6)$ ✓$+ ½ (0,5)(3)^2$ ✓
$= 5,19$ J ✓ (5,25 J)

OPTION 2
$E_p = mgh = (0,5)(9,8)(0,6)$ ✓$= 2,94$ J (3 J)
$E_k = ½ mv^2 = ½ (0,5)(3)^2$ ✓$= 2,25$ J
$E_{mech} = E_p + E_k$ ✓$= 2,94 + 2,25$
$= 5,19$ J✓

[12.2.3] (4)

4.3

Accepted formulae
$E_{mech(A)} = E_{mech(B)} / E_{mech(i)} = E_{mech(f)} / E_{mech(top)} = E_{mech(bottom)}$
$(E_p + E_k)_A = (E_p + E_k)_B / (E_p + E_k)_{bottom} = (E_p + E_k)_{top}$
$(E_p + E_k)_i = (E_p + E_k)_f / (U + K)_{bottom} = (U + K)_{top}$
$(U + K)_i = (U + K)_f / (U + K)_A = (U + K)_B /$ $mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$

OPTION 1
$(U + K)_B = (U + K)_C$ ✓
$mgh_B + ½ m v_B^2 = mgh_C + ½ m v_C^2$
$5,19$ ✓ $= 0 + ½ (0,5)v^2$ ✓
$\therefore$ $v = 4,56$ m·s^{-1}

OPTION 2
$W_{net} = \Delta E_k$ ✓
$mg\Delta y\cos\theta = ½ m(v_f^2 - v_i^2)$
$(0,5)(9,8)(0,6)(1)$✓$= ½ (0,5)(v_f^2 - 3^2)$ ✓
$\therefore v_f = 4,56$ m·s^{-1}

$\Sigma p_{before} = \Sigma p_{after}$ ✓
$(0,5)(4,56) + 0$ ✓ $= (0,5)v_{f2} + (0,1)(3,5)$ ✓
$\therefore v_{f2} = 3,86$ m·s^{-1} ✓(to the right) (3,88 m·s^{-1})

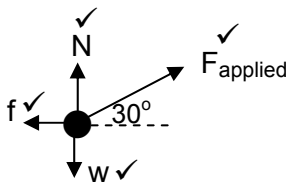
Other formulae:
$p_{t\ before} = p_{t\ after}$ or $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$
or $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

[12.1.3] [12.2.3] (7) **[13]**

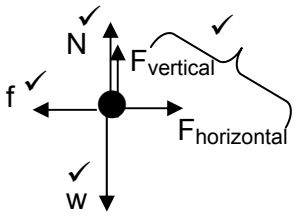
QUESTION 5

Accepted Labels	
N	Normal / Force of surface on crate / F_N / 269 N / 275 N
w	F_g / force of Earth on crate / weight / 294 N /300 N mg / gravitational force
$F_{applied}$	F / force of worker on crate / 50 N / F_A
f	$F_{friction}$ / 20 N / F_f / friction
$F_{horizontal}$ / F_x / $F_{//}$	43,30 N
$F_{vertical}$ / F_y / $F_{\perp}$	25 N

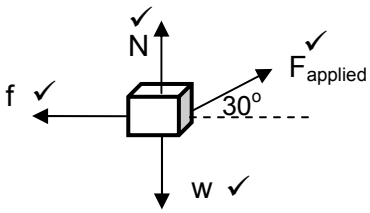
5.1



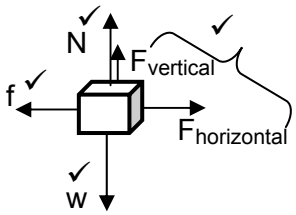
OR



Accept: Force diagram



OR



[12.1.2] (4)

5.2 $W = F\Delta x \cos 90^{o}$✓✓$= 0$

OR
They (normal force and the gravitational force) are perpendicular /at 90^{o} to the (direction of the) displacement / motion / Δx✓✓of the crate.

OR
The angle between the force and displacement / motion / Δx is 90^{o}.✓✓

OR
The crate moves horizontally and the forces act vertically.✓✓ [12.2.2] (2)

5.3

Accepted symbols for applied force: F_{appl} / F / F_A
Accepted symbols for frictional force: f / F_f / $F_{friction}$
Accepted symbols for gravitational force: w / F_g / $F_{force\ of\ Earth\ on\ crate}$ / gravitational force

OPTION 1

$W_{net} = W_{appl} + W_f$ ✓ For either formula
$= F_{app}\ \Delta x \cos\theta + f\Delta x \cos\theta$
$= \underline{(50)(6)(\cos 30°)}$✓ + $\underline{(20)(6)(\cos 180°)}$ ✓
$= 259{,}81 + (-120)$
$W_{net} = 139{,}81$ J ✓

OPTION 2

$W_{applied} = F_{app}\ \Delta x \cos\theta$
$= \underline{(50)(6)(\cos 30°)}$✓
$= 259{,}81$ J
$W_f = f\Delta x \cos\theta$
$= \underline{(20)(6)(\cos 180°)}$ ✓
$= -120$ J

$W_{net} = W_{applied} + W_f$ ✓ OR $F_{app}\Delta x\cos\theta + F\Delta x\cos\theta$
$= 139{,}81$ J ✓

OPTION 3

$W_{net} = W_{appl\ //} + W_f$ ✓ For either formula
$= F_{app//}\ \Delta x \cos\theta + f\Delta x \cos\theta$
$= \underline{(50)(\cos 30°)(6)\cos 0°}$✓ + $\underline{(20)(6)(\cos 180°)}$ ✓
$= 259{,}81 + (-120)$
$W_{net} = 139{,}81$ J ✓

OPTION 4

$F_{net} = F_{horizontal} + f$
$= \underline{(50)(\cos 30°) + (-20)}$ ✓
$= 23{,}30$ N

$W_{net} = F_{net}\ \Delta x \cos\theta$ ✓
$= \underline{(23{,}30)(6)(\cos 0°)}$ ✓
$= 139{,}81$ J✓

OPTION 5

$F_{net} = F_{horizontal} + f$
$ma = \underline{(50)(\cos 30°) + (-20)}$ ✓
$(30)a = (50)(\cos 30°) + (-20)$
$a = 0{,}776...\ m\cdot s^{-2}$

✓one mark for all three formulas

$v_f^2 = v_i^2 + 2a\Delta x$
$= (0)^2 + 2(0{,}78...)(6)$
$v_f = 3{,}052...\ m\cdot s^{-1}$

$W_{net} = \Delta K = \frac{1}{2}\ m(v_f^2 - v_i^2)$
$= \underline{\frac{1}{2}\ (30)(3{,}052...^2 - 0^2)}$ ✓
$= 139{,}81$ J✓

[12.1.3] (4)

5.4

$W_{net} = \Delta K$ / $W_{net} = \Delta E_k$ ✓
$= ½ mv_f^2 - ½ mv_i^2$
$\underline{139,81 = ½ (30)v_f^2 - 0}$ ✓
$v_f = 3,05 \text{ m·s}^{-1}$ ✓

If: W instead of W_{net} max $(2/3)$

No marks for any other method

[12.2.3] (3)

5.5 Greater than ✓

The horizontal component (of the force) / force in direction of motion will now be greater / F_{net} will now be greater.✓

OR
As θ decreases cos θ increases✓

OR
For θ smaller than 30°, cos θ > cos 30°.✓ [12.3.2] (2)
[15]

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ / } f_L = \frac{v + v_L}{v} f_s \text{ ✓}$$

$$\therefore 1\,000 \text{ ✓} = \left(\frac{340 + v_L}{340}(960)\right) \text{ ✓}$$

$\therefore v_L = 14,17 \text{ m·s}^{-1}$ ✓

[12.2.3] (4)

6.3 Higher than ✓ [12.2.2] (1)
[6]

QUESTION 7

7.1 When two waves pass through the same region of space at the same time✓,
resulting in the superposition of waves. ✓ [12.2.1] (2)

7.2 Constructive (interference)✓

- The waves crossing each other are in phase. ✓/ Two troughs meet./
The path difference is an integer number of λ. [12.1.2] (2)

7.3 Dark band ✓

- It lies on the line combining all the points where crests and troughs overlap ✓ resulting in destructive interference. ✓

OR
It lies on the (nodal) line✓ where destructive interference occurs. ✓
(3)
[12.1.2] **[7]**

QUESTION 8

8.1 The ability of a wave to bend / spread out (in wave fronts)✓
as they pass through a (small) aperture / opening or around a (sharp) edge/ points /corners / barrier. ✓ (2)

