basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2014

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages, 3 data sheets and 1 graph sheet.

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INSTRUCTIONS AND INFORMATION

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

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

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

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

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

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

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

9. Show ALL formulae and substitutions in ALL calculations.

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

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

12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following physical quantities is a measure of the inertia of a body?

A Mass

B Energy

C Velocity

D Acceleration (2)

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

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

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

C $2F$

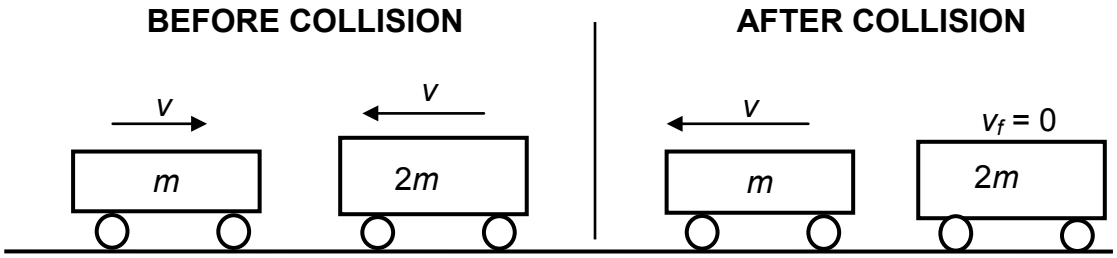
D $4F$ (2)

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

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

(2)

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



Ignore the effects of friction.

Which ONE of the following is CORRECT?

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

(2)

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

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

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

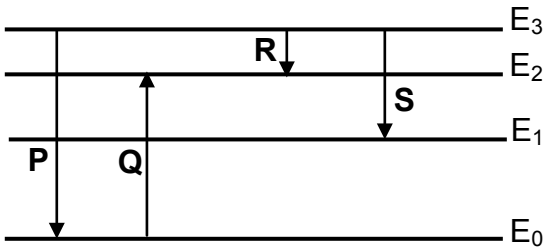
B $\frac{1}{2}x$

C x

D $2x$

(2)

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



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

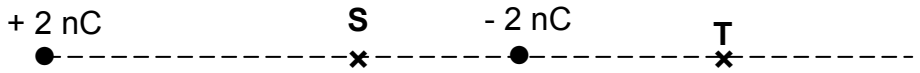
A **P**

B **Q**

C **R**

D **S** (2)

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



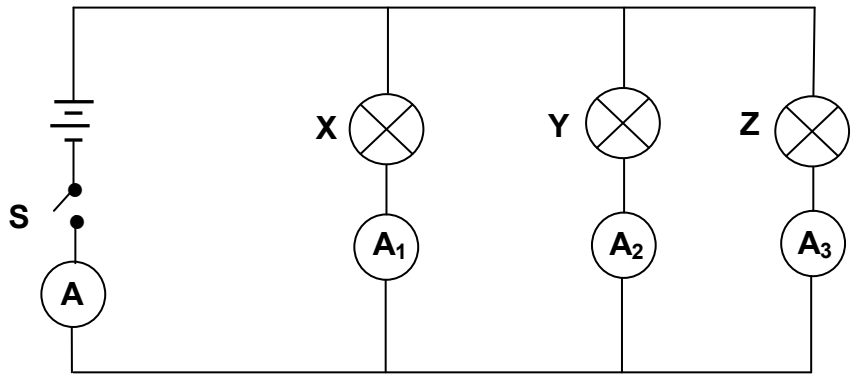
Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T**?

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

(2)

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

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

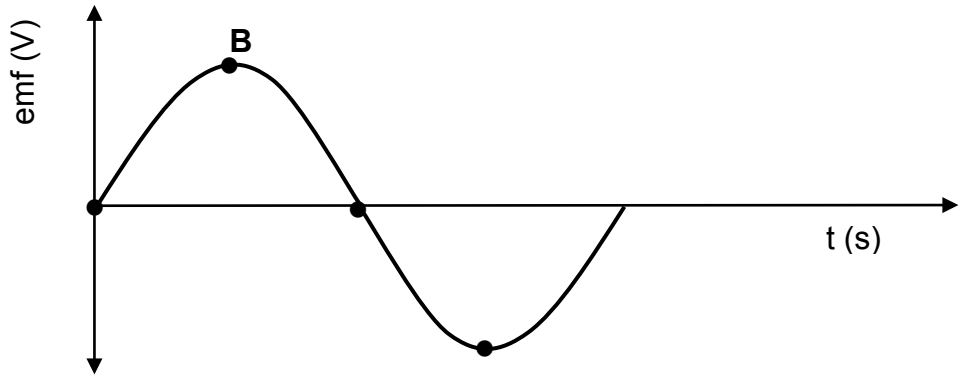


Which ONE of the following correctly describes the readings on the ammeters (in amperes) when bulb **Z** burns out?

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

(2)

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



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

A 0º

B 60º

C 90º

D 120º (2)

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

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

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

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

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

A (i) only

B (ii) only

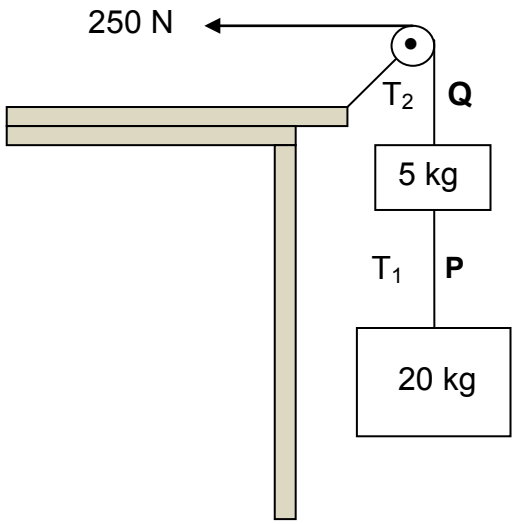
C (i) and (ii) only

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

[20]

QUESTION 2 (Start on a new page.)

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



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

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

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

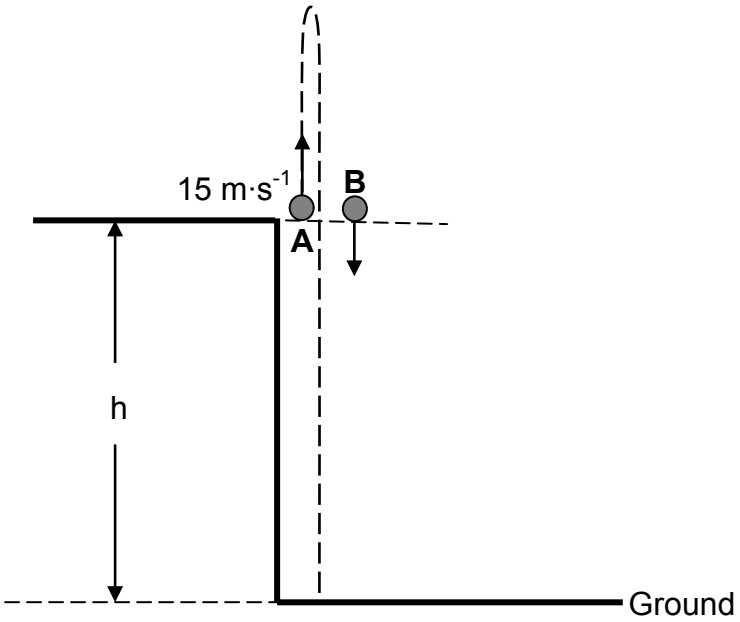
2.4 When the 250 N force is replaced by a sharp pull on the string, one of the two strings break.

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

QUESTION 3 (Start on a new page.)

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

Both balls undergo free fall and eventually hit the ground.



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

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

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

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

Clearly show the following on your graph:

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

(4)
[17]

QUESTION 4 (Start on a new page.)

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

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

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

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

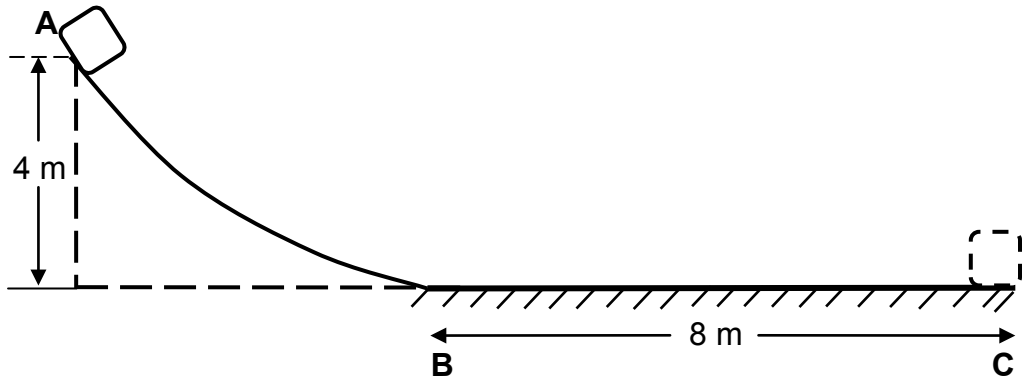
Assume that the dancer performs the same jump as before but lands without bending her knees.

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

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

QUESTION 5 (Start on a new page.)

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



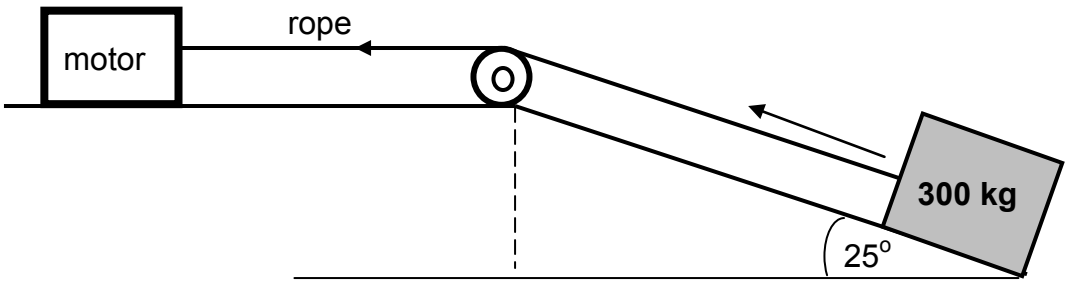
An object of mass 10 kg is released from point **A** which is 4 m above the ground. It slides down the track and comes to rest at point **C**.

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

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

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

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



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

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

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

[18]

QUESTION 6 (Start on a new page.)

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

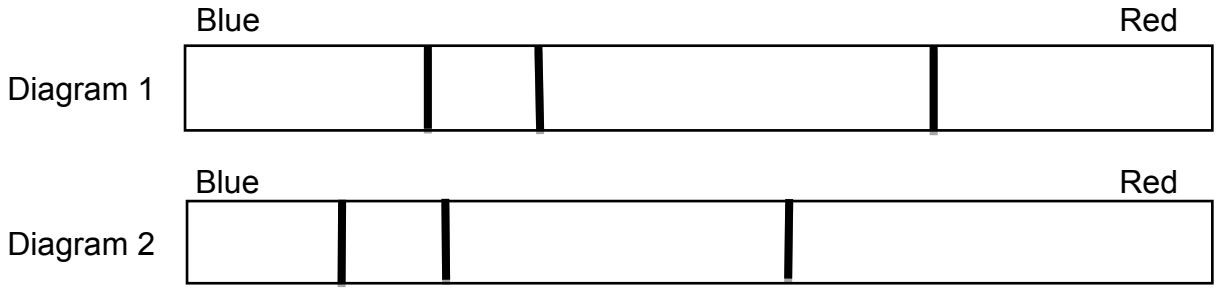
6.1.1 State the Doppler effect in words. (2)

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

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

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

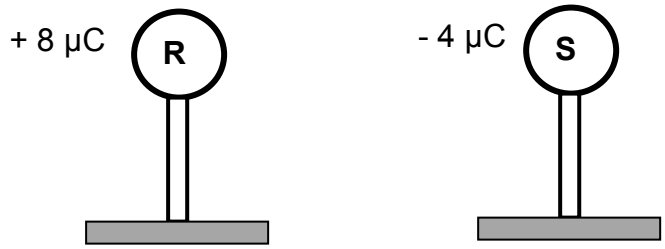
The two diagrams below represent different spectral lines of an element. Diagram **1** represents the spectrum of the element in a laboratory on Earth. Diagram **2** represents the spectrum of the same element from a distant star.



Is the star moving *towards* or *away from* the Earth? Explain the answer by referring to the shifts in the spectral lines in the two diagrams above. (2)
[11]

QUESTION 7 (Start on a new page.)