8.2 8.2.1 Angle of / (Degree of) diffraction ✓
Position of minima
α or β [12.1.1] (1)

8.2.2 (Slit) width / a ✓ [12.1.1] (1)

8.3 (Slit) 1 ✓
Slit 1 represents the most diffraction. ✓

OR
Diffraction /Angle / sin θ / θ is inversely proportional to slit width. ✓

OR
$\sin\theta \ \alpha \frac{1}{a}$ or $\theta \ \alpha \frac{1}{a}$ ✓

OR
Larger angle at which first minimum for slit 1 is obtained. ✓

OR
Smaller angle at which first minimum for slit 2 is obtained.✓

OR
Actual calculations showing slit 1 is narrower than slit 2. ✓ [12.1.2] [12.2.2] (2)

8.4

OPTION 1

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 5° = \frac{(1)(410 \times 10^{-9})}{a}$ ✓ ✓

$\therefore$ a = 4,70 x 10^{-6} m ✓ (0,0000047 m / 4,7 µm)

OPTION 2

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 10° = \frac{(2)(410 \times 10^{-9})}{a}$ ✓ ✓

$\therefore$ a = 4,72 x 10^{-6} m ✓ (0,00000472 m / 4,72 µm)

OPTION 3

Allocated full marks if calculation shown correctly in QUESTION 8.3. [12.1.3] (4)

[10]

QUESTION 9

9.1 The ratio of the (amount of) charge (transferred) ✓
to the (resulting) potential difference. ✓

[12.2.1] (2)

9.2 $C = \frac{\varepsilon_0 A}{d}$ or $C = \frac{K\varepsilon_0 A}{d}$ ✓ where $K = 1$ ✓

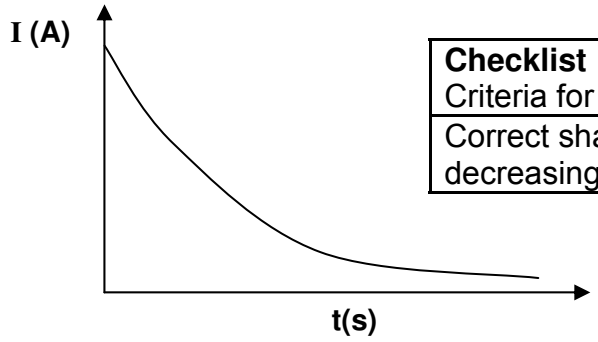
3 x 10^{-4}

$= \frac{(8,85\times10^{-12})(2\times10^{-2})(1,5\times10^{-2})}{1,5\times10^{-3}}$ ✓

$\therefore C = 1,77 \times 10^{-12}$ F ✓ (1,77 pF)

[12.2.3] (5)

9.3



Checklist Criteria for graph:	**Mark/** ***Punt***
Correct shape of graph showing decreasing current with time.	✓✓

[12.1.2] (2)

9.4 $C = \frac{Q}{V}$ ✓

$\therefore 1,77 \times 10^{-12} = \frac{Q}{12}$ ✓

$\therefore Q = 2,12 \times 10^{-11}$ C ✓

[12.2.3] (3)

9.5

OPTION 1	**OPTION 2**
$F = \frac{Vq}{d}$ ✓✓ $= \frac{(12)(3,2\times10^{-19})}{1,5\times10^{-3}}$ ✓ ✓ $= 2,56 \times 10^{-15}$ N ✓	$E = \frac{V}{d}$ ✓ $= \frac{12}{1,5\times10^{-3}}$ ✓ $= 8 \times 10^3$ V·m^{-1} $E = \frac{F}{q}$ ✓ $8 \times 10^3 = \frac{F}{3,2\times10^{-19}}$ ✓ $\therefore F = 2,56 \times 10^{-15}$ N ✓

(5)

[12.1.3] **[17]**

QUESTION 10

10.1 The current in a conductor is directly proportional to the potential difference ✓
across its ends at constant temperature. ✓

OR
The ratio of potential difference to current is constant✓
at constant temperature ✓ [12.2.1] (2)

10.2.1 $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}$ ✓ = $\frac{1}{1,4}+\frac{1}{1,4}$ ✓ ∴ R_p = 0,7 Ω ✓

OR
$R_p = \frac{R_1R_2}{R_1+R_2}$ ✓ = $\frac{1,4\times1,4}{1,4+1,4}$ ✓= 0,7 Ω ✓ [12.2.3] (3)

10.2.2

OPTION 1:
emf = I(R + r) ✓
∴ 12 = I(0,7 + 0, 1) ✓
∴ I = 15 A
R = $\frac{V}{I}$
0,7 = $\frac{V}{15}$ ✓
∴V = 10,5 V ✓

OPTION 2:
I = $\frac{V}{R}$ ✓ = $\frac{12}{0,8}$ ✓ = 15 A

V = IR
= (15)(0,7) ✓
= 10,5 V ✓

emf = I(R + r)
12 = $V_{external}$ + (15)(0,1) ✓
$V_{external}$ = 12 – (15)(0,1)
= 10,5 V ✓

$V_{"lost"}$ = Ir = (15)(0,1) ✓= 1,5 V
$V_{external}$ = 12 – 1,5 V = 10,5 V✓

$I_{headlight} = \frac{15}{2}$ = 7,5 A✓
V = IR = (7,5)(1,4) = 10,5 V✓

OPTION 3
Voltage divides 0,7: 0,1 / 7:1
∴$V_{headlight}$ = $\frac{7}{8}$ ✓✓x 12 ✓
= 10,5 V ✓

[12.2.3] (4)

10.2.3

OPTION 1

$P = \frac{V^2}{R}$ ✓

$= \frac{10,5^2}{1,4}$ ✓

= 78,75 W ✓

OPTION 2

I(light) = 7,5 A

P = VI ✓
= (10,5)(7,5) ✓
= 78,75 W ✓

OPTION 3

I(light) = 7,5 A

$P = I^2R$ ✓
$= (7,5)^2(1,4)$ ✓
= 78,75 W ✓

OPTIONS ACCEPTED ONLY BECAUSE BULBS ARE IDENTICAL:

$P_{total} = \frac{V^2}{R}$ ✓

$= \frac{(10,5)^2}{0,7}$

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

P_{total} = VI ✓
= (10,5)(15)
= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

$P_{total} = I^2R$ ✓
$= (15)^2(0,7)$
= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

[12.2.3] (3)

10.3 Decreases ✓

\- (Effective/ total) resistance decreases. ✓
(Total) current increases. ✓
"Lost volts" / $V_{internal}$ / Ir increases, thus potential difference / V (across headlights) decreases.✓
$P = \frac{V^2}{R}$ decreases.

[12.1.3] (4)
[16]

QUESTION 11

11.1 11.1.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{311{,}13}{\sqrt{2}}$ ✓ $= 220$ V ✓

[12.2.3] (3)

11.1.2

OPTION 1

$P_{ave} = V_{rms}I_{rms}$ ✓ $\therefore$ $100 = (220)I_{rms}$ ✓ $\therefore$ $I_{rms} = 0{,}45$ A

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max} = 0{,}45\sqrt{2}$ ✓ $= 0{,}64$ A ✓

OPTION 2

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$100 = \frac{(220)^2}{R}$ ✓ $\therefore R = 484\ \Omega$

$R = \frac{V_{max}}{I_{max}}$ ✓

$484 = \frac{311{,}13}{I_{max}}$ ✓

$I_{max} = 0{,}64$ A ✓

OPTION 3

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \frac{V_{max}}{\sqrt{2}} \times \frac{I_{max}}{\sqrt{2}} = \frac{V_{max}I_{max}}{2}$ ✓

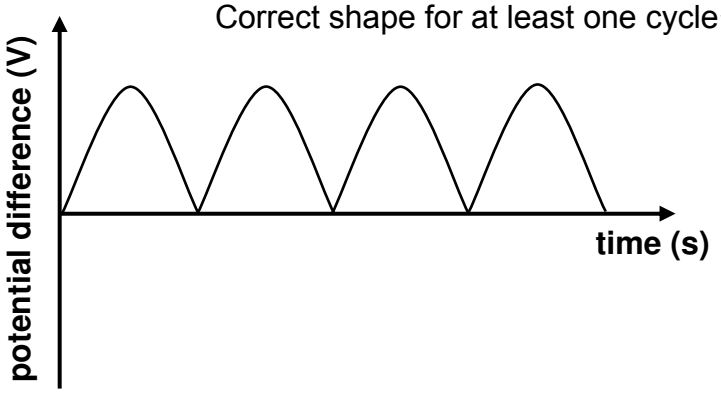
100 ✓ $= \frac{311{,}13 \times I_{max}}{2}$ ✓