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



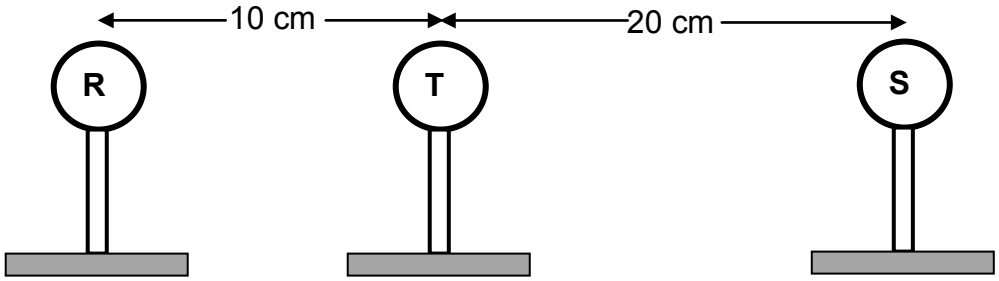
7.1 Explain why the spheres were placed on wooden stands. (1)

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

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

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

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



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

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

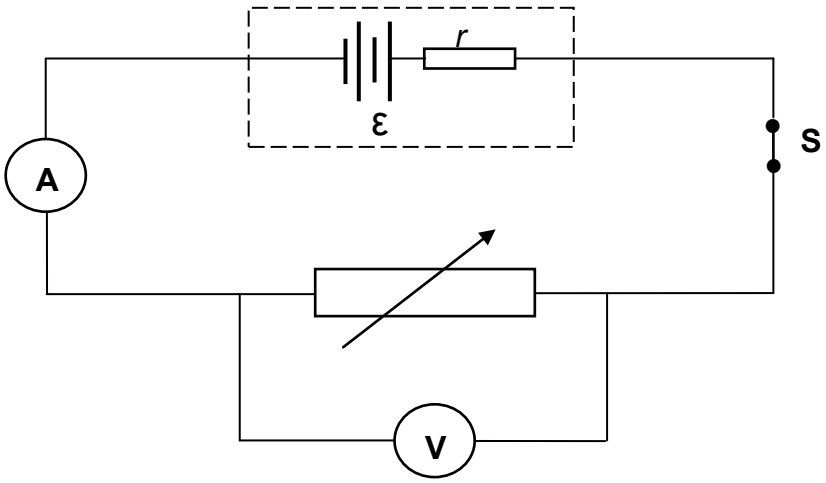
7.6 Define the *electric field at a point*. (2)

7.7 Calculate the magnitude of the net electric field at the location of **T** due to **R** and **S**. (Treat the spheres as if they were point charges.) (3)
[19]

QUESTION 8 (Start on a new page.)

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

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



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

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

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

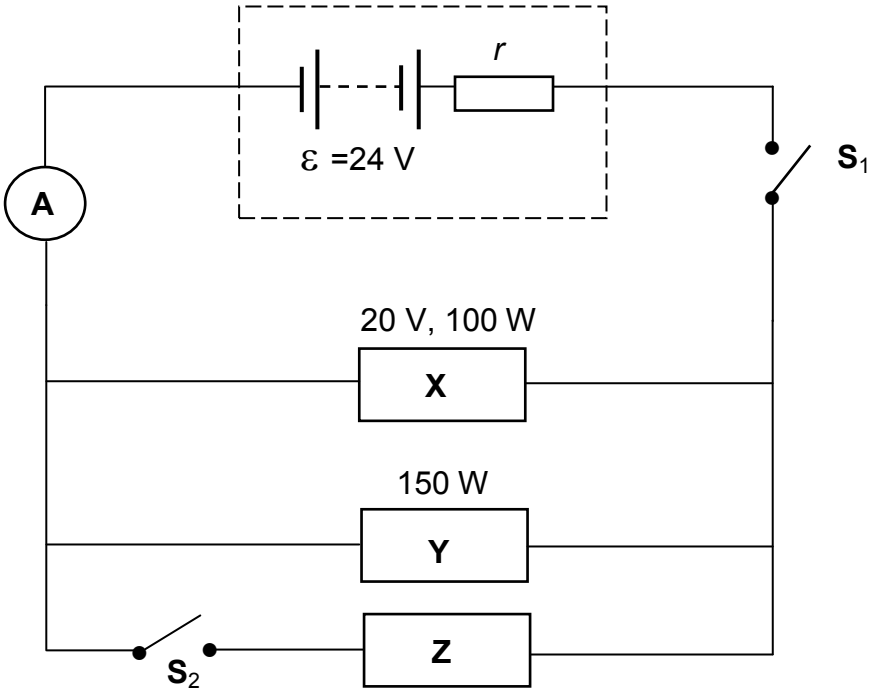
8.1.2 Using the information in the table above, plot the points and draw the line of best fit on the attached GRAPH SHEET. (3)

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

8.1.3 Emf (ε) of the battery (1)

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

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



With switch S_1 closed and S_2 open, the devices function as rated.

Calculate the:

8.2.1 Current in **X** (3)

8.2.2 Resistance of **Y** (3)

8.2.3 Internal resistance of the battery (5)

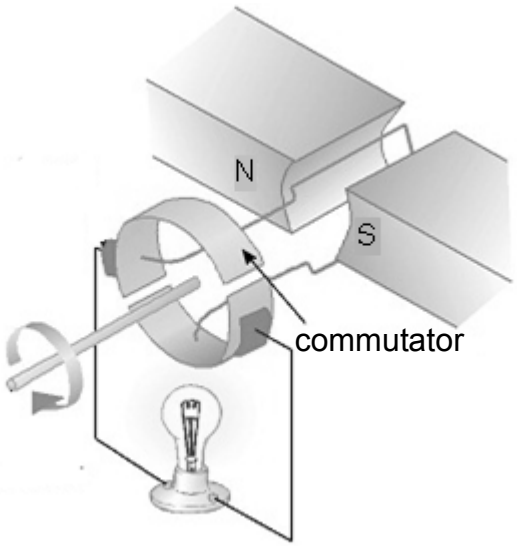
Now switch S_2 is also closed.

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

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

QUESTION 9 (Start on a new page.)

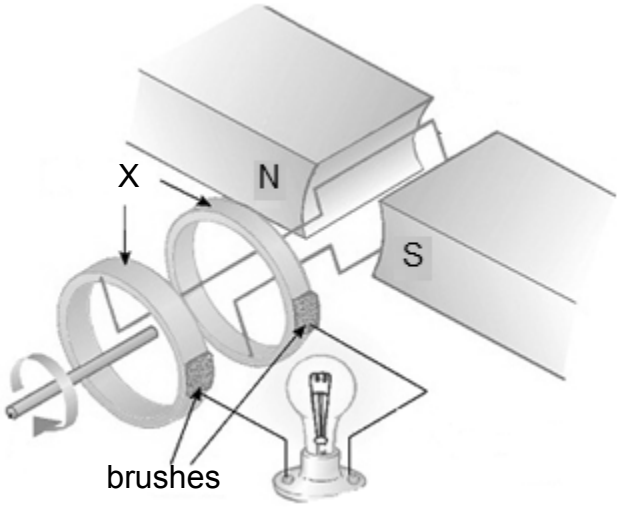
The diagram below represents a simplified version of an electrical machine used to light up a bulb.



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

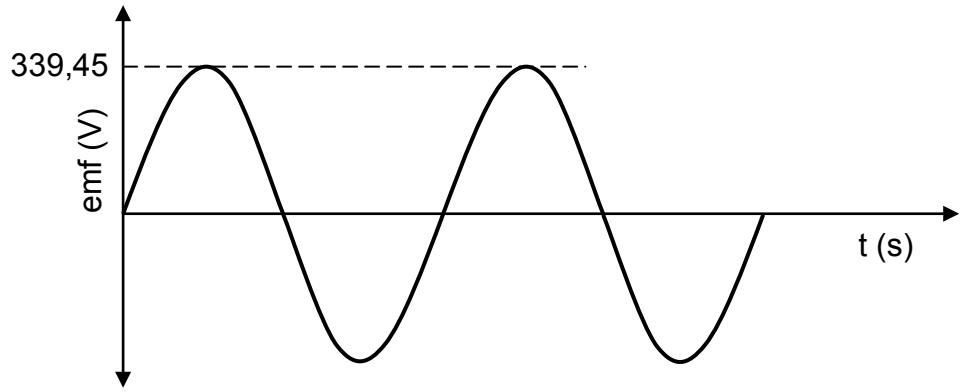
9.2 State ONE way in which to make this bulb burn brighter. (1)

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



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

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

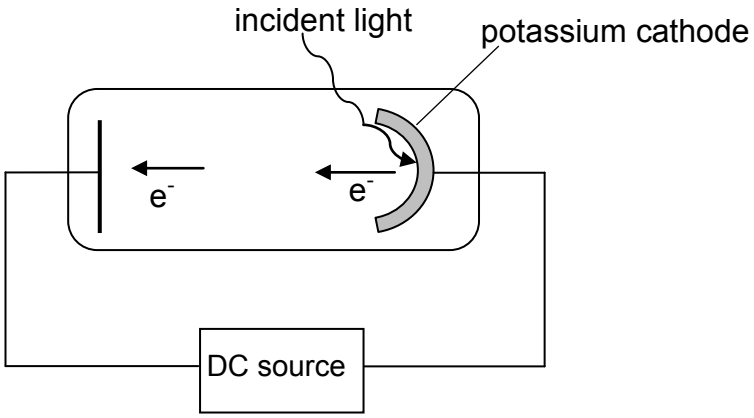


9.4.1 Define the term *root mean square value* of an AC voltage. (2)

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

QUESTION 10 (Start on a new page.)

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



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

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

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

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

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

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

TOTAL: 150

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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 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} $J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	-e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of Earth *Massa van Aarde*	M	5,98 x 10^{24} kg
Radius of Earth *Radius van Aarde*	R_E	6,38 x 10^6 m

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{\ max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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

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

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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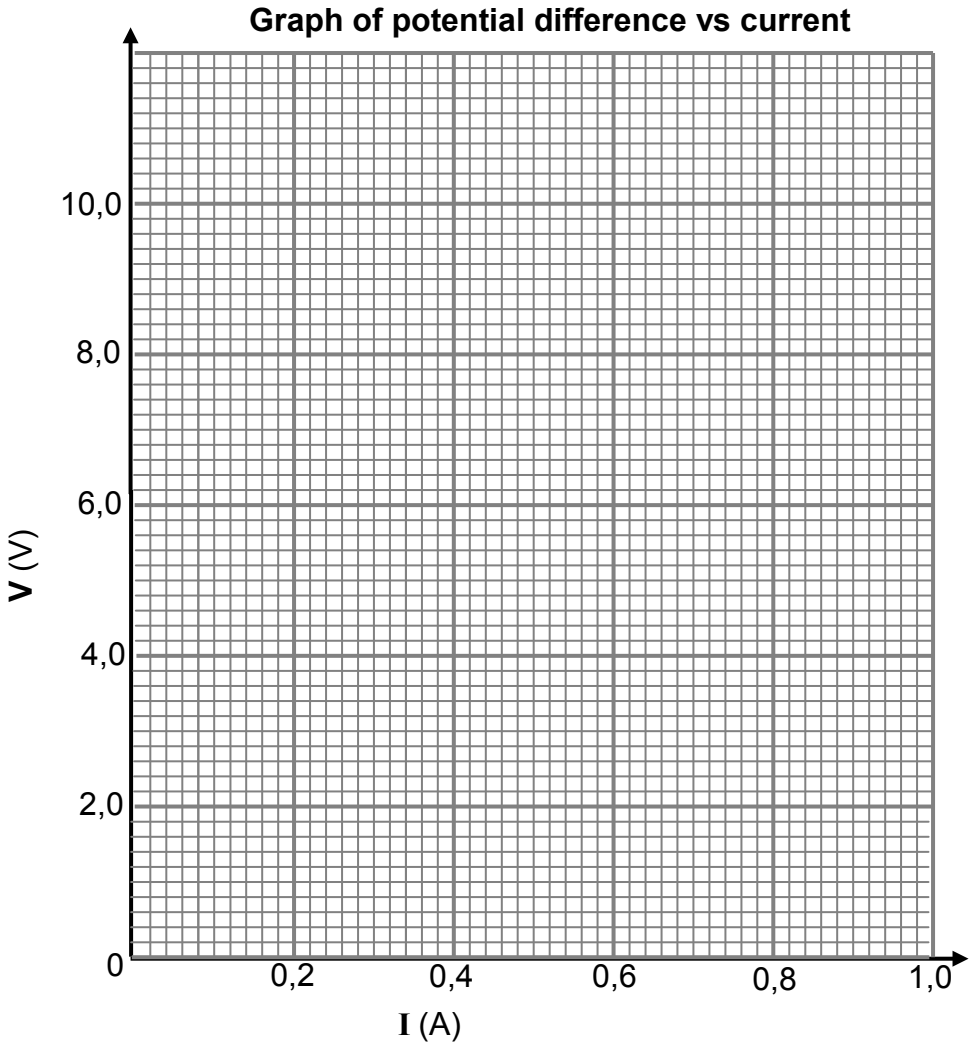
QUESTION 8.1.2

ATTACH THIS GRAPH SHEET TO YOUR ANSWER BOOK.



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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

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

NOVEMBER 2014

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 20 pages.
Hierdie memorandum bestaan uit 20 bladsye.