$I_{max} = 0{,}64$ A ✓

[12.1.3] (5)

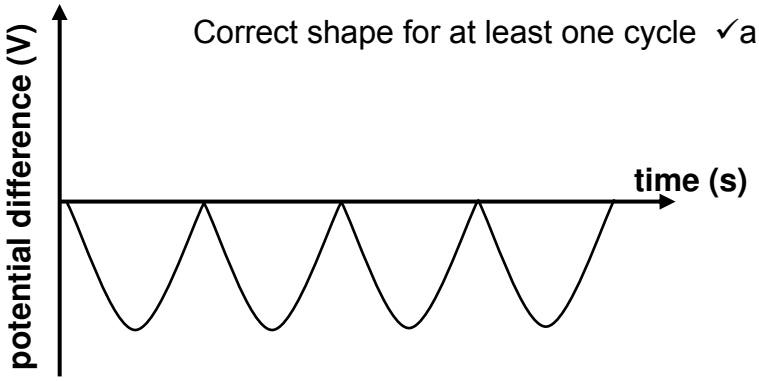
11.2

Correct shape for at least one cycle✓ and loops of equal height. ✓



OR

Correct shape for at least one cycle ✓and loops of equal height. ✓



[12.1.2] (2)
[10]

QUESTION 12

12.1 Any ONE: ✓
Damage to skin./Causes (skin) cancer.
Damage to eyes./Increased occurrence of cataracts.
Damage to crops resulting in food shortages. [12.3.2] (1)

12.2 Kills bacteria / germs / Sterilises/ sanitises / disinfects equipment.✓ [12.3.2] (1)

12.3

OPTION 1

$E = \frac{hc}{\lambda}$ ✓

$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{200 \times 10^{-9}}$ ✓✓

$= 9,95 \times 10^{-19}$ J ✓

OPTION 2

$c = f\lambda$

$3 \times 10^{8} = f(200 \times 10^{-9})$ ✓

$f = 1,5 \times 10^{15}$ Hz

✓ for both formulae

$E = hf$

$= (6,63 \times 10^{-34})(1,5 \times 10^{15})$ ✓

$= 9,95 \times 10^{-19}$ J ✓

[12.2.3] (4)

12.4

OPTION 1

$E = W_o + E_k$
$hf = hf_o + \frac{1}{2} mv^2$ } ✓ For either formula

$9,95 \times 10^{-19}$ ✓ $= \underline{3,84 \times 10^{-19} + \frac{1}{2}(9,11 \times 10^{-31})v^2}$ ✓

$\therefore v = 1,16 \times 10^{6}$ m·s^{-1}✓ (1157583,69 - 1158180,94 m·s^{-1})

OPTION 2

$E = W_o + E_k$ ✓

$E_k = \underline{9,95 \times 10^{-19} - 3,84 \times 10^{-19}}$ ✓
$= 6,11 \times 10^{-19}$ J

$E_k = \frac{1}{2} mv^2$
$\underline{6,11 \times 10^{-19} = \frac{1}{2}(9,11 \times 10^{-31})v^2}$ ✓

$\therefore v = 1,16 \times 10^{6}$ m·s^{-1}✓ (1157583,69 - 1158180,94 m·s^{-1})

Other symbols:
E: hf
W_o: hf_o
K: E_k: $\frac{1}{2} mv^2$

[12.2.3] (4)

12.5 Yes✓
(Photons of) X rays have a higher frequency / shorter wavelength / energy (than ultraviolet radiation). ✓

OR
UV light has lower frequency than X-rays. [12.2.2] (2)
[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2010

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

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

2. Answer ALL the questions in the ANSWER BOOK.

3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

4. You may use a non-programmable calculator.

5. You may use appropriate mathematical instruments.

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

7. Data sheets and a periodic table are attached for your use.

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

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The homologous series to which H – C ≡ C – H belongs (1)

1.2 The electrode in a galvanic cell at which reduction takes place (1)

1.3 The type of chemical reaction that releases energy (1)

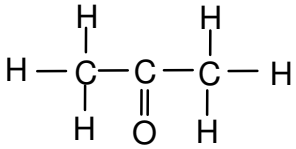
1.4 The type of electrochemical cell used in industry to produce elements such as chlorine and aluminium (1)

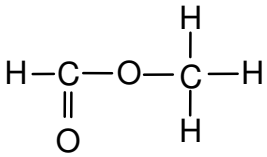
1.5 The process by which an increase in the concentration of primary nutrients in a river leads to algal bloom (1)
[5]

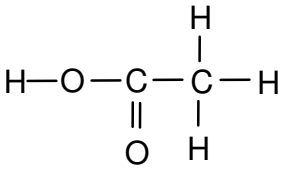
QUESTION 2: MULTIPLE-CHOICE QUESTIONS

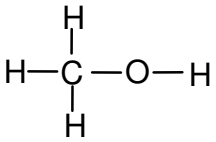
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

2.1 Which ONE of the following compounds represents a ketone?

A 

B 

C 

D 
(2)

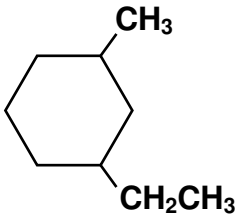
2.2 Consider the compound with molecular formula C_4H_{10}. How many structural isomers does this compound have?

A 1
B 2
C 3
D 4
(2)

2.3 Which ONE of the following pairs of reactants can be used to prepare the ester ethyl butanoate in the laboratory?

A Ethanal and butanol
B Ethanoic acid and butanol
C Ethanol and butanoic acid
D Ethanal and butanoic acid (2)

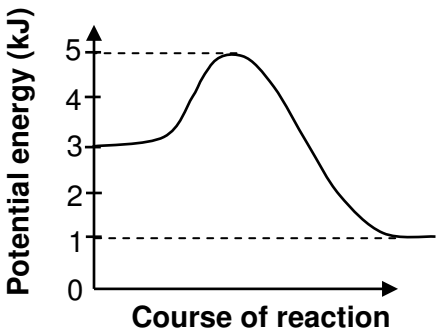
2.4 A cyclic hydrocarbon is represented below.



Which ONE of the following is the correct IUPAC name of this compound?

A 3-methyl-1-ethylcyclohexane
B 1-ethyl-5-methylcyclohexane
C 1-methyl-5-ethylcyclohexane
D 1-ethyl-3-methylcyclohexane (2)

2.5 The graph below represents the relationship between potential energy and course of reaction for a certain chemical reaction.



The activation energy for the forward reaction is …

A 1 kJ.
B 2 kJ.
C 3 kJ.
D 4 kJ. (2)

2.6 The reaction represented by the equation below reaches equilibrium.

$$\underset{\text{pink}}{Co(H_2O)_6^{2+}}(aq) + 4C\ell^-(aq) \rightleftharpoons \underset{\text{blue}}{CoC\ell_4^{2-}}(aq) + 6H_2O(\ell) \qquad \Delta H > 0$$

Which ONE of the following changes to the reaction mixture will change its colour from blue to pink?

A Add a catalyst.

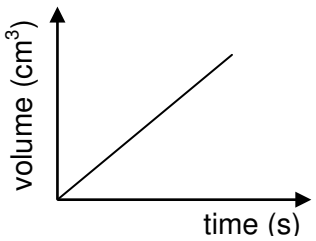
B Place the reaction mixture in a container with hot water.

C Add a few drops of concentrated hydrochloric acid to the reaction mixture.

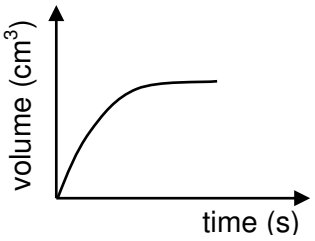
D Add water to the reaction mixture. (2)

2.7 One of the products formed in a chemical reaction is a gas. Which ONE of the following graphs of volume versus time best represents the formation of this gas until the reactants are used up?

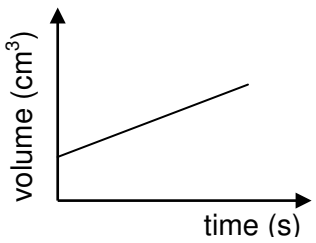
A



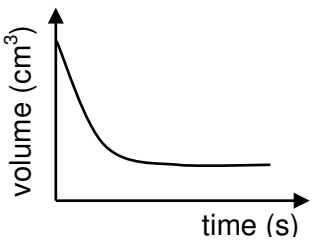
B



C



D



(2)

2.8 Which ONE of the following statements regarding the anode of a standard galvanic cell in operation is correct?

A The anode accepts electrons.