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QUESTION 1/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 A ✓✓ (2)

1.3 D ✓✓ (2)

1.4 C ✓✓ (2)

1.5 B ✓✓ (2)

1.6 C ✓✓ (Accept/ *Aanvaar* R) (2)

1.7 A ✓✓ (2)

1.8 D ✓✓ (2)

1.9 A ✓✓ (2)

1.10 C ✓✓ (2)

[20]

QUESTION 2/*VRAAG 2*

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

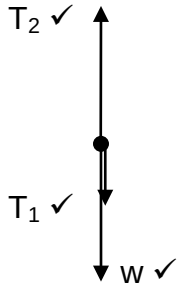
Wanneer 'n resulterende (netto) krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*

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

Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering in momentum van die voorwerp (in die rigting van die krag).(2 of 0) (2)

2.2



(3)

2.3

OPTION 1/*OPSIE 1*

F_{net} = ma✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 - (5)(9,8) - T_1$✓= 5 a ✓

$201 - T_1 = 5\ a$

$T_1 = 201 - 5a$.....(1)

For 20 kg block/*Vir 20 kg-blok*

$T_1 + (-mg) = ma$.....(2)

$T_1 + [-20(9,8)]$ ✓ = 20a

$5 = 25\ a$

$a = 0,2\ m{\cdot}s^{-2}$ upwards/*opwaarts*

$\therefore T_1 = 201 - 5(0,2)$ ✓

= 200 N ✓

OR/*OF* $T_1 = 20(9,8) + 20(0,2)$ ✓

= 200 N ✓

(6)

OPTION 2 /*OPSIE 2*

F_{net} = ma✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 - (5)(9,8) - T_1$✓= 5 a ✓

$201 - T_1 = 5a$

$T_1 = 201 - 5a$.....(1)

For 20 kg block/*Vir 20 kg-blok* ,

$T_1 + (-mg) = ma$.....(2)

$T_1 + [-20(9,8)]$ ✓ = 20a

(1) x 4 : $4T_1 = 804 - 20a$

$\therefore T_1 - 196 = 804 - 4T_1$ ✓

$\therefore 5T_1 = 1\ 000$

$\therefore T_1 = 200$ N ✓

(6)

OPTION 3/*OPSIE 3*

$F_{net} = ma$✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 - (5)(9,8) - T_1$✓$= 5\ a$ ✓

$201 - T_1 = 5\ a$

$T_1 = 201 - 5a$.....(1)

$\therefore a = \frac{201 - T_1}{5}$

For 20 kg block/*Vir 20 kg-blok* ,

$T_1 + (-mg) = ma$.....(2)

$T_1 + [-(20)(9,8)]$ ✓ $= 20a$

$\therefore T_1 - 196 = 20(\frac{201 - T_1}{5})$✓

$\therefore T_1 = 200$ N✓ (6)

2.4 **Q** ✓ (1)
[12]

QUESTION 3/*VRAAG 3*

3.1 An object moving / Motion under the influence of gravity / weight / gravitational force only (and there are no other forces such as friction).✓✓ (2 or/*of* 0)
('n Voorwerp wat / Beweging slegs onder die invloed van swaartekrag / gewig / gravitasiekrag (en daar is geen ander kragte soos wrywing nie). (2)

3.2

OPTION 1/*OPSIE 1*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$✓	$\Delta y = v_i\Delta t + ½\ a\Delta t^2$✓
0 ✓$= 15\ \Delta t + ½\ (-9,8)\ \Delta t^2$✓	0✓ $= -15\ \Delta t + ½\ (9,8)\ \Delta t^2$✓
$\Delta t = 3,06$ s	$\Delta t = 3,06$ s
It takes/*Dit neem* 3,06 s✓	It takes/*Dit neem* 3,06 s✓

(4)

OPTION 2/*OPSIE 2*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f = v_i + a\Delta t$✓	$v_f = v_i + a\Delta t$✓
0✓ $= 15 + (-9,8)\Delta t$✓	0✓ $= -15 + (9,8)\Delta t$✓
$\Delta t = 1,53$ s	$\Delta t = 1,53$ s
It takes (2)(1,53) = 3,06 s✓	It takes/*Dit neem* 3,06 s✓

(4)

OPTION 3 / *OPSIE 3*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f = v_i + a\Delta t$✓	$v_f = v_i + a\Delta t$✓
-15 ✓$= 15 + (-9,8)\Delta t$✓	15 ✓$= -15 + (9,8)\Delta t$✓
$\Delta t = 3,06$ s✓	$\Delta t = 3,06$ s✓

(4)

OPTION 4/*OPSIE 4*	
Upwards positive/*Opwaarts positief:*	**Downwards positive /*Afwaarts positief:***
$F_{net}\ \Delta t = \Delta p$✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{(0-15)}{-9,8}$ ✓✓ Δt = 1,53 s It takes/*Dit neem* (2)(1,53s) = 3,06 s✓	$F_{net}\ \Delta t = \Delta p$✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{0-(-15)}{9,8}$ ✓✓ Δt = 1,53 s It takes/*Dit neem* (2)(1,53s) = 3,06 s✓

(4)

OPTION 5/*OPSIE 5*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$F_{net}\ \Delta t = \Delta p$✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{-15-(15)}{-9,8}$ ✓✓ = 3,06 s✓	$F_{net}\ \Delta t = \Delta p$✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{15-(-15)}{9,8}$ ✓✓ Δt = 3,06 s✓

(4)

OPTION 5/*OPSIE 6*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ For ball A/*Vir bal A* $0 = (15)^2 + 2\ (-9,8)\Delta y$✓ Δy_A = 11,48 m $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ $11,48 = \left(\frac{15+0}{2}\right)\Delta t$ ✓ Δt = 1,53 s It takes/*Dit neem* (2)(1,53s) = 3,06 s✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ For ball A/*Vir bal A* $0 = (-15)^2 + 2\ (9,8)\Delta y$✓ Δy_A = -11,48 m $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ $-11,48 = \left(\frac{-15+0}{2}\right)\Delta t$ ✓ Δt = 1,53 s It takes/*Dit neem* (2)(1,53s) = 3,06 s✓

3.3

OPTION 1/*OPSIE 1*

Upwards positive/*Opwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
For ball A/*Vir bal A*
$0 = (15)^2$✓ + 2 (-9,8)Δy✓
Δy_A = 11,48 m

When A is at highest point
Wanneer A op hoogste punt is

$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$= 0 + ½ (-9,8) (1,53)^2$✓✓
Δy_B = -11,47 m
Δy_B = 11,47 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,47 + 11,48 ✓
= 22,95 m✓

Downwards positive/*Afwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
For ball A/*Vir bal A*
$0 = (-15)^2$✓ + 2 (9,8)Δy✓
Δy_A = -11,48 m

When A is at highest point
Wanneer A op hoogste punt is

$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$= 0 + ½ (9,8) (1,53)^2$✓✓
Δy_B = 11,47 m
Δy_B = 11,47 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,47 ✓
= 22,95 m✓

OPTION 2/*OPSIE 2*

Upwards positive/*Opwaarts positief:*

At maximum height $v_f = 0$:
By maksimum hoogte $v_f = 0$:

Ball/*Bal* A
$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$✓
= 15 (1,53) ✓ + ½ (-9,8) $(1,53)^2$✓
= 11,48 m

When A is at highest/point
Wanneer A op hoogste punt is

$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$= 0 + ½ (-9,8) (1,53)^2$✓✓
Δy_B = -11,47 m
Δy_B = 11,47 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,47✓
= 22,95 m✓

Downwards positive/*Afwaarts positief:*

At maximum height $v_f = 0$:
By maksimum hoogte $v_f = 0$:

Ball/*Bal* A
$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$✓
= (-15) (1,53) ✓+ ½ (9,8) $(1,53)^2$✓
= -11,48 m

When A is at highest point
Wanneer A by hoogste punt is

$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$= 0 + ½ (-9,8) (1,53)^2$✓✓
Δy_B = -11,47 m
Δy_B = 11,47 m downward/*afwaarts*

Distance/*Afstand* = ($y_A + y_B$)
= 11,48 + 11,47 ✓
= 22,95 m✓ (7)

OPTION 3/*OPSIE 3*

Upwards positive/*Opwaarts positief:*

Ball A/*Bal A*

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

$\Delta y_A = 15(1,53)$ ✓$+ \frac{1}{2}(-9,8)(1,53)^2$✓

$= 11,48$ m

For ball B/*Vir bal B*

$v_f = v_i + a\Delta t$

$v_f = 0 + (-9,8)(1,53)$

$v_f = 14,99\ m\cdot s^{-1}$

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

$14,99^2$✓ $= 0 + 2(-9,8)\ \Delta y_B$✓

$\Delta y_B = -11,47$ (m)

$= 11,47$ m downward/*afwaarts*

Distance/*Afstand* $= (y_A + y_B)$

$= 11,48 + 11,47$✓

$= 22,95$ m✓

Downwards positive/*Afwaarts positief:*

Ball A/*Bal A*

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

$\Delta y_A = -15\ (1,53)$ ✓ $+ \frac{1}{2}(9,8)(1,53)^2$✓

$= -11,48$ (m)

$= 11,48$ m upward/*opwaarts*

For ball B/*Vir bal B*

$v_f = v_i + a\Delta t$

$v_f = 0 + (9,8)(1,53)$

$v_f = 14,99\ m\cdot s^{-1}$

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

$14,99^2$ ✓$= 0 + 2(9,8)\ \Delta y_B$✓

$\Delta y_B = 11,47$ (m)

Distance/*Afstand* $= (y_A + y_B)$

$= 11,48 + 11,47$✓

$= 22,95$ m✓

(7)

OPTION 4/*OPSIE 4*

Upwards positive/*Opwaarts positief:*

Ball A/*Bal A*

$\Delta y_A = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(15 + 0)}{2}$ ✓ $(1,53)$ ✓

$= 11,48$ m

For ball B/*Vir bal B*

$v_f = v_i + a\Delta t$

$= 0 + (-9,8)(1,53)$

$= -15\ m\cdot s^{-1}$

$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 - 15)\times 1,53}{2}$ ✓

$= -11,47$ m

$= 11,47$ m downward/*afwaarts*

Distance/*Afstand* $= (y_A + y_B)$

$= 11,48 + 11,47$✓

$= 22,95$ m✓

Downwards positive/*Afwaarts positief:*

Ball A/*Bal A*

$\Delta y_A = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(-15 + 0)}{2}$ ✓ $(1,53)$ ✓

$= -11,48$ (m)

$= 11,48$ m upwards/*opwaarts*

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

$= 0 + (9,8)(1,53)$

$= 15\ m\cdot s^{-1}$

$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 + 15)\times 1,53}{2}$ ✓

$= 11,47$m

Distance/*Afstand* $= y_A + y_B$

$= 11,48 + 11,47$✓

$= 22,95$ m✓

(7)

OPTION 5/*OPSIE 5*

Upwards positive/*Opwaarts positief:*

Ball A/*Bal A*
$W_{net} = \Delta K$✓

OR/*OF*
$\frac{1}{2} m(v_f^2 - v_i^2) = mg(h_f - h_i)\cos\theta$
$\frac{1}{2} m(0 - 15^2)$ ✓$= m(9,8)h_f\cos 180^o$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point./ *Vir Bal B wanneer A by sy hoogste punt is.*

$v_f = v_i + a\Delta t$
$= 0 + (-9,8)(1,53) = -15\ m\cdot s^{-1}$ ✓
$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 - 15) \times 1,53}{2}$ ✓
=-11,48 m
= 11,48 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48✓
= 22,96 m✓

Downwards positive/*Afwaarts positief:*

Ball A/*Bal A*
$W_{net} = \Delta K$✓

OR/*OF*
$\frac{1}{2} m(v_f^2 - v_i^2) = mg(h_f - h_i)\cos\theta$
$\frac{1}{2} m(0 - 15^2)$ ✓$= m(9,8)h_f\cos 180^o$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point./ *Vir Bal B wanneer A by sy hoogste punt is.*

$v_f = v_i + a\Delta t$
$= 0 + (9,8)(1,53) = 15\ m\cdot s^{-1}$ ✓
$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 + 15)(1,53)}{2}$ ✓
= 11,48 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48✓
= 22,96 m✓

(7)

OPTION 7/*OPSIE 7*

Upwards positive/*Opwaarts positief:*
Ball A
$\frac{1}{2} m v_i^2 + mgh_i = \frac{1}{2} m v_f^2 + mgh_f$✓
$\frac{1}{2} m(15^2)$ ✓ $+0 = \frac{1}{2} m(0) + m(9,8)h$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point.
Vir Bal B wanneer A by sy hoogste punt is.

$v_f = v_i + a\Delta t$
$= 0 + (-9,8)(1,53)$
$= -15\ m\cdot s^{-1}$
$\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓
$= \frac{(0 - 15)(1,53)}{2}$ ✓
=-11,48 m
= 11,48 m downward/*afwaarts*
Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48✓
= 22,96 m✓

Downwards positive/*Afwaarts positief:*
Ball A
$\frac{1}{2} m v_i^2 + mgh_i = \frac{1}{2} m v_f^2 + mgh_f$✓
$\frac{1}{2} m(15^2)$ ✓ $+0 = \frac{1}{2} m(0) + m(9,8)h$ ✓
h = 11,48 m

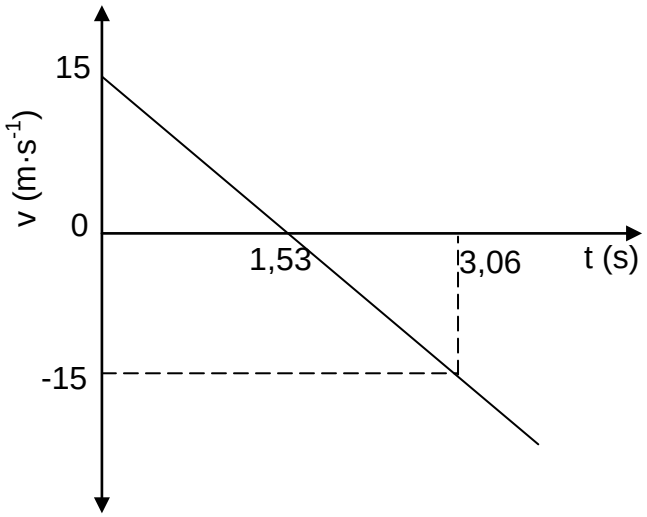
OR/*OF*
For Ball B when A is at highest point.
Vir Bal B wanneer A by sy hoogste punt is.

$v_f = v_i + a\Delta t$
$= 0 + (9,8)(1,53)$
$= 15\ m\cdot s^{-1}$
$\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓
$= \frac{(0 + 15)(1,53)}{2}$ ✓
= 11,48 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48✓
= 22,96 m✓

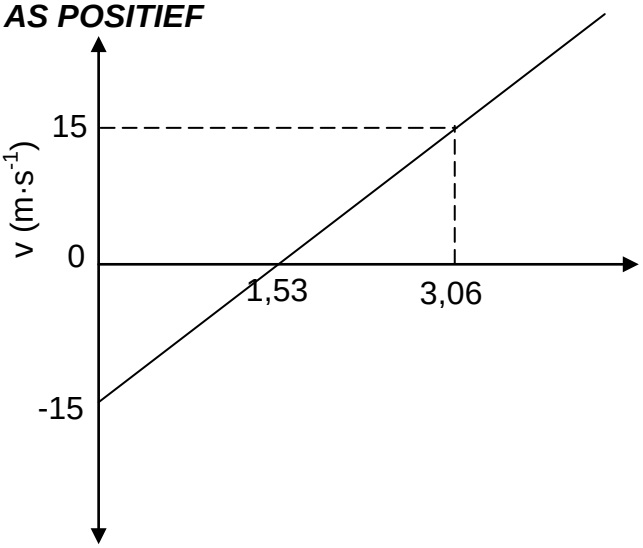
(7)

3.4



(4)
[17]

CONSIDER MOTION DOWNWARD AS POSITIVE/*BESKOU BEWEGING AFWAARTS AS POSITIEF*



Criteria/*Kriteria*	**Marks/*Punte***
Graph starts at correct Initial velocity shown./*Grafiek begin by korrekte beginsnelheid aangetoon.*	✓
Time for maximum height shown (1,53 s)./*Tyd vir maksimum hoogte aangetoon.(1,53 s)*	✓
Time for return shown (3,06 s) /*Tyd om terug te keer (3,06) aangetoon.*	✓
Shape/*Vorm*: Straight line extending beyond 3,06 s/ *Reguitlyn wat verby 3,06 s strek.*	✓

(4)
[17]

QUESTION 4/*VRAAG 4*

4.1 $p = mv$✓
$= 50(5)$✓
$= 250\ kg{\cdot}m{\cdot}s^{-1}$✓ (downward/*afwaarts)*

OR/*OF*
$p = mv$✓
$= 50(-5)$✓
$= -250\ kg{\cdot}m{\cdot}s^{-1}$
$= 250\ kg{\cdot}m{\cdot}s^{-1}$✓ (downward/*afwaarts)* (3)

4.2 The product of the (net) force and the time interval (during which the force acts)✓✓ (2 or 0)
Die produk van die (netto) krag en die tydinterval (waartydens die krag inwerk) (2 of 0). (2)

4.3

OPTION 1/*OPSIE 1*		
$\Delta p = F_{net}\Delta t$✓ $0 - 250$ ✓$= F_{net}(0,2)$ $F_{net} = -1\ 250\ N$ $= 1\ 250\ N$ ✓	$\Delta p = F_{net}\Delta t$✓ $250 - 0$ ✓$= F_{net}(0,2)$ $F_{net} = 1\ 250\ N$ ✓	$\Delta p = F_{net}\Delta t$✓ $50(0 - (-5))$✓$= F_{net}(0,2)$ $F_{net} = 1\ 250\ N$ ✓

(3)

OPTION 2/*OPSIE 2*	
$m(v_f - v_i) = F_{net}\Delta t$✓ $50\ (0 - 5)$ ✓$= F_{net}\ (0,2)$ $F_{net} = -1\ 250\ N$ $= 1\ 250\ N$ ✓	$m(v_f - v_i) = F_{net}\Delta t$✓ $50\ (5 - 0)$ ✓$= F_{net}\ (0,2)$ $F_{net} = 1\ 250\ N$ ✓

(3)

OPTION 3 /*OPSIE 3*	
$v_f = v_i + a\Delta t$ $0 = 5 + a(0,2)$ ✓ $a = -25\ m{\cdot}s^{-2}$ $F_{net} = ma$✓ $= 50\ (-25)$ $= -1\ 250\ N$ $= 1\ 250\ N$✓	$v_f = v_i + a\Delta t$ $5 = 0 + a(0,2)$ ✓ $a = 25\ m{\cdot}s^{-2}$ $F_{net} = ma$✓ $= 50\ (25)$ $= 1\ 250\ N$✓

(3)

4.4 Greater than/*Groter as*✓ (1)

4.5 For the same momentum change, ✓
the stopping time (contact time) ✓will be smaller (less) ✓
∴ the (upward) force exerted (on her) is greater.
Vir dieselfde verandering in momentum,
sal die stilhoutyd (kontaktyd) kleiner wees
∴ *die (opwaartse)krag wat (op haar) uitgeoefen word, sal groter wees.* (3)
[12]

QUESTION 5/*VRAAG 5*

5.1.1 In an isolated/closed system, ✓ the total mechanical energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly die totale meganiese energie behoue / bly konstant.

OR/*OF*
The total mechanical energy of a system is conserved/ remains constant ✓ in the absence of friction.✓
Die totale meganiese energie van 'n sisteem bly behoue/bly konstant in die afwesigheid van wrywing.

OR/*OF*
The total mechanical energy of a system remains constant ✓provided the net work done by external non conservative forces is zero.✓
Die totale meganiese energie van 'n sisteem bly konstant, mits die arbeid verrig deur eksterne nie-konserwatiewe kragte, nul is.

OR/*OF*
In the absence of a non-conservative force, the total mechanical energy is conserved/remains constant
In die afwesigheid van 'n nie-konserwatiewe krag, bly die totale meganiese energie behoue / konstant

OR/*OF*
In an isolated/closed system, ✓ the sum of kinetic and gravitational potential energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly som van kinetiese en gravitasionele potensiële energie behoue / bly konstant.

5.1.2 No/*Nee*✓ (1)

5.1.3

OPTION 1/*OPSIE 1*	
Along **AB**/*Langs* **AB** $E_{mechanical\ at\ A} = E_{mechanical\ at\ B}$ $(E_p + E_k)_A = (E_p + E_k)_B$ ✓ $(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ $(10)(9,8)(4) + 0 = 0 + ½ (10) v_f^2$ ✓ $v_f = 8,85\ m·s^{-1}$	Along **AB**/*Langs* **AB** $W_{net} = \Delta E_k$ ✓ $F_g \Delta h \cos\theta = ½ m(v_f^2 - v_i^2)$ $(10)(9,8)(4)\cos 0^o = ½ (10)(v_f^2 - 0)$ ✓ $v_f = 8,85\ m·s^{-1}$

(6)

Along **AB**/*Langs* **AB**

$W_{nc} = \Delta K + \Delta U$ ✓
$0 = ½ (10)(v_f^2 - 0) + 10(9,8)(4 - 0)$ ✓
$v_f = 8,85 \text{ m·s}^{-1}$

Substitute 8,85 m·s^{-1} in one of the following options
Vervang 8,85 m·s^{-1} in een van die volgende opsies

Along **BC**/*Langs* **BC**	Along **BC**/*Langs* **BC**
$W_{net} = \Delta K$✓ $f\Delta x \cos\theta = \Delta K$ $\underline{f(8)\cos 180^o}$ ✓$= \underline{½ (10)(0 - 8,85^2)}$ ✓ $f = 48,95$ N✓	$W_{nc} = \Delta K + \Delta U$ ✓ $f\ \Delta x\cos\theta = \Delta K + \Delta U$ $\underline{f(8)\cos 180}$ ✓$= \underline{½ (10)(0 - 8,85^2)} + 0$✓ $f = 48,95$ N✓ (Accept/ *Aanvaar* 49 N)

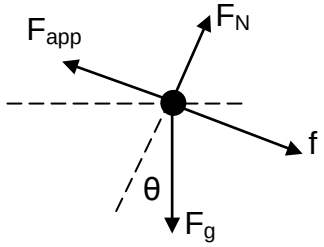
<u>OPTION 2/*OPSIE 2*</u>
Along **AC**/*Langs* **AC**

$W_{nc} = \Delta K + \Delta U$✓
$f\Delta x\cos\theta = \Delta K + \Delta U$
$(f)(8)$✓$(\cos 180^o)$✓ $= (0 - 0)$ ✓ $+ 10\ (9,8)(0 - 4)$ ✓
$f = 49$ N ✓ (6)

5.2.1 $f_k = \mu_k N$✓
$= \mu_k mg\cos\theta$
$= \underline{(0,19)(300)(9,8)\cos 25^o}$✓
$= 506,26$ N✓ (3)

5.2.2

<u>OPTION 1/*OPSIE 1*</u>



$F_{net} = 0$
$\underline{F_{app} + (-F_g\sin\theta) + (-f) = 0}$ ✓
$F_{app} - (300)(9,8)\sin 25^o$✓ $- 506,26$✓ $= 0$
$F_{app} = 1\ 748,76$ N

$P_{ave} = Fv_{ave}$ ✓
$= 1748,76 \times 0,5$✓
$= 874,38$ W ✓ (6)

OPTION 2/*OPSIE 2*

$W_f + W_{app} + W_N + W_g = 0$ ✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\Delta x\cos\theta = 0$
$(506,26\Delta x\cos180^o)$✓ + $(F_{app}\Delta x\cos0) + 300(9,8)\Delta x\cos115^o$✓= 0

F_{app} = 1748,76 N
$P_{ave} = Fv_{ave}$✓
= (1748,76) (0,5)✓
= 874,38 W✓ (6)

OPTION 3/*OPSIE 3*

$W_f + W_{app} + W_N + W_g = 0$✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\sin\theta\Delta x\cos\theta = 0$
$(506,26\Delta x\cos0)$ ✓ + $(F_{ap}\Delta x\cos0) + 300\,(9,8)\sin25^o\,\Delta x\cos180)$ ✓= 0
F_{app} = 1 748,76 N

$P_{ave} = Fv_{ave}$✓
= (1 748,76)(0,5)✓
= 874,38 W✓ (6)
[18]

QUESTION 6/*VRAAG 6*

6.1.1 An (apparent) change in observed/detected frequency (pitch), (wavelength) ✓as a result of the relative motion between a source and an observer ✓(listener).
'n Skynbare verandering in waargenome frekwensie (toonhoogte),(golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.1.2 Towards/*Na*✓

Observed/detected frequency is greater than the actual frequency.✓
Waargenome frekwensie is groter as die werklike frekwensie. (2)

6.1.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$(1200)^{\checkmark} = \frac{343^{\checkmark}}{343 - v_s} 1130$ ✓
v_s = 20,01 m·s^{-1}✓
Accept/*Aanvaar:* (19,42 – 20,01 m·s^{-1}) (5)

6.2 The star is approaching the earth. ✓
Die ster nader die aarde.
OR/*OF*
The earth and the star are approaching (moving towards) each other.✓
Die aarde en die ster nader mekaar.