B The mass of the anode decreases.

C The concentration of the electrolyte in the half-cell containing the anode initially decreases.

D The anode is the positive terminal of the cell. (2)

2.9 Consider the reaction represented by the following equation:

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

Which ONE of the following represents the oxidising agent in the above reaction?

A Ag^{+}

B Ag

C Cu

D Cu^{2+} (2)

2.10 A membrane cell is used for the electrolysis of brine (saturated solution of salt and water). One function of the membrane in this cell is to allow …to pass through it.

A molecules

B anions

C cations

D both anions and cations (2)

[20]

TOTAL SECTION A: 25

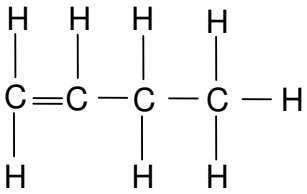
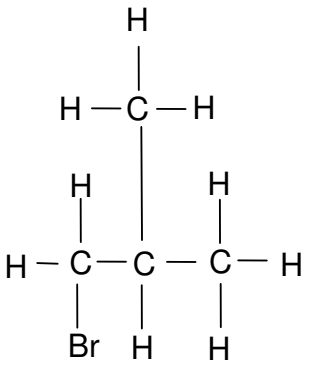
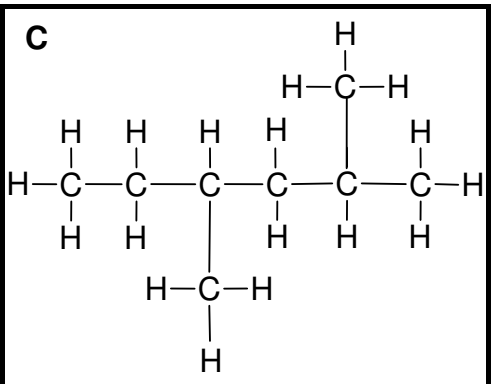
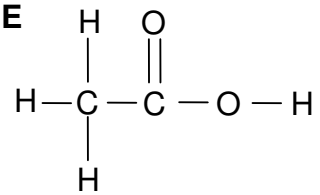
SECTION B

INSTRUCTIONS

1. Start each question on a NEW page.
2. Leave one line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off ALL numerical answers to TWO decimal places.

QUESTION 3 (Start on a new page.)

The chemical properties of organic compounds are determined by their functional groups. The letters **A** to **F** in the table below represent six organic compounds.

A 	**B** 	**C** 
D Methanal	**E** 	**F** Methyl methanoate

3.1 Write down the LETTER that represents the following:

3.1.1 An alkene (1)

3.1.2 An aldehyde (1)

3.2 Write down the IUPAC name of the following:

3.2.1 Compound **B** (2)

3.2.2 Compound **C** (2)

3.3 Write down the structural formula of compound **D**. (2)

3.4 Write down the IUPAC name of the carboxylic acid shown in the table. (2)

3.5 Write down the structural formula of compound **F**. (2)

[12]

QUESTION 4 (Start on a new page.)

Five alcohols represented by the letters **A** – **E** are listed in the table below.

A	Methanol	**B**	Ethanol
C	Propan-1-ol	**D**	Butan-2-ol
E	2-methylpropan-2-ol		

4.1 Which ONE of the above alcohols is a SECONDARY alcohol? Write down only the LETTER that represents the alcohol. (1)

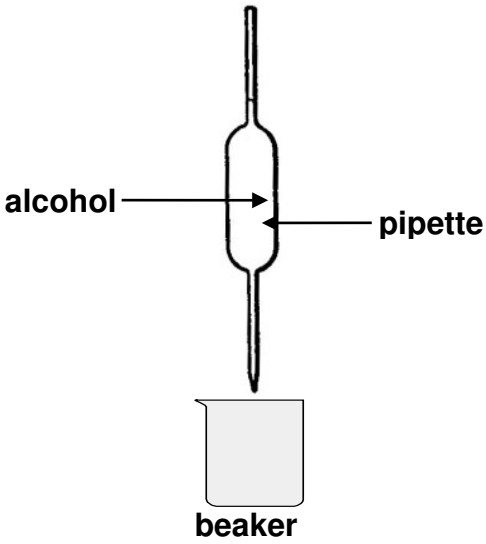
4.2 The letter **E** represents 2-methylpropan-2-ol. For this alcohol, write down the following:

4.2.1 Its structural formula (2)

4.2.2 The LETTER in the table that represents one of its structural isomers (1)

4.3 Viscosity is a measure of a fluid's resistance to flow. Learners conduct an investigation to compare the viscosities of the first three alcohols (**A – C**) in the table above. They use the apparatus shown below.

stopwatch



The learners use the stopwatch to measure the time it takes a FIXED VOLUME of each of the alcohols to flow from the pipette. They record this flow time, which is an indication of the viscosity of each alcohol, as given in the table below.

	Alcohol	Flow time (s)
A	Methanol	4,0
B	Ethanol	7,9
C	Propan-1-ol	14,3

4.3.1 Formulate an investigative question for this investigation. (2)

4.3.2 Which ONE of the alcohols (**A**, **B**, or **C**) has the highest viscosity? Use the data in the table to give a reason for the answer. (2)

4.3.3 Refer to the intermolecular forces of the three alcohols (**A**, **B** and **C**) to explain the trend in viscosities as shown in the table. (2)

4.3.4 Lubricants reduce friction. Which one of alcohols, **A**, **B** or **C**, will be the best lubricant? (1)

4.4 Which ONE of 2-methylpropan-2-ol and butan-2-ol has the higher viscosity? (1)

4.5 Refer to intermolecular forces to explain the answer to QUESTION 4.4. (2)
[14]

QUESTION 5 (Start on a new page.)

Prop-1-ene is a flammable alkene.

5.1 Why is prop-1-ene considered to be a dangerous compound? (1)

Through addition reactions, prop-1-ene can be converted to other compounds, such as alkanes and alcohols.

5.2 Which part of the structure of an alkene allows it to undergo addition reactions? (1)

5.3 In one type of addition reaction, prop-1-ene can be converted to an alcohol.

5.3.1 Use structural formulae to write a balanced equation for the formation of the alcohol during this addition reaction. (4)

5.3.2 Name the type of addition reaction that takes place. (1)

5.3.3 Write down the name or formula of the catalyst used in this reaction. (1)

5.4 Use molecular formulae to write down a balanced chemical equation for the complete combustion of propane. (3)

Prop-1-ene can be produced from an alcohol by an elimination reaction.

5.5 Use structural formulae to write a balanced chemical equation for the formation of prop-1-ene from a PRIMARY alcohol. (4)

5.6 Name the type of elimination reaction that takes place. (1)
[16]

QUESTION 6 (Start on a new page.)

6.1 The collision theory explains why chemical reactions occur and why they take place at different rates.

Some of the terms used in the collision theory and reaction rate are given below.

surface area;	catalyst;	effective collision;	activated complex;
concentration;	temperature;	heat of reaction;	activation energy

Give ONE term for each of the following descriptions by choosing a term from the list above. Write down only the term next to the question number (6.1.1 – 6.1.6) in the ANSWER BOOK.

6.1.1 A chemical substance that speeds up the rate of a chemical reaction by lowering the net activation energy (1)

6.1.2 A collision in which the reacting particles have sufficient kinetic energy and the correct orientation (1)

6.1.3 The factor responsible for increasing the rate of a reaction when a solid is broken up into smaller pieces (1)

6.1.4 The temporary unstable state that is formed during the course of a chemical reaction (1)

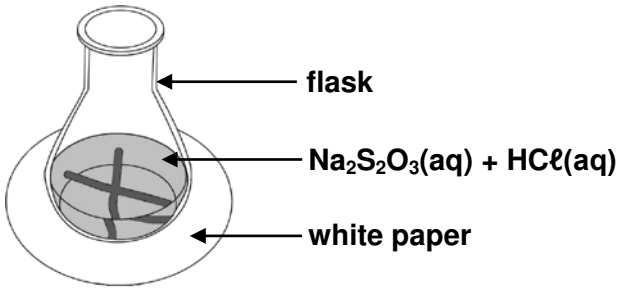
6.1.5 A measure of the average kinetic energy of the particles in a gas (1)

6.1.6 The net amount of energy released or absorbed during a chemical reaction (1)

6.2 Learners use hydrochloric acid and a sodium thiosulphate ($Na_2S_2O_3$) solution to investigate the relationship between rate of reaction and temperature. The reaction that takes place is represented by the following equation:

$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + S(s) + H_2O(\ell) + SO_2(g)$$

They add 5 cm^3 dilute hydrochloric acid solution to 50 cm^3 sodium thiosulphate solution in a flask placed over a cross drawn on a sheet of white paper, as shown in the diagram below. The temperature of the mixture is 30 °C.