The spectral lines in diagram 2 are shifted towards the blue end/blue shifted.✓ (2)
Die spektrumlyne in diagram 2 het verskuif na die blou ent/blou verskuiwing **[11]**

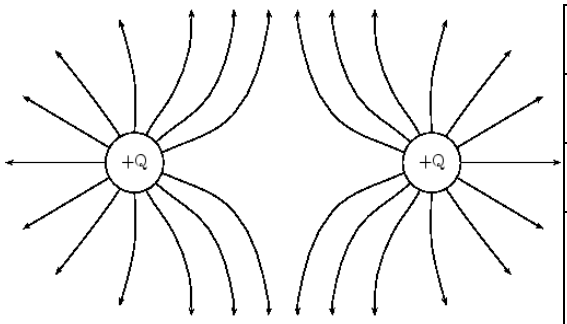
QUESTION 7/*VRAAG 7*

7.1 To ensure that charge does not leak to the ground/insulated. ✓
Om te verseker dat die lading nie na die grond toe lek nie/isoleer. (1)

Notes/*Aantekeninge*
Accept/*Aanvaar* In order retain original charge✓/To insulate the charges./ *Om oorspronklike lading te behou/ Om lading te isoleer.*

7.2 Net charge/*Netto lading* = $\frac{Q_R + Q_S}{2} = \frac{+8 + (-4)}{2}$ ✓= 2 µC✓ (2)

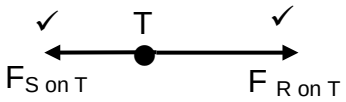
7.3



Criteria for sketch:/*Kriteria vir skets:*	Marks/ *Punte*
Correct direction of field lines *Korrekte rigting van veldlyne*	✓
Shape of the electric field *Vorm van elektrieseveld*	✓
No field line crossing each other / No field lines inside the spheres/ *Geen veldlyne wat maekaar kruis nie / Geen veldlyne binne sfeer nie*	✓

(3)

7.4



(2)

7.5

OPTION 1/*OPSIE 1*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{ST} = (9\times10^9)\frac{(1\times10^{-6})(2\times10^{-6})}{(0,2)^2}$ ✓ ✓ = 0,45 N / 4,5 x 10^{-1} N left/*links*

OR/*OF*

$F_{TS} = \frac{1}{4}F_{RT} = \frac{1}{4}(1,8) = 0,45$ N

$F_{RT} = 9\times10^9 \times \frac{(2\times10^{-6})(1\times10^{-6})}{(0,1)^2}$ ✓ = 1,8 N right/*regs*

OR/*OF*

$F_{RT} = 4F_{ST} = 4(0,45) = 1,8$ N right /*regs*

$F_{net} = F_{ST} + F_{RT} = \underline{1,8 + (-0,45)}$ ✓

= <u>1,35 N</u> or towards sphere S / *na sfeer* or/*of* <u>right/*regs S*</u>✓ (6)

OPTION 2/*OPSIE 2*

$E_R = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 N.C^{-1} right/*regs*

$E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ ✓= 4,5 x 10^5 N.C^{-1} left/*links*

E_{net} = 1,8 x 10^6 - 4,5 x 10^5 ✓= 1,35 x 10^6 N.C^{-1}right/*regs*

F = EQ ✓= (1,35 x 10^6)(1 x 10^{-6}) ✓
= 1,35 N towards sphere S / na sfeer S right/*regs* ✓ (6)

7.6 Force experienced ✓per unit positive charge ✓placed at that point.
Krag ondervind per eenheid positiewe lading by daardie punt. (2)

7.7

OPTION 1/*OPSIE 1*

$E = \frac{F}{q}$ ✓ = $\frac{1,35}{1\times10^{-6}}$ ✓= 1,35 x 10^6 N·C^{-1}✓ (3)

OPTION 2/*OPSIE 2*

$E_R = \frac{kQ}{r^2}$ ✓ = $\frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 N·C^{-1} right/*regs*

$E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ = 4,5 x 10^5 N·C^{-1} left/*links*

E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 N·C^{-1}✓ (3)

OPTION 3/*OPSIE 3*

$E = \frac{F}{q}$ ✓ = $\frac{1,8}{1\times10^{-6}}$ ✓= 1,8 x 10^6 N·C^{-1}

$E = \frac{F}{q} = \frac{0,45}{1\times10^{-6}}$ = 4,5 x 10^5 N·C^{-1}

E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 N·C^{-1}✓ (3)

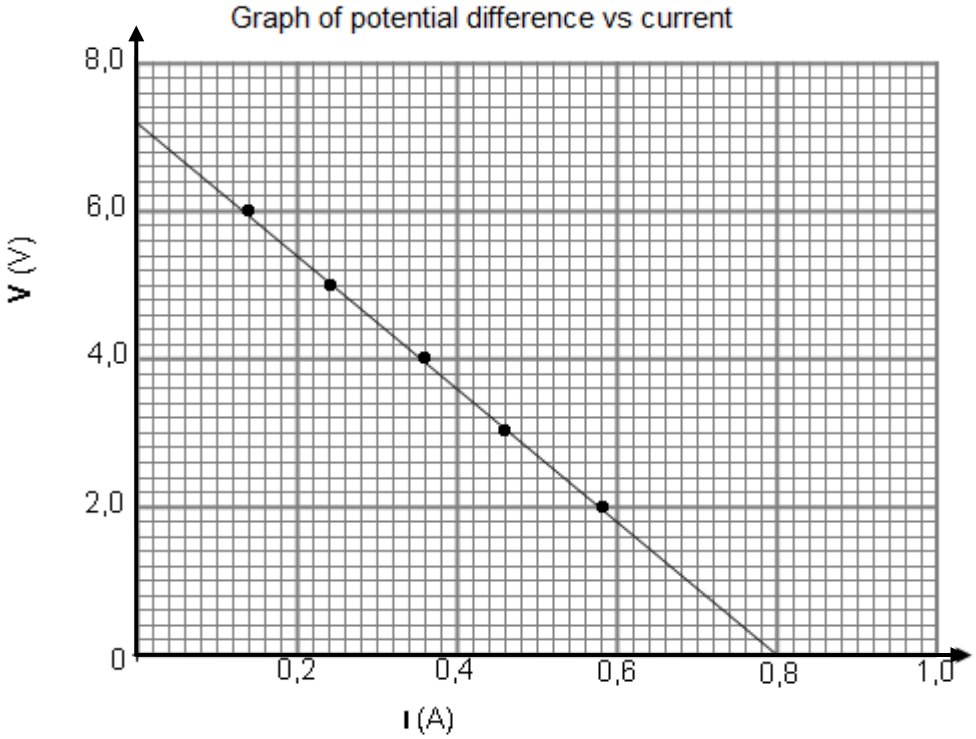
[19]

QUESTION 8/*VRAAG 8*

8.1.1 Keep the temperature (of battery) constant.
Hou die temperatuur (van battery) konstant (1)

8.1.2

Grafiek van potensiaalverskil teenoor stroom



Criteria for drawing line of best fit:/*Kriteria vir teken van lyn van beste pas:*	Marks/ *Punte*
ALL points correctly plotted (at least 4 points) *ALLE punte korrek gestip (ten minste 4 punte)*	✓✓
Correct line of best fit if all plotted points are used (at least 3 point) *Korrekte lyn van beste pas indien alle punte gebruik word (ten minste 3 punte)*	✓

(3)

8.1.3 7,2 V✓
(Accept any readings between 7,0 V and 7,4 V or the value of the y-intercept
/*Aanvaar enige lesing tussen 7,0 V en 7,4 V of die waarde van die y-afsnit* (1)

8.1.4

$$\text{Slope/}\textit{Helling} = \frac{\Delta V}{\Delta I}$$
$$= \frac{0 - 7{,}2}{0{,}8 - 0} \checkmark\checkmark = -9$$
$$r = 9\ \Omega\checkmark$$

(3)

8.2.1

OPTION 1/*OPSIE 1*

$P = VI$ ✓
$100 = 20(I)$ ✓
$I = 5$ A ✓ (3)

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$ ✓
$100 = \frac{(20)^2}{R}$
$R = 4\ \Omega$

$V = IR$
$20 = I(4)$ ✓
$I = 5$ A ✓ (3)

OPTION 3/*OPSIE 3*

$P = \frac{V^2}{R}$ ✓
$100 = \frac{(20)^2}{R}$
$R = 4\ \Omega$

$P = I^2R$
$100 = I^2(4)$ ✓
$I = 5$ A ✓

8.2.2

OPTION 1/*OPSIE 1*

$P = \frac{V^2}{R}$ ✓
$R = \frac{(20)^2}{150}$ ✓
$= 2{,}67\ \Omega$ ✓ (3)

OPTION 2/OPSIE 2

$P = VI$ ✓
$150 = (20)I$
$I = 7{,}5$ A

$V = IR$
$20 = (7{,}5)R$ ✓
$R = 2{,}67\ \Omega$ ✓

OR/*OF*

$P = I^2R$
$150 = (7{,}5)^2R$ ✓
$R = 2{,}67\ \Omega$ ✓ (3)

OPTION 3/*OPSIE 3*

I_X : I_Y
5 : 7,5
1 : 1,5

R_X : R_Y
1,5 : 1✓
4 ✓: 2,67 Ω✓

(3)

8.2.3

OPTION 1/*OPSIE 1*

$P = VI$ **OR/*OF*** $P = I^2R$

$I_{150W} = \frac{150}{20}$ ✓ = 7,5 A $I_{150W} = \sqrt{\frac{150}{2,67}}$ ✓ = 7,5 A

I_{tot} = (5 + 7,5) ✓
$\varepsilon = I(R + r)$ ✓
24 = 12,5(R + r)
24 = $V_{ext} + V_{ir}$
24 = 20 + 12,5(r) ✓
r = 0,32 Ω ✓

(5)

OPTION 2/*OPSIE 2*

$V = Ir$✓
I_{tot} = (5 + 7,5) ✓
(24 - 20) ✓= 12,5 r✓
$\therefore r = \frac{4}{12,5}$
r = 0,32 Ω✓

(5)

OPTION 3/*OPSIE 3*

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

$\frac{1}{R_{//}} = \frac{1}{4} + \frac{1}{2,67}$ ✓ OR/*OF* $R_{//} = \frac{(4)(2,67)}{4 + 2,67}$

$\therefore R_{||}$ =1,6 Ω

$I_{tot} = \frac{20}{1,6}$ = 12,5 A✓

$\varepsilon = I(R + r)$ ✓

24 = 12,5(R + r)
24 = $V_{ext} + V_{ir}$
24 = 20 + 12,5(r) ✓
r = 0,32 Ω ✓

(5)

OPTION 4/*OPSIE 4*

$P = VI$ ✓
$250 = (20)I$ ✓
$I = 12,5$ A

$V = Ir$ ✓
$4 = (12,5)r$ ✓
$r = 0,32\ \Omega$ ✓ (5)

8.2.4 Device Z is a voltmeter ✓.
Toestel Z is 'n voltmeter (1)

8.2.5 Device **Z** should be a voltmeter (or a device with very high resistance) because it has a very high resistance ✓ and will draw very little current. ✓
The current through **X** and **Y** will remain the same hence the device can operate as rated.
*Toestel **Z** moet 'n voltmeter wees (of 'n toestel met 'n baie hoë weerstand) omdat dit 'n baie hoë weerstand het en baie min sal stroom trek*
*Die stroom deur **X** en **Y** sal dieselfde bly, gevolglik kan die toestel werk soos ontwerp.* (2)
[22]

QUESTION 9/*VRAAG 9*

9.1 Electromagnetic induction / *Elektromagnetiese induksie* ✓ (1)

9.2 Rotate the coil faster/Increase the number of coils/ Increase the strength of the magnetic field.
Roteer die spoel vinniger/Verhoog die aantal spoele / Verhoog die sterkte van die magneetveld. (1)

9.3 Slip rings/*Sleepringe* ✓ (1)

9.4.1 It is the value of the voltage in a DC circuit ✓ that will have the same heating effect as an AC circuit. ✓
Dit is die waarde van die potensiaalverskil in 'n GS-stroombaan ✓ wat dieselfde verhittingseffek het as 'n WS-stroombaan ✓ (2)

9.4.2 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓
$= \frac{339,45}{\sqrt{2}}$ ✓
$V_{rms} = 240,03$ V ✓ (3)
[8]

QUESTION 10/*VRAAG 10*

10.1 The minimum frequency (of a photon/light) needed to emit electrons ✓ from (the surface of) a metal. (substance) ✓
Die minimum frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) vry te stel. (2)

10.2 **OPTION 1/*OPSIE 1***

$E = W_o + E_{k(max)}$
$E = W_o + \frac{1}{2}mv^2_{max}$
$h\frac{c}{\lambda} = hf_0 + \frac{1}{2}mv^2_{max}$
✓Any one / *Enige een*

$\frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{\lambda}$ ✓$= (6{,}63 \times 10^{-34})(5{,}548 \times 10^{14})$ ✓$+ \frac{1}{2}(9{,}11 \times 10^{-31})(5{,}33 \times 10^5)^2$ ✓

$\lambda = 4 \times 10^{-7}$ m✓ (5)

OPTION 2/*OPSIE 2*

$E = W_o + E_{k(max)}$
$E = W_o + \frac{1}{2}mv^2_{max}$
$hf = hf_0 + \frac{1}{2}mv^2_{max}$
✓Any one / *Enige een*

$(6{,}63 \times 10^{-34})f = (6{,}63 \times 10^{-34})(5{,}548 \times 10^{14})$ ✓$+ \frac{1}{2}(9{,}11 \times 10^{-31})(5{,}33 \times 10^5)^2$ ✓

$f = 7{,}5 \times 10^{14}$ Hz

$c = f\lambda$
$3 \times 10^8 = (7{,}5 \times 10^{14})\lambda$✓
$\lambda = 4 \times 10^{-7}$ m ✓ (5)

10.3 Smaller (less) than ✓
Kleiner (minder) as (1)

10.4 The wavelength/frequency/energy of the incident light (photon/hf) is constant✓.
Die golflengte/frekwensie/energie van die invallende lig (foton/hf) is konstant

Since the speed is larger, the kinetic energy is larger ✓ the work function/W_0/threshold frequency smaller. ✓

Aangesien die spoed vergroot, is die kinetiese energie groter, is die arbeidsfunksie / W_0 / drumpel frekwensie kleiner (3)
[11]

GRAND TOTAL/*GROOTTOTAAL*: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2014

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

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

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

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

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

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

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

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

9. Show ALL formulae and substitutions in ALL calculations.

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

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

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following is a primary nutrient for plants?

A Oxygen

B Carbon

C Potassium

D Magnesium (2)

1.2 Which ONE of the following statements is CORRECT?

Alkenes ...

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

B are unsaturated hydrocarbons.

C readily undergo substitution reactions.

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

1.3 Consider the reaction represented by the balanced equation below:

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

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

A oxidising agent and is reduced.

B oxidising agent and is oxidised.

C reducing agent and is reduced.

D reducing agent and is oxidised. (2)

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

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

(2)

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

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

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

A Prop-1-ene

B Propane

C Ethene

D Ethane (2)

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

A but-1-ene.

B but-2-ene.

C butan-1-ol.

D butan-2-ol. (2)

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

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

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

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

(2)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

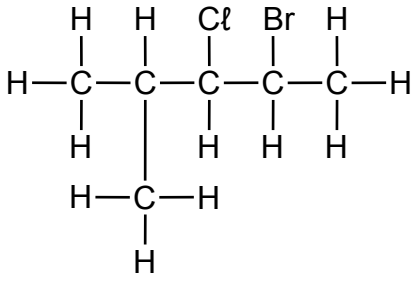
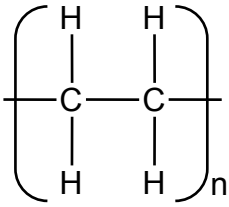
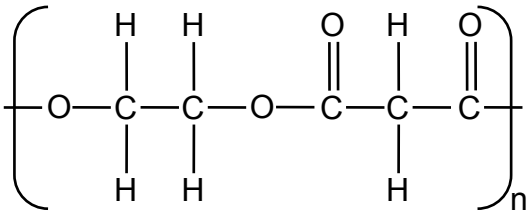
Which ONE of the following is correct as the reaction approaches a new equilibrium?

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

(2)
[20]

QUESTION 2 (Start on a new page.)

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

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

2.1 Write down the LETTER that represents the following:

2.1.1 An aldehyde (1)

2.1.2 A condensation polymer (1)

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

2.2 Write down the IUPAC name of:

2.2.1 Compound **C** (3)

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

2.3 Write down the structural formula of:

2.3.1 Compound **A** (2)

2.3.2 Compound **F** (2)

2.4 The table contains compounds which are functional isomers.

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

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

[14]

QUESTION 3 (Start on a new page.)

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

3.2 Write down the structural formula of:

3.2.1 The functional group of alcohols (1)

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

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

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

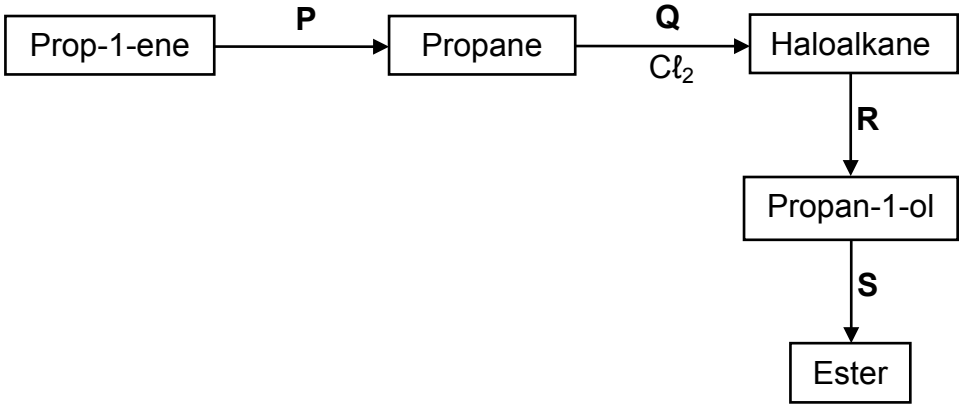
3.3.2 Fully explain why the boiling point increases from methane to propane. (3)

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

Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)
[12]

QUESTION 4 (Start on a new page.)

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



4.1 Write down the type of reaction represented by:

4.1.1 **Q** (1)

4.1.2 **R** (1)

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

4.2.1 Type of addition reaction (1)

4.2.2 Balanced equation using structural formulae (3)

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

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

For this reaction write down the:

4.4.1 Name of the reaction that takes place (1)

4.4.2 FORMULA or NAME of the catalyst needed (1)

4.4.3 Structural formula of the ester formed (2)

4.4.4 IUPAC name of the ester formed (2)

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

[15]

QUESTION 5 (Start on a new page.)

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

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

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

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

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

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

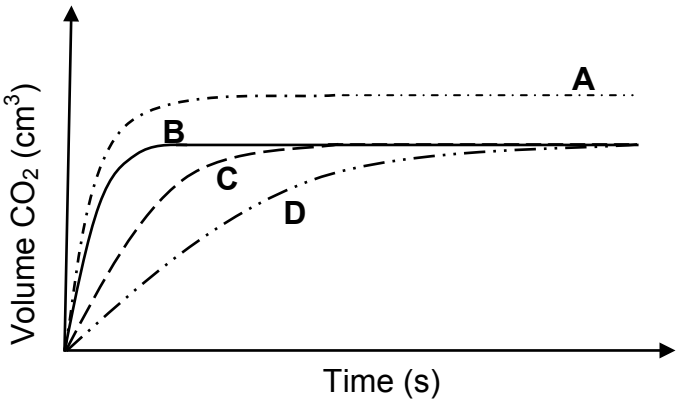
Write down the:

5.2.1 Independent variable (1)

5.2.2 Dependent variable (1)

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

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



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

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

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

[18]

QUESTION 6 (Start on a new page.)

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

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

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

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

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

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

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

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

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

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

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

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

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

[16]

QUESTION 7 (Start on a new page.)

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

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

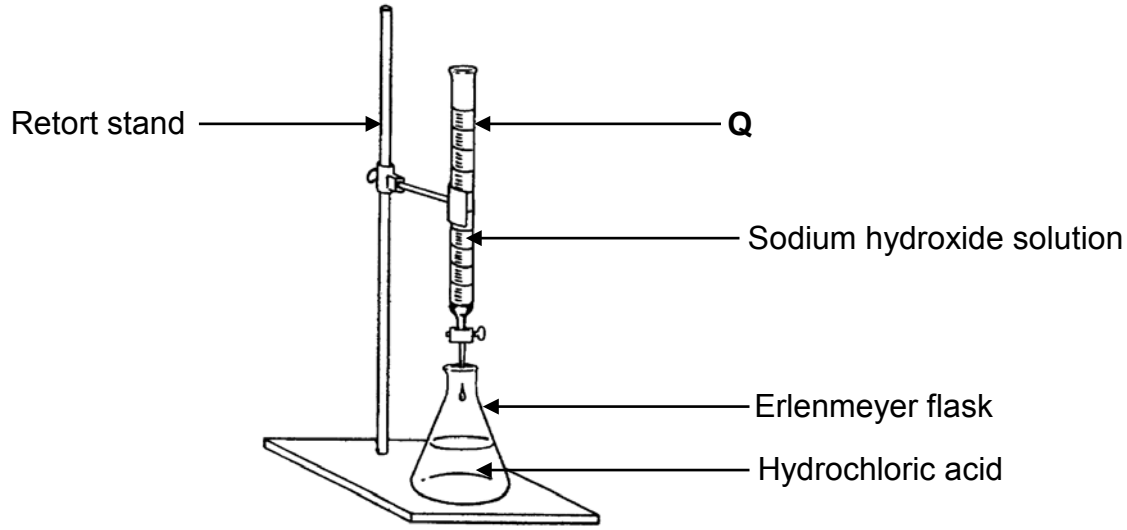
7.1.2 Write down the NAME or FORMULA of the conjugate base of nitric acid. (1)

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

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

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

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



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

7.2.3 The following indicators are available for the titration:

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

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

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

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

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

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

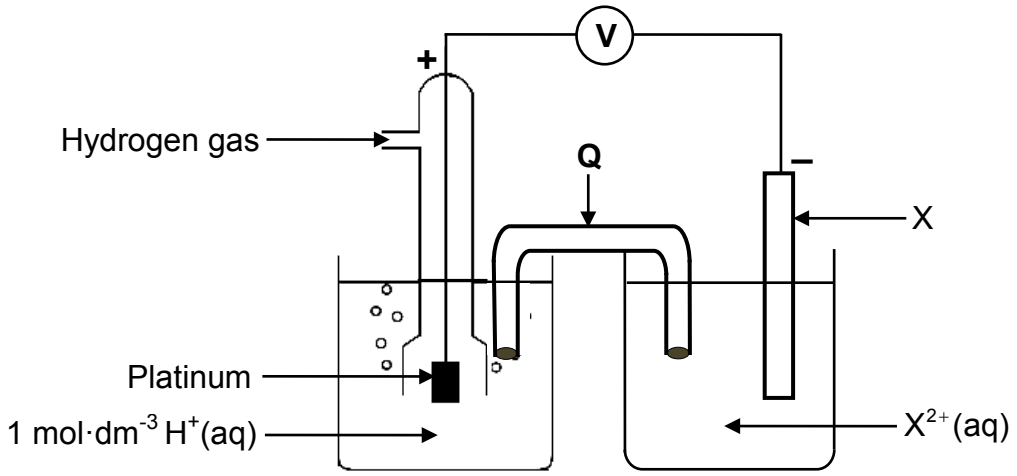
7.2.6 The balanced equation for the reaction between hydrochloric acid and magnesium oxide is:

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

Calculate the percentage purity of the magnesium oxide. Assume that only the magnesium oxide in the 4,5 g sample reacted with the acid. (5)
[21]

QUESTION 8 (Start on a new page.)

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



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

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

8.3 Write down the:

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

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

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

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

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

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

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

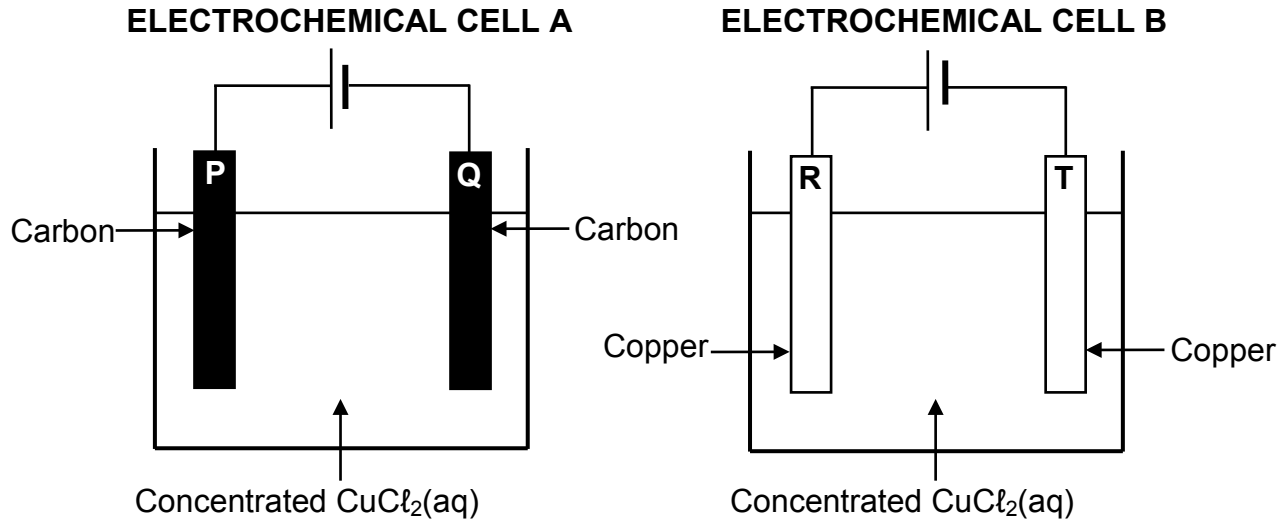
8.4.2 Is the cell reaction EXOTHERMIC or ENDOTHERMIC? (1)

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

[15]

QUESTION 9 (Start on a new page.)

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



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

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

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

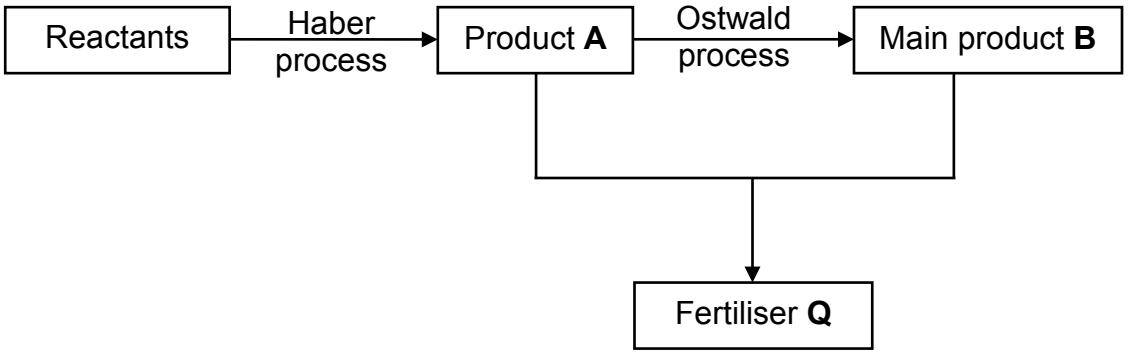
9.3.1 Electrode **P** (1)

9.3.2 Electrode **R** (1)

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

QUESTION 10 (Start on a new page.)