They measure the time it takes for the cross to become invisible. The experiment is repeated with the temperature of the mixture at 40 °C, 50 °C and 60 °C respectively.

6.2.1 Write down a possible hypothesis for this investigation. (2)

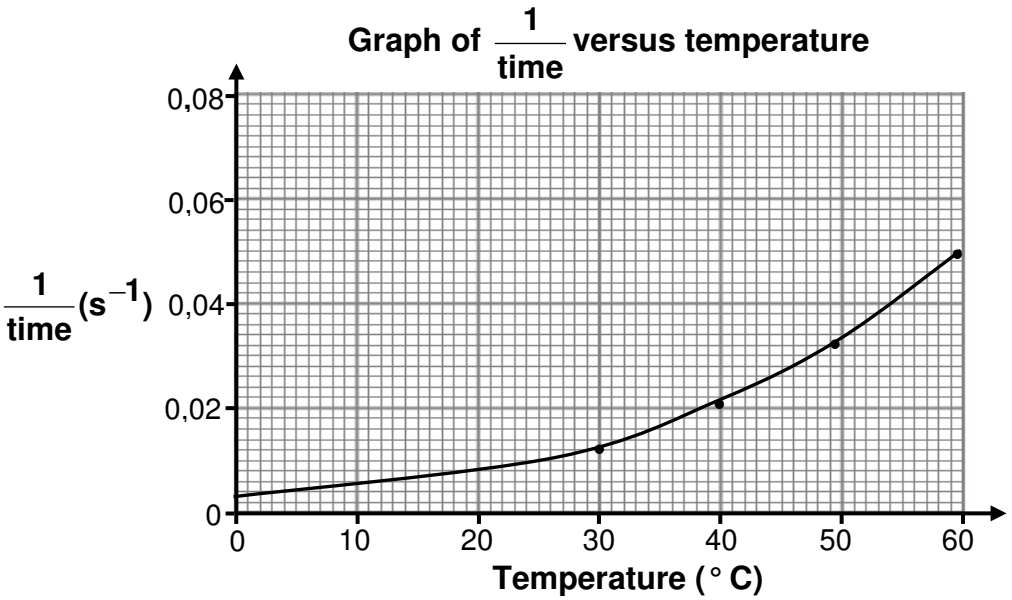
6.2.2 Write down the NAME or FORMULA of the product that requires the need to work in a well-ventilated room. (1)

6.2.3 Apart from the volume of the reactants, state ONE other variable that must be kept constant during this investigation. (1)

6.2.4 Write down the NAME or FORMULA of the product that causes the cross to become invisible. (1)

6.2.5 Why is it advisable that the same learner observes the time that it takes for the cross to become invisible? (1)

The graph shown below is obtained from the results.

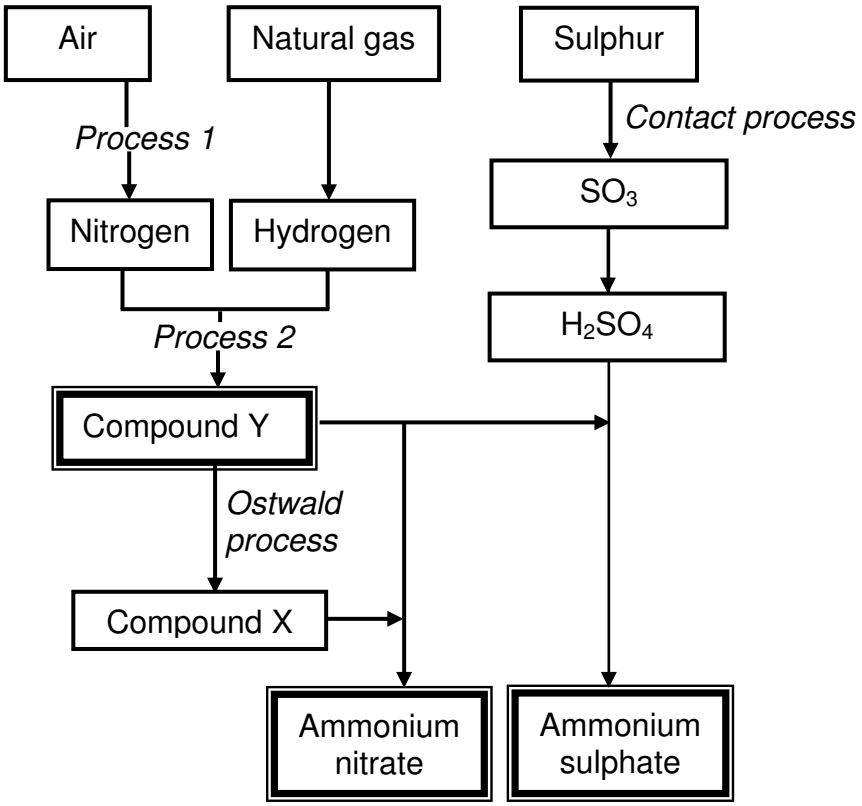


6.2.6 What is represented by $\frac{1}{\text{time}}$ on the vertical axis? (1)

6.2.7 What conclusion can be drawn from the results obtained? (2)
[15]

QUESTION 7 (Start on a new page.)

Ammonia, **ammonium nitrate** and **ammonium sulphate** are three important nitrogen-containing fertilisers. The flow diagram below shows how these fertilisers are produced in industry.



7.1 Use the information in the flow diagram above and write down the following:

7.1.1 Name of Process 1 (1)

7.1.2 Balanced equation for Process 2 (3)

7.1.3 NAME or FORMULA of compound X (1)

7.1.4 Balanced equation for the preparation of ammonium sulphate using sulphuric acid and compound Y (3)

7.1.5 NAME or SYMBOL of the primary nutrient in ammonium sulphate (1)

7.2 Write down ONE positive impact of fertilisers on humans. (2)

7.3 Write down TWO negative impacts of the use of ammonium nitrate, as fertiliser, on humans. (4)

The reaction below represents the catalysed step in the contact process:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

7.4 The reaction takes place in a closed container and reaches equilibrium at 427 °C. How will a HIGHERtemperature affect each of the following? Write down only INCREASES, DECREASES or REMAINS THE SAME.

7.4.1 The rate of production of $SO_3(g)$ (2)

7.4.2 The yield of $SO_3(g)$ (2)

7.5 The reaction is investigated on a small scale in the laboratory. Initially 4 mol of $SO_2(g)$ and an unknown mass, x, of $O_2(g)$ are sealed in a 2 dm^3 flask and allowed to reach equilibrium at a certain temperature.

At equilibrium it is found that the concentration of $SO_3(g)$ present in the flask is 1,5 $mol \cdot dm^{-3}$.

Calculate the mass of $O_2(g)$ initially present in the flask if the equilibrium constant (K_c) at this temperature is 4,5. (9)

[28]

QUESTION 8 (Start on a new page.)