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

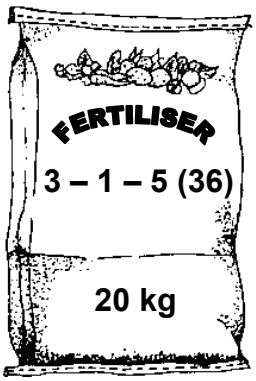


Write down the:

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

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

10.2 The diagram below shows a bag of NPK fertiliser.



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

TOTAL: 150

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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
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

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*

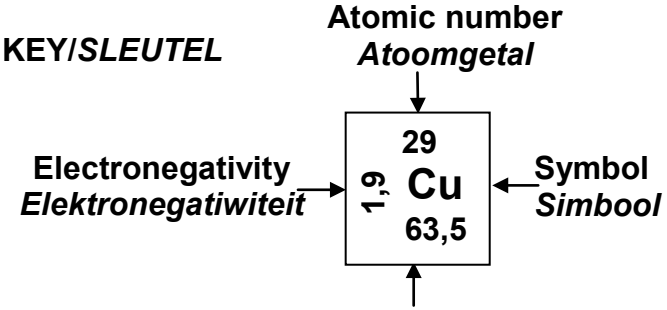

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARDREDUKSIEPOTENSIALE

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* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARDREDUKSIEPOTENSIALE

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* ↑

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2014

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 20 pages.
Hierdie memorandum bestaan uit 20 bladsye.

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QUESTION 1 / *VRAAG 1*

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 B ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 D ✓✓ (2)

1.10 C ✓✓ (2)

[20]

QUESTION 2 / *VRAAG 2*

2.1

2.1.1 B ✓ (1)

2.1.2 E ✓ (1)

2.1.3 F ✓ (1)

2.2

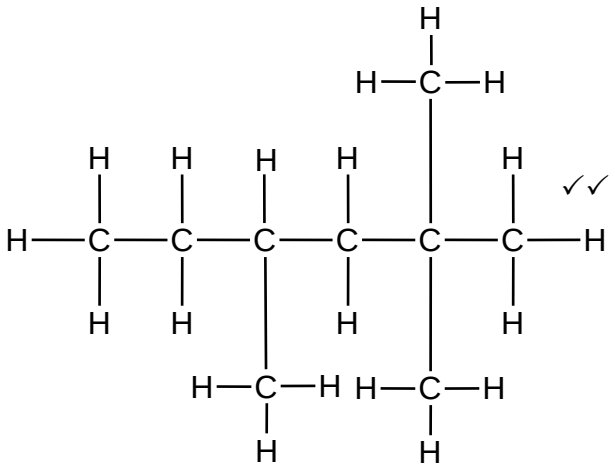
2.2.1 2-bromo-3-chloro-4-methylpentane
2-bromo-3-chloro-4-metielpentaan / 2-broom-3-chloor-4-metielpentaan

Marking criteria / *Nasienriglyne:*
- Correct stem i.e. pentane. / *Korrekte stam d.i. pentaan.* ✓
- All substituents correctly identified. / *Alle substituente korrek geïdentifiseer.* ✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used. ✓
  Substituente korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik.

(3)

2.2.2 Ethene / *Eteen* ✓ (1)

2.3
2.3.1



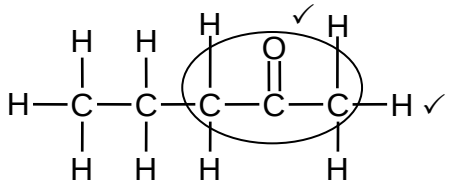
✓✓

Marking criteria / *Nasienriglyne:*
- Six saturated C atoms in longest chain i.e. hexane. ✓ *Ses versadigde C-atome in langste ketting d.i. heksaan.*
- Three methyl substituents on second C and fourth C. ✓ *Drie metielsubstituente op tweede C en vierde C.*

Notes / *Aantekeninge:*
- If correct structure, but H atoms omitted / *Indien korrekte struktuur, maar H-atome weggelaat:* Max / *Maks.* $\frac{1}{2}$
- Condensed or semi-structural formula: *Gekondenseerde of semistruktuurformule*: Max./*Maks.* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule*: $\frac{0}{2}$

(2)

2.3.2



✓ ✓

Marking criteria / *Nasienriglyne:*
- Whole structure correct / *Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct / *Slegs funksionele groep korrek:* $\frac{1}{2}$

Notes / *Aantekeninge:*
- If two or more functional groups/Indien *twee of meer funksionele groepe:* $\frac{0}{2}$
- Condensed or semi-structural formula: *Gekondenseerde of semistruktuurformule*: Max / *Maks* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule*: $\frac{0}{2}$

(2)

2.4
2.4.1 (Compounds with) the same molecular formula ✓ but different functional goups / different homologous series. ✓
(Verbindings met) dieselfde molekulêre formule, maar verskillende funksionele groepe / verskillende homoloë reekse. (2)

2.4.2 B & F ✓ (1)

[14]

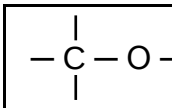
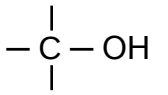
QUESTION 3 / *VRAAG 3*

3.1 **ANY ONE / *ENIGE EEN*:**

- Alkanes have ONLY single bonds. ✓
  Alkane het SLEGS enkelbindings.
- Alkanes have single bonds between C atoms.
  Alkane het enkelbindings tussen C-atome.
- Alkanes have no double OR triple bonds OR multiple bonds.
- *Alkane het geen dubbel- OF trippelbindings OF meervoudige bindings nie.*
- Alkanes contain the maximum number of H atoms bonded to C atoms.
  Alkane bevat die maksimum getal H-atome gebind aan C-atome. (1)

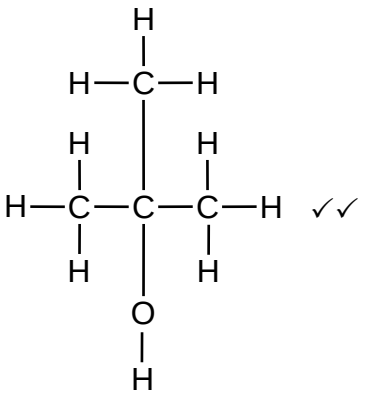
3.2

3.2.1 **ANY ONE / *ENIGE EEN:***

 ✓		– OH	– O – H
R – OH	R – O – H		

(1)

3.2.2

 ✓✓

Marking criteria / *Nasienriglyne:*

- - OH group on second C atom of longest chain. ✓
  - OH-groep op tweede C-atoom van langste ketting.
- Tertiary group consisting of four C atoms with methyl group on 2nd C atom. ✓
  Tersiêre groep bestaande uit vier C-atome met metielgroep op 2de C-atoom.
- If two or more functional groups / *Indien twee of meer funksionele groepe:* $0/2$

Notes / *Aantekeninge:*

- Accept / *Aanvaar* – OH
- If correct structure and number of bonds, but H atoms omitted / *Indien korrekte struktuur en getal bindings, maar H-atome weggelaat:* Max / *Maks.* $1/2$
- Condensed or semi-structural formula / *Gekondenseerde of semistruktuurformule*: Max / *Maks.* $1/2$
- Molecular formula / *Molekulêre formule*: $0/2$

(2)

3.3
3.3.1

Criteria for investigative question / *Riglyne vir ondersoekende vraag:*	
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Ask a question about the relationship between the independent and dependent variables. *Vra 'n vraag oor die verwantskap tussen die onafhanklike en afhanklike veranderlikes.*	✓

Examples / *Voorbeelde*:

- How does an increase in chain length / molecular size / molecular structure / molecular mass / surface area influence boiling point?
  Hoe beïnvloed 'n toename in kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / reaksieoppervlak die kookpunt?
- What is the relationship between chain length / molecular size / molecular structure / molecular mass / surface area and boiling point?
  Wat is die verwantskap tussen kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte en kookpunt? (2)

3.3.2

- **Structure / *Struktuur*:**
  The chain length / molecular size / molecular structure / molecular mass / surface area increases. ✓
  Die *kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte neem toe.*
- **Intermolecular forces / *Intermolekulêre kragte*:**
  Increase in strength of intermolecular forces / induced dipole / London / dispersion / Van der Waals forces. ✓
  Toename in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte / Van der Waalskragte.
- **Energy / *Energie*:**
  More energy needed to overcome / break intermolecular forces. ✓
  Meer *energie benodig om intermolekulêre kragte te oorkom / breek.*

OR / *OF*

- **Structure / *Struktuur*:**
  From propane to methane the chain length / molecular size / molecular structure / molecular mass / surface area decreases. ✓
  Van propaan na metaan neem die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte af.
- **Intermolecular forces / *Intermolekulêre kragte:***
  Decrease in strength of intermolecular forces / induced dipole forces / London forces / dispersion forces. ✓
  Afname in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte.
- **Energy / *Energie*:**
  Less energy needed to overcome / break intermolecular forces. ✓
  Minder energie benodig om intermolekulêre kragte te oorkom / breek. (3)

3.4
- Between <u>propane</u> molecules are <u>London forces</u> / <u>dispersion forces / induced dipole forces</u>. ✓
  Tussen <u>propaan</u>molekule is <u>Londonkragte / dispersiekragte / geïnduseerde dipoolkragte</u>.
- Between <u>propan-1-ol</u> molecules are London forces / dispersion forces / induced dipole forces and <u>hydrogen bonds</u>. ✓
  Tussen <u>propan-1-</u>ol molekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en <u>waterstofbindings.</u>
- Hydrogen bonds / Forces between alcohol molecules are <u>stronger or need more energy than</u> London forces / dispersion forces / induced dipole forces. ✓
  Waterstofbindings / Kragte tussen alkoholmolekule is <u>sterker</u> of benodig meer energie om oorkom te word as Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.

OR/*OF*

Between <u>propane molecules are weak London forces</u> / dispersion forces / induced dipole forces ✓ and between <u>propan-1-ol molecules are strong hydrogen bonds</u>. ✓✓
Tussen propaanmolekule is swak Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en tussen propan-1-olmolekule is sterk waterstofbindings. (3) **[12]**

QUESTION 4 / *VRAAG 4*

4.1

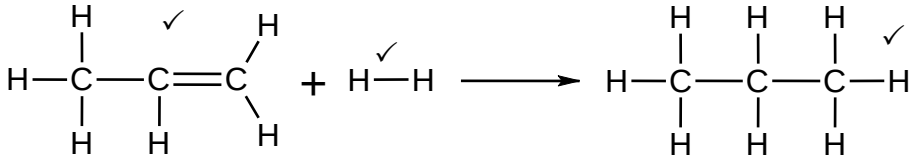
4.1.1 Substitution / chlorination / halogenation ✓
Substitusie / chlorering / halogenering / halogenasie (1)

4.1.2 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

4.2

4.2.1 Hydrogenation / *Hidrogenasie / Hidrogenering* ✓ (1)

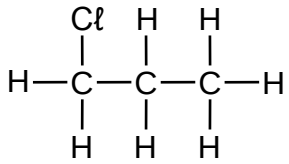
4.2.2



<u>Notes / *Aantekeninge*</u>*:*
- Ignore/*Ignoreer* ⇌
- Accept H_2 if condensed. / *Aanvaar H_2 as gekondenseerd.*
- Any additional reactants and/or products
  Enige addisionele reaktanse en / of produkte: Max./*Maks.* $\frac{2}{3}$
- Accept coefficients that are multiples.
  Aanvaar koëffisiënte wat veelvoude is.
- Molecular / condensed formulae
  Molekulêre-/ gekondenseerde formule: Max./*Maks.* $\frac{2}{3}$

(3)

4.3



Marking criteria / *Nasienriglyne:*
- Whole structure correct:/ *Hele struktuur korrek:* 2/2
- Only ONE Cℓ atom as functional group. / *Slegs EEN Cℓ-atoom as funksionele groep.* 1/2

Notes / *Aantekeninge:*
- Condensed or semi-structural formula
  Gekondenseerde of semistruktuurformule: Max./*Maks.* 1/2
- Molecular formula. / *Molekulêre formule*: 0/2
- If functional group is incorrect. / *Indien funksionele groep verkeerd is*: 0/2

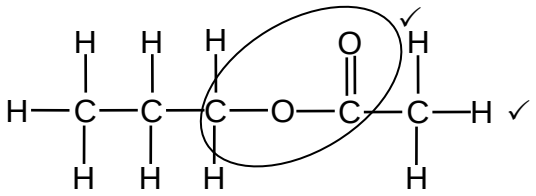
(2)

4.4

4.4.1 Esterification / Condensation ✓
Verestering / Esterifikasie / Kondensasie (1)

4.4.2 (Concentrated) H_2SO_4 / (Concentrated) sulphuric acid ✓
(Gekonsentreerde) H_2SO_4 / (Gekonsentreerde) swawelsuur of swaelsuur (1)

4.4.3



Marking criteria / *Nasienriglyne:*
- Whole structure correct / *Hele struktuur korrek:* 2/2
- Only functional group correct / *Slegs funksionele groep korrek:* 1/2