The cell notation of a standard galvanic (voltaic) cell containing an unknown metal electrode **X** is shown below.

$$X(s) \mid X^{3+}(1\ mol \cdot dm^{-3}) \parallel Pb^{2+}(1\ mol \cdot dm^{-3}) \mid Pb(s)$$

8.1 Name the component of the cell represented by the double vertical lines (||) in the above cell notation. (1)

8.2 State the TWO standard conditions that are applicable to the $Pb^{2+}|Pb$ half-cell. (2)

8.3 Identify the oxidising agent in the above cell. (1)

8.4 The initial reading on a voltmeter connected across the electrodes of the above cell is 1,53 V. Identify metal **X** by calculating the standard reduction potential of the unknown metal **X**. (5)

8.5 Write down the balanced equation for the net (overall) reaction taking place in this cell. Omit the spectator ions. (3)

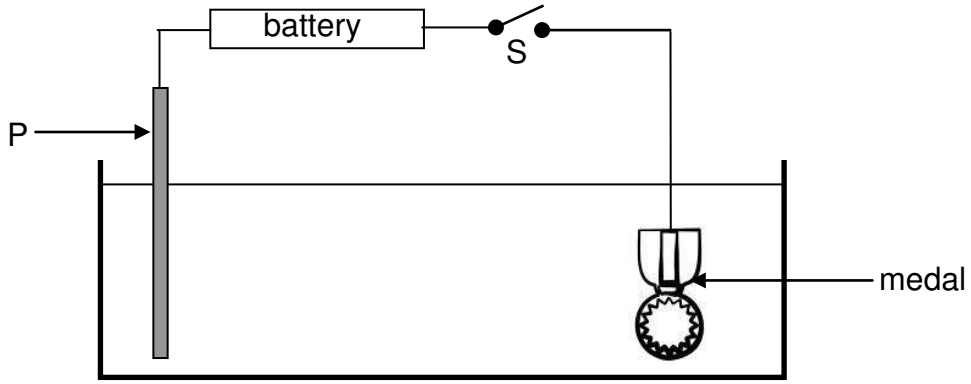
8.6 How will the initial voltmeter reading be affected if the concentration of the electrolyte in the $X(s)|X^{3+}(aq)$ half-cell is increased? Write down only INCREASES, DECREASES or REMAINS THE SAME. (2)

8.7 Write down the value of the reading on the voltmeter when the cell reaction has reached equilibrium. (2)

[16]

QUESTION 9 (Start on a new page.)

The diagram below represents a cell that can be used to electroplate a tin medal with a thin layer of silver to improve its appearance.



9.1 Which one of **P** or the **MEDAL** is the anode in this cell? (1)

9.2 Write down the following:

9.2.1 NAME or SYMBOL of the element of which electrode **P** is composed (1)

9.2.2 NAME or FORMULA of the electrolyte that has to be used to achieve the desired results (1)

9.3 Switch **S** is now closed. Write down the visible changes that will occur at the following:

9.3.1 Electrode **P** (1)

9.3.2 The medal (1)

9.4 Write down the equation for the half-reaction to support the answer to QUESTION 9.3.2. (2)

9.5 How will the concentration of the electrolyte change during the electroplating process? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

9.6 You want to coat the medal with copper instead of silver. State TWO changes that you will make to the above cell to obtain a medal coated with copper. (2)
[10]

QUESTION 10 (Start on a new page.)

Lead-acid batteries have been used in cars for the past 85 years. The equations of the half-reactions that take place in each cell of such batteries are shown below.

$Pb(s) + HSO_4^-(aq) \rightarrow PbSO_4(s) + H^+(aq) + 2e^-$

$PbO_2(s) + 3H^+(aq) + HSO_4^-(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(\ell)$

10.1 Write down the oxidation number of lead (Pb) in $PbSO_4(s)$. (1)

10.2 Write down the balanced equation for the net (overall) cell reaction. (3)

10.3 Which ONE of the reactants is the reducing agent in this cell reaction? Give a reason for the answer. (2)

One of the safety concerns related to the lead-acid battery is the dangers associated with recharging (that is reversing the net reaction) of a flat battery. Water in the battery can be electrolysed to produce hydrogen and oxygen gas during recharging.

10.4 Use the Table of Standard Reduction Potentials and write down the half-reaction which explains the formation of oxygen gas. (2)

10.5 Why is the recharging of flat batteries a safety concern? (1)

10.6 If the cell capacity of such a cell is 3,5 A·h, calculate the number of electrons that flow through the cell in 30 minutes. Assume the cell discharges completely during the 30 minutes. (5)
(The charge on one electron is $-1,6 \times 10^{-19}$ C.) **[14]**

TOTAL SECTION B: 125
GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$
$q = I\Delta t$ $W = Vq$	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **1 H 1**																	**2 He 4**
1,0 **3 Li 7**	1,5 **4 Be 9**											2,0 **5 B 11**	2,5 **6 C 12**	3,0 **7 N 14**	3,5 **8 O 16**	4,0 **9 F 19**	**10 Ne 20**
0,9 **11 Na 23**	1,2 **12 Mg 24**											1,5 **13 Aℓ 27**	1,8 **14 Si 28**	2,1 **15 P 31**	2,5 **16 S 32**	3,0 **17 Cℓ 35,5**	**18 Ar 40**
0,8 **19 K 39**	1,0 **20 Ca 40**	1,3 **21 Sc 45**	1,5 **22 Ti 48**	1,6 **23 V 51**	1,6 **24 Cr 52**	1,5 **25 Mn 55**	1,8 **26 Fe 56**	1,8 **27 Co 59**	1,8 **28 Ni 59**	1,9 **29 Cu 63,5**	1,6 **30 Zn 65**	1,6 **31 Ga 70**	1,8 **32 Ge 73**	2,0 **33 As 75**	2,4 **34 Se 79**	2,8 **35 Br 80**	**36 Kr 84**
0,8 **37 Rb 86**	1,0 **38 Sr 88**	1,2 **39 Y 89**	1,4 **40 Zr 91**	**41 Nb 92**	1,8 **42 Mo 96**	1,9 **43 Tc**	2,2 **44 Ru 101**	2,2 **45 Rh 103**	2,2 **46 Pd 106**	1,9 **47 Ag 108**	1,7 **48 Cd 112**	1,7 **49 In 115**	1,8 **50 Sn 119**	1,9 **51 Sb 122**	2,1 **52 Te 128**	2,5 **53 I 127**	**54 Xe 131**
0,7 **55 Cs 133**	0,9 **56 Ba 137**	**57 La 139**	1,6 **72 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**	1,8 **81 Tℓ 204**	1,8 **82 Pb 207**	1,9 **83 Bi 209**	2,0 **84 Po**	2,5 **85 At**	**86 Rn**
0,7 **87 Fr**	0,9 **88 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

29 Cu 1,9 63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2010

MEMORANDUM

MARKS: 150

This memorandum consists of 16 pages.

Learning Outcomes and Assessment Standards		
LO 1	**LO 2**	**LO 3**
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. **AS 12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. **AS 12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems. **AS 12.1.4:** Communicate and defend scientific arguments with clarity and precision.	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge. **AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words. **AS 12.2.3:** Apply scientific knowledge in everyday life contexts.	**AS 12.3.1:** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims. **AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. **AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally.

GENERAL GUIDELINES

1. CALCULATIONS

1.1 Award marks for: correct formula, correct substitution, correct answer with unit.

1.2 Do no award any marks if an incorrect or inappropriate formula is used, even though there may be relevant symbols and applicable substitutions.

1.3 When an error is made during **substitution into a correct formula**, award a mark for the correct formula and for the correct substitutions, but **do not give any further marks**.

1.4 If no formula is given, but all substitutions are correct, the candidate forfeits one mark.

Example:
No K_c expression, correct substitution

$$K_c = \frac{(2)^2}{(2)(1)^3} \checkmark = 2 \checkmark \left(\frac{2}{3}\right)$$

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

1.6 All calculations, when not specified in the question, must be done to two decimal places.

2. UNITS

2.1 Candidates must be penalised only once for the repeated use of an incorrect unit **within a question or subquestion**.

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

2.3 Award marks for an answer only, and not for a unit *per se*. Candidates forfeit the mark allocated for the answer in each of the following situations:

- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

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

3. GENERAL

3.1 If one answer or calculation is required, but the candidate gives two, mark only the first one, irrespective of which one is correct. If two answers are required, mark only the first two, etc.

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

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

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

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

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

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

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

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

3.4 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, do not accept the following:

- Stating the position of a substance on table 4 only (e.g. Cu is above Mg).
- Using relative reactivity only (e.g. Mg is more reactive than Cu).
- The correct answer would be for instance: Mg is a stronger reducing agent than Cu, and therefore Mg will be able to reduce Cu^{2+} ions to Cu. The answer can also be given in terms of the relative strength as electron acceptors and donors.

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

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

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

3.8 When a structural formula is asked, marks must be deducted if the learner writes the condensed formula.

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

3.10 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.

3.11 If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or product(s). If only a reactant(s) or only a product(s) are written, without an arrow, no marks are awarded for the reactant(s) or product(s).

Examples: $N_2 + 3H_2$ ✓→ $2NH_3$ ✓ bal. ✓

$N_2 + H_2$ →✓	1/3
→ NH_3 ✓	1/3
$N_2 + H_2$	0/3
NH_3	0/3

4. POSITIVE MARKING

Positive marking regarding calculations is followed in the following cases:

4.1 **Subquestion to subquestion:** When a certain variable is calculated in one sub-question (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks must** be awarded for the subsequent sub-questions.

4.2 **A multi-step question in a subquestion**: If the candidate has to calculate, for example, the number of moles in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer is forfeited.

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

SECTION A

QUESTION 1

1.1	Alkynes ✓	[12.2.1]	(1)
1.2	Cathode / Positive (electrode) ✓	[12.2.1]	(1)
1.3	Exothermic (reaction) ✓	[12.2.1]	(1)
1.4	Electrolytic (cell) ✓	[12.2.1]	(1)
1.5	Eutrophication ✓	[12.2.1]	(1)
			[5]

QUESTION 2

2.1	A ✓✓	[12.2.3]	(2)
2.2	B ✓✓	[12.2.3]	(2)
2.3	C ✓✓	[12.2.3]	(2)
2.4	D ✓✓	[12.1.2]	(2)
2.5	B ✓✓	[12.1.2]	(2)
2.6	D ✓✓	[12.2.3]	(2)
2.7	B ✓✓	[12.1.2]	(2)
2.8	B ✓✓	[12.2.3]	(2)
2.9	A ✓✓	[12.2.3]	(2)
2.10	C ✓✓	[12.2.1]	(2)
			[20]

TOTAL SECTION A: 25

SECTION B

QUESTION 3

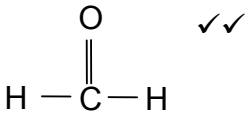
3.1 3.1.1 A ✓ [12.2.3] (1)

3.1.2 D ✓ [12.2.3] (1)

3.2 3.2.1 1-bromo-2-methylpropane ✓✓ [12.2.3] (2)

3.2.2 2,4-dimethylhexane ✓✓ [12.2.3] (2)

3.3

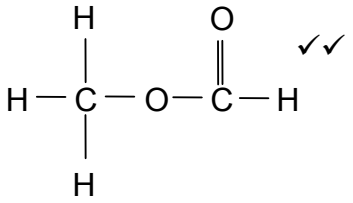


✓✓

[12.2.3] (2)

3.4 Ethanoic acid ✓✓ [12.2.1] (2)

3.5 `



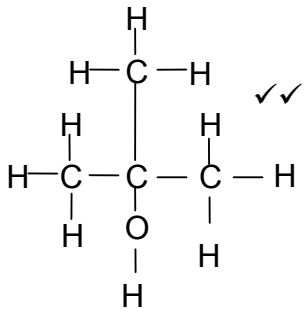
✓✓

[12.2.3] (2)
[12]

QUESTION 4

4.1 D ✓ [12.2.3] (1)

4.2.1



✓✓

[12.2.3] (2)

4.2.2 D ✓ [12.2.3] (1)

Criteria for investigative question	Mark
The dependent and independent variables are stated.	✓
Asks a question about the relationship between dependent and independent variables.	✓

4.3 4.3.1

Example:
What is the relationship between viscosity / flow time
and
chain length / number of C atoms / molecular mass / molecular size / molar mass / surface area / number of electrons / alcohols?
(or vice versa.) [12.1.1] (2)

4.3.2 C ✓
Longest flow time ✓ [12.1.2] [12.2.2] (2)

4.3.3 Increase in chain length / molecular mass / molar mass / molecular size / surface area from A to C. ✓

Increase in (strength of) intermolecular / Van der Waals / dispersion / London / forces ✓ [12.1.4] [12.2.2] (2)

4.3.4 C ✓ [12.3.2] (1)

4.4 D ✓ [12.1.2] (1)

4.5 The more branched /more compact /more spherical alcohol / E has a smaller surface area (over which the intermolecular forces act). ✓
Decrease in (strength of) intermolecular forces / Van der Waals / dispersion / London /forces ✓
reduces resistance to flow (and thus lower viscosity). [12.2.2] (2)

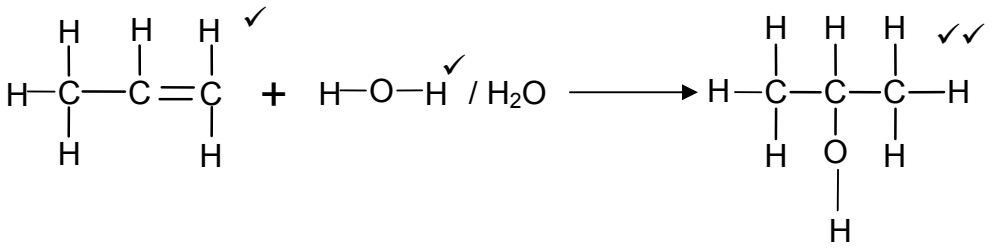
[14]

QUESTION 5

5.1 Any ONE: ✓
Prop-1-ene is highly flammable. [12.3.2] (1)

5.2 Any ONE: ✓
Alkenes contain a double carbon – carbon / (C=C) / bond.
The presence of the pi bond.
They are unsaturated.
Contains an sp^2 hybridised C atom.
All the carbon atoms are not bonded to the max. number of atoms. [12.2.1] (1)

5.3.1



[12.2.3] (4)

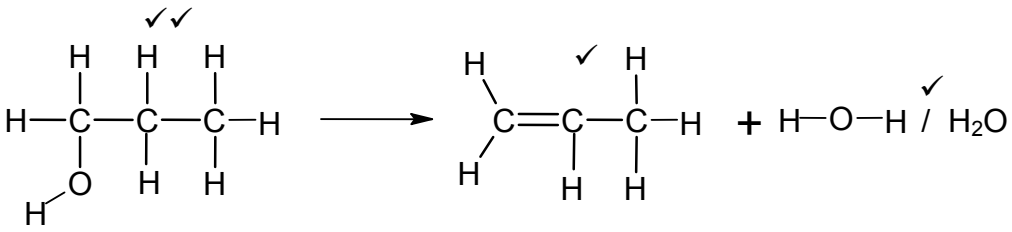
5.3.2 Hydration ✓ [12.2.1] (1)

5.3.3 Sulphuric acid/Hydrogen sulphate/H_2SO_4/Phosphoric acid / H_3PO_4 / Hydrogen phosphate✓ [12.2.1] (1)

5.4 $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

(reactants ✓ ; products✓ ; bal ✓) [12.2.3] (3)

5.5



[12.2.3] (4)

5.6 Dehydration ✓ [12.2.1] (1)
[16]

QUESTION 6

6.1 6.1.1 Catalyst ✓ [12.2.1] (1)

6.1.2 Effective collision ✓ [12.2.1] (1)

6.1.3 Surface area ✓ [12.2.1] (1)

6.1.4 Activated complex ✓ [12.2.1] (1)

6.1.5 Temperature ✓ [12.2.1] (1)

6.1.6 Heat of reaction ✓ [12.2.1] (1)

6.2 6.2.1

Criteria for hypothesis:	**Mark**
The dependent and independent variables are stated.	✓
Makes a prediction about the relationship between dependent and independent variables.	✓

Example:
Reaction rate increases with increase in temperature.

[12.1.1] (2)

6.2.2 Sulphur dioxide / SO_2 ✓ [12.1.1] (1)

6.2.3 Concentration / mass / mol ✓(of acid and sodium thiosulphate) [12.1.1] (1)

6.2.4 Sulphur / S ✓ [12.1.1] (1)

6.2.5 Different people have different sight abilities/reaction times.✓ [12.1.1] (1)

6.2.6 Reaction rate ✓ [12.1.2] (1)

6.2.7

Criteria for conclusion:	**Mark**
The dependent and independent variables are stated.	✓
Makes a correct /true statement about the relationship between dependent and independent variables obtained from the graph.	✓

Example:
Reaction rate increases with increase in temperature. [12.1.2] (2)

[15]

QUESTION 7

7.1 7.1.1 Fractional distillation of liquid air ✓ [12.2.1] (1)

7.1.2 $N_2 + 3H_2 \rightarrow 2NH_3$

(reactants ✓ products ✓ bal ✓) [12.2.3] (3)

7.1.3 Nitric acid / HNO_3 ✓ [12.2.1] (1)

7.1.4 $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$

(reactants ✓ ; products✓ ; bal ✓) [12.2.3] (3)

7.1.5 Nitrogen / N ✓ [12.2.1] (1)

7.2 Any ONE:

- Enhance growth of crops/plants ✓ to produce more food for humans /food security for humans.✓
- Production/application of fertiliser ✓ results in job creation.✓
- Selling of fertilisers ✓ stimulates the economy. ✓ [12.3.2] (2)

7.3 Any TWO:

- (Excessive) nitrates in water (eutrophication) ✓ can result in blue-baby syndrome / cancer. ✓
- (Excessive) nitrates/ammonium ions in water ✓can result in poor quality drinking water. ✓
- (Excessive) nitrates / ammonium ions in water cause death of fish (eutrophication)✓ can result in less food. ✓
- (Excessive) nitrates /ammonium ions in water (eutrophication)✓ can result in poorer water recreational facilities. ✓
- (Excessive) nitrates in soil kill plants/crops✓ resulting in food shortages/famine. ✓
- (Excessive) ammonium ions in soil increases the acidity of the soil ✓ limiting food production✓. [12.3.2] (4)

7.4 7.4.1 Increases ✓✓ [12.2.3] (2)

7.4.2 Decreases✓✓ [12.2.3] (2)

7.5

Option 1:

	SO_2	O_2	SO_3	
Molar ratio	2	1	2	
Initial quantity (mol)	4	$\frac{x}{32}$ ✓✓	0	
Change (mol)	3	1,5	3	Ratio ✓
Quantity at equilibrium (mol)	1	$\frac{x}{32}$ - 1,5 ✓	3✓	
Concentration (mol·dm^{-3})	0,5	$\frac{x-48}{64}$	1,5	Divide by 2 ✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark \therefore 4,5 = \frac{(1,5)^2}{(0,5)^2(\frac{x-48}{64})} \checkmark \therefore x = 176 \text{ g} \checkmark$$

Option 2

$n(SO_3$ at equilibrium) = cV = (1,5)(2) = 3 mol ✓
$n(SO_2$ reacted) = $n(SO_3$ formed) = 3 mol
$n(O_2$ reacted) = ½ $n(SO_3$ formed) = 1,5 mol } Using ratio ✓

At equilibrium: $n(SO_2) = 4 - 3 = 1$ mol
$n(O_2) = (y - 1,5)$ mol } ✓
$n(SO_3) = 3$ mol

$c(SO_3) = 1,5$ mol·dm^{-3}

$c(SO_2) = \frac{n}{V} = \frac{1}{2} = 0,5$ mol·dm^{-3}
$c(O_2) = \frac{n}{V} = \frac{y-1,5}{2}$ mol·dm^{-3} } ✓ divide by 2

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark \therefore 4,5 = \frac{(1,5)^2}{(0,5)^2(\frac{y-1,5}{2})} \checkmark \therefore y = 5,5$$

$\therefore n(O_2) = 5,5$ mol $\therefore m(O_2) = nM = (5,5)\checkmark(32) \checkmark = 176$ g ✓

Option 3:

	SO_2	O_2	SO_3
Molar ratio	2	1	2
Initial quantity (mol)	4	y	0
Change (mol)	3	1,5	3
Quantity at equilibrium (mol)	1	y – 1,5 ✓	3✓
Concentration ($mol \cdot dm^{-3}$)	0,5	$\frac{y-1,5}{2}$	1,5

Ratio ✓

Divide by 2 ✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark \therefore 4,5 = \frac{(1,5)^2}{(0,5)^2(\frac{y-1,5}{2})} \checkmark \therefore y = 5,5$$

$\therefore n(O_2) = 5,5 \text{ mol} \therefore m(O_2) = nM = (5,5)\checkmark(32) \checkmark = 176 \text{ g} \checkmark$

Option 4

	SO_2	O_2	SO_3
Molar ratio	2	1	2
Initial quantity (mol)	4	y	0
Change (mol)	3	1,5	3
Quantity at equilibrium (mol)	1	4	3 ✓
Concentration ($mol \cdot dm^{-3}$)	0,5		1,5

Ratio ✓

Divide by 2 ✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark$$

$$= \frac{(1,5)^2}{(0,5)^2[O_2]} \checkmark$$

$\therefore [O_2] = 2 \text{ mol} \cdot dm^{-3}$

✓

$4 = y - 1,5 \quad \therefore y = 5,5$

$\therefore \quad \therefore n(O_2) = 5,5 \text{ mol}$

$\therefore m(O_2) = nM = (5,5)\checkmark(32) \checkmark = 176 \text{ g} \checkmark$

Option 5

	SO_2	O_2	SO_3
Molar ratio	2	1	2
Initial concentration ($mol \cdot dm^{-3}$)	$\frac{4}{2} = 2\checkmark$	$\frac{x}{32x2}$ ✓✓	0
Change in concentration ($mol \cdot dm^{-3}$)	1,5	0,75	1,5
Equilibrium concentration ($mol \cdot dm^{-3}$)	0,5	0,015625x – 0,75 ✓	1,5

Divide by 2 ✓

Ratio ✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark \therefore 4,5 = \frac{(1,5)^2}{(0,5)^2(0,015625x - 0,75)} \checkmark \therefore x = 176 \text{ g} \checkmark$$

Option 6

	SO_2	O_2	SO_3
Molar ratio	2	1	2
Initial concentration ($mol \cdot dm^{-3}$)	$\frac{4}{2} = 2$ ✓	y	0
Change in concentration ($mol \cdot dm^{-3}$)	~~1,5~~	~~0,75~~	1,5
Equilibrium concentration ($mol \cdot dm^{-3}$)	~~0,5~~	~~y – 0,75~~ ✓	1,5

Ratio ✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark \therefore 4,5 = \frac{(1,5)^2}{(0,5)^2(y-0,75)} \checkmark \therefore y = 2,75 \text{ mol} \cdot \text{dm}^{-3}$$

$$m = cMV = (2,75)\checkmark(32)\checkmark(2) \checkmark = 176 \text{ g} \checkmark$$

[12.1.3] (9)
[28]

QUESTION 8

8.1 Salt bridge ✓ [12.2.1] (1)

8.2 Concentration of the electrolyte – 1 $mol \cdot dm^{-3}$ ✓
Temperature – 25 °C/298 K ✓ [12.2.1] (2)

8.3 Pb^{2+} ✓/ lead(II) ions / lead ions [12.2.3] (1)

8.4 $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ ✓ OR any other correct formula from data sheet
1,53 ✓= (-0,13) ✓- E^o_{anode}
E^o_{anode} = -1,66 (V) ✓

∴ unknown metal X is Aℓ ✓

[12.2.3] (5)

8.5 $2A\ell + 3Pb^{2+} \rightarrow 2A\ell^{3+} + 3Pb$

(reactants ✓ ; products ✓; bal ✓) [12.2.3] (3)

8.6 Decreases ✓✓ [12.2.2] (2)

8.7 0 V✓✓ [12.2.2] (2)
[16]

QUESTION 9

9.1		P ✓	[12.2.3]	(1)
9.2	9.2.1	Ag / Silver ✓	[12.2.1]	(1)
	9.2.2	Silver nitrate / $AgNO_3$ ✓ or silver ethanoate /acetate / CH_3COOAg. (These are the only two soluble silver salts.)	[12.2.1]	(1)
9.3	9.3.1	Silver /metal bar becomes eroded /pitted/ smaller / thinner / eaten away ✓	[12.1.1]	(1)
	9.3.2	A (silver) layer forms on the medal. ✓	[12.1.1]	(1)
9.4		$Ag^+ + e^- \rightarrow Ag$ ✓✓	[12.2.3]	(2)
9.5		Remains the same. ✓	[12.2.3]	(1)
9.6		Replace the silver solution with a copper solution✓/soluble copper salt. Replace the silver bar/electrode P/anode with a copper bar.✓	[12.2.3]	(2) **[10]**

QUESTION 10

10.1 +2 ✓ [12.2.3] (1)

10.2 $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$

OR

$Pb + PbO_2 + 2H^+ + 2HSO_4^- \rightarrow 2PbSO_4 + 2H_2O$

(reactants ✓ ; products ✓ bal ✓) [12.2.3] (3)

10.3 Pb / lead✓
Pb is oxidised/loses electrons. /Highest reducing ability / stronger reducing agent / smaller reduction potential (E^o)✓/causes reduction /
The oxidation number of Pb increases (from 0 → 2) [12.2.3] (2)

10.4 $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ ✓✓ [12.2.3] (2)

10.5 The gases produced during recharging (hydrogen and oxygen) may explode if sparked. ✓ [12.3.2] (1)

10.6 Charge = (3,5)(1)(60)(60) ✓ ✓ [12.1.3]
= 12 600 C✓

Number of electrons = $\frac{q}{1,6 \times 10^{-19}}$

= $\frac{12\,600}{1,6 \times 10^{-19}}$ ✓

= 7,88 x 10^{22} electrons✓ (5)

[14]

TOTAL SECTION B: 125
GRAND TOTAL: 150