Notes / *Aantekeninge:*
- If two or more functional groups/Indien *twee of meer funksionele groepe:* 0/2
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max./*Maks.* 1/2
- Molecular formula / *Molekulêre formule*: 0/2
- If functional group is incorrect/*Indien funksionele groep verkeerd is:* 0/2

(2)

4.4.4 Propyl ✓ ethanoate ✓
Propieletanoaat (2)

4.5 Sulphuric acid / H_2SO_4 / Phosphoric acid / H_3PO_4 ✓
Swawelsuur / Swaelsuur / H_2SO_4 / Fosforsuur / H_3PO_4 (1)

[15]

QUESTION 5 / *VRAAG 5*

5.1 **ONLY ANY ONE OF/ *SLEGS ENIGE EEN VAN*:**

- Change in concentration of products / reactants ✓ per (unit) time. ✓
  Verandering in konsentrasie van produkte / reaktanse per (eenheids)tyd.
- Rate of change in concentration. ✓✓
  Tempo van verandering in konsentrasie.
- Change in amount / number of moles / volume / mass of products or reactants per (unit) time.
  Verandering in hoeveelheid / getal mol/volume / massa van produkte of reaktanse per (eenheids)tyd.
- Amount / number of moles / volume / mass of products formed or reactants used per (unit) time.
  Hoeveelheid / getal mol / volume / massa van produkte gevorm of reaktanse gebruik per (eenheids)tyd. (2)

5.2

5.2.1 Temperature / *Temperatuur* ✓ (1)

5.2.2 Rate of reaction / Volume of gas (formed) per (unit) time ✓
Reaksietempo / Volume gas (gevorm) per (eenheids)tyd (1)

5.3

- Larger mass / amount / surface area. ✓
  Groter massa / hoeveelheid / reaksieoppervlak.
- More effective collisions per (unit) time. / Frequency of effective collisions increase./ More particles collide with sufficient kinetic energy & correct orientation per (unit) time. ✓✓
  Meer effektiewe botsings per (eenheids)tyd. / Frekwensie van effektiewe botsings verhoog./ Meer deeltjies bots met genoeg kinetiese energie & korrekte oriëntasie per tyd(seenheid).

IF / *INDIEN*: • Larger mass / amount / surface area. ✓ *Groter massa / hoeveelheid / reaksieoppervlak.* • More particles collide. / More collisions. ✓ *Meer deeltjies bots. / Meer botsings.* *Max./Maks.* $^{2}/_{3}$
Notes / *Aantekeninge*: **IF/INDIEN:** No reference to mass / amount / surface area in answer: Geen verwysing na mas*sa / hoeveelheid / reaksieoppervlak in antwoord:* $^{0}/_{3}$

(3)

5.4 **Marking criteria / *Nasienriglyne:***

Compare Exp.1 with Exp. 2: *Vergelyk Eksp. 1 met Eksp. 2:*	The reaction in exp. 1 is faster in exp. 1 than in exp. 2 due to the higher acid concentration. *Die reaksie in eksp. 1 is vinniger as dié in eksp. 2 as gevolg van die hoër suurkonsentrasie.*	✓
	Therefore the gradient of the graph representing exp. 1 is greater / steeper than that of exp. 2. / Graph of Exp. 1 reaches constant volume in shorter time than exp. 2. *Dus is die gradiënt van die grafiek wat eksp. 1 voorstel, groter/steiler as dié vir eksp. 2. / Grafiek van exp. 1 bereik konstante volume in korter tyd as dié vir eksp. 2.*	✓
Compare Exp. 1 with Exp 3 & 4: *Vergelyk Eksp. 1 met Eksp. 3 & 4:*	The reaction in exp. 3 is faster than that in exp. 1 due to the higher temperature. *Die reaksie in eks. 3 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur.*	✓
	The reaction in exp. 4 is faster than that in exp. 1 due to the higher temperature / larger surface area. *Die reaksie in eks. 4 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur / groter reaksieoppervlak.* **OR/*OF*** *Graph A represents exp. 4 due to the greater mass of $CaCO_3$ - greater yield of CO_2 at a faster rate.* *Grafiek A stel eksp. 4 voor as gevolg van die groter massa $CaCO_3$ - groter opbrengs CO_2 teen vinniger tempo.*	✓
	Therefore the gradient of the graphs of exp. 3 & 4 are greater/steeper than that of exp. 1. / Graphs of Exp. 3 & 4 reaches constant volume in shorter time than exp. 1. *Dus is die gradiënte van die grafieke vir eksp. 3 & 4 is groter/steiler as dié in eksp. 1./ Grafieke van exp. 3 & 4 bereik konstante volume in korter tyd as dié vir eksp. 1.*	✓
Final answer *Finale antwoord*	C	✓

(6)

Notes/*Aantekeninge*

- Compare exp. 1 with exp. 2 / *Vergelyk eksp. 1 met eksp. 2*:
  - Factor & rate / *Faktor & tempo*.
  - Gradient / volume CO_2 per time / gradient / *volume CO_2 per tyd.*
- Compare exp. 1 with exp. 3 / *Vergelyk eksp. 1 met eksp. 3*:
  - Factor & rate / *Faktor & tempo.*
- Compare exp. 1 with exp. 4/ *Vergelyk eksp. 1 met eksp. 4*:
  - Factor & rate / *Faktor & tempo.*
- Compare gradient / volume CO_2 per time of exp 1 with that of exp. 3 & 4 *Vergelyk gradient/volume CO_2 per tyd van eksp 1 met die van eksp. 3 & 4*
- Final answer / *finale antwoord*: C

5.5

Marking criteria / *Nasienriglyne:*

- Divide volume by / *Deel volume deur*: 25,7 ✓
- Use ratio / Gebruik v*erhouding*: $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute / *Vervang* 100 in $n = \frac{m}{M}$. ✓
- Subtraction / *Aftrekking.* ✓
- Final answer / *Finale antwoord:* 7,00 g to*/tot* 7,5 g ✓

OPTION 1 / *OPSIE 1*

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{4,5}{25,7} \checkmark$$
$$= 0,18 \text{ mol } (0,175 \text{ mol})$$

$n(CaCO_3) = n(CO_2) = 0,18$ mol ✓

$$n(CaCO_3) = \frac{m}{M}$$
$$0,18 = \frac{m}{100} \checkmark$$
$$\therefore m = 18 \text{ g } (17,5 \text{ g})$$

$m(CaCO_3)$ not reacted/*nie gereageer nie):*
25 – 18 ✓ = 7,00 g ✓ (7,49 g)

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7.00 g – 7,5 g)

OPTION 2 / *OPSIE 2*

Calculate mass of CO_2:
Bereken massa CO_2:

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{4,5}{25,7} \checkmark$$
$$= 0,18 \text{ mol } (0,175 \text{ mol})$$

$$n(CO_2) = \frac{m}{M}$$
$$0,18 = \frac{m}{44}$$
$$\therefore m(CO_2) = 7,92 \text{ g } (7,7043 \text{ g})$$

Ratio/ verhouding ✓

$$m(CaCO_3 \text{ needed / } benodig) = \frac{7,92}{44} \times 100 \checkmark$$
$$= 18 \text{ g } (17,5 \text{ g})$$

$m(CaCO_3$ not reacted/*nie gereageer nie):*
25 – 18,00 ✓ = 7,00 g ✓ (7,49 g)

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7.00 g – 7,5 g)

OPTION 3 / *OPSIE 3*

25,7 dm^3 : 1 mol
4,5 dm^3 : 0,18 mol ✓

100 g ✓: 1 mol
x : 0,18 mol ✓
x = 18 g

$m(CaCO_3$ not reacted/*nie gereageer nie):*
25 – 18 ✓ = 7,00 g ✓

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

OPTION 4 / *OPSIE 4*

100 g $CaCO_3 \rightarrow 25,7$ dm^3 CO_2 ✓✓
x g $\rightarrow 4,5$ dm^3 CO_2 ✓
$\therefore$ x = 17,51 g

Mass not reacted/*Massa nie gereageer nie*
= 25 – 17,51 ✓
= 7,49 g ✓

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

(5)

(5)

QUESTION 6 / *VRAAG 6*

6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ✓✓

OR / *OF*
The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly. ✓✓ (2)

6.2

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation / *Puntetoekenning:*

- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_C expression. ✓
  Vervanging van konsentrasies in K_C-uitdrukking.
- Substitution of K_C value / *Vervanging van K_C-waarde*. ✓
- Equilibrium concentration of both NO_2 & N_2O_4 multiplied by 0,08 dm^3. ✓
  Ewewigskonsentrasie van beide NO_2 & N_2O_4 vermenigvuldig met 0,08 dm^3
- Change in n(N_2O_4) = equilibrium n(N_2O_4) – initial n(N_2O_4) ✓
  Verandering in n(N_2O_4) = *ewewig* n(N_2O_4) – *aanvanklike* n(N_2O_4)
- **USING** ratio ***/ GEBRUIK*** *verhouding: NO_2 : N_2O_4 = 2 : 1* ✓
- Initial n(NO_2)= equilibrium n(NO_2) + change n(NO_2). ✓
  Aanvanklike n(NO_2)= ewewig n(NO_2) + verandering n(NO_2).
- Final answer / *Finale antwoord*: 1,11 (mol) ✓
  Accept range/*Aanvaar gebied:* 1,11 – 1,12 (mol)

OPTION 1 / *OPSIE 1*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ = $\frac{[N_2O_4]}{(0,2)^2}$ ✓

∴ $[N_2O_4] = 171 \times (0,2)^2$
$= 6,84 \text{ mol·dm}^{-3}$

No K_C expression, correct substitution / *Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

(8)

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	1,11 ✓	0	
Change (mol) *Verandering (mol)* ✓	1,094	0,55 ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	0,55	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,2	6,84	x 0,08 ✓

OPTION 2 / *OPSIE 2*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ = $\frac{[N_2O_4]}{(0,2)^2}$ ✓

∴ $[N_2O_4] = 171 \times (0,2)^2$
$= 6,84 \text{ mol·dm}^{-3}$

No K_C expression, correct substitution /*Geen K_c-uitdrukking*, *korrekte substitusie:* Max./*Maks.* $\frac{7}{8}$
Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

Equilibrium moles / *Ewewigsmol:*
$n(N_2O_4) = (6,84)(0,080)$
$= 0,55 \text{ mol}$
$n(NO_2) = (0,2)(0,080)$
$= 0,016 \text{ mol}$
} ✓ x 0,08 dm^3

$n(N_2O_4$ formed/*gevorm*$) = \underline{0,55 – 0} = 0,55$ mol ✓

Ratio / *Verhouding*:
$n(NO_2$ reacted / *gereageer*$) = 2n(N_2O_4$ formed/*gevorm*$) = 2(0,55) = 1,094$ mol ✓
Initial / *Aanvanklike* $n(NO_2) = 0,016 + 1,094$ ✓ $= 1,11$ (mol) ✓ (8)

OPTION 3 / *OPSIE 3*

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2x + 0,016	0	
Change (mol) *Verandering (mol)* ✓	2x	x ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	x	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x}{0,08}$	x 0,08 & ÷0,08 ✓

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{\frac{x}{0,08}}{(0,2)^2}$ ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

$\therefore$ x = 0,5472

$\therefore$ n(initial/*aanvanklik*) = 2(0,5472) + 0,016
= 1,11 mol ✓

(8)

OPTION 4 / *OPSIE 4*

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x	0	
Change (mol) *Verandering (mol)* ✓	x – 0,016	$\frac{x-0,016}{2}$ ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	$\frac{x-0,016}{2}$	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x-0,016}{0,16}$	x 0,08 & ÷0,08 ✓

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{\frac{x-0,016}{0,16}}{(0,2)^2}$ ✓

$\therefore$ x = 1,11 mol ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

(8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Mark allocation / *Puntetoekenning:*

- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_C expression. ✓
  Vervanging van konsentrasies in *K_C-uitdrukking*.
- Substitution of K_C value. / *Vervanging van K_C-waarde*. ✓
- Change in $[N_2O_4]$ = equilibrium $[N_2O_4]$ – initial $[N_2O_4]$. ✓
  Verandering in $[N_2O_4]$ = ewewig $[N_2O_4]$ – aanvanklike $[N_2O_4]$.
- **USING** ratio/***GEBRUIK*** *verhouding: NO_2 : N_2O_4 = 2 : 1* ✓
- Initial $[NO_2]$ = equilibrium $[NO_2]$ + change in $[NO_2]$. ✓
  Aanvanklike $[NO_2]$ = ewewigs $[NO_2]$ + verandering in $[NO_2]$.
- Equilibrium concentration of $[NO_2]$ multiplied by 0,08 dm^3. ✓
  Ewewigskonsentrasie van $[NO_2]$ vermenigvuldig met 0,08 dm^3.
- Final answer/*Finale antwoord*: 1,11 (mol) ✓
  Accept range/*Aanvaar gebied:* 1,11 – 1,12 (mol)

OPTION 5 / *OPSIE 5*

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2$$
$$= 6,84 \text{ mol·dm}^{-3}$$

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $^5/_8$

	NO_2	N_2O_4	
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	13,88	0	
Change (mol·dm^{-3}) *Verandering (*mol·dm^{-3}*)* ✓	13,68	6,84 ✓	ratio ✓ *verhouding*
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,2	6,84	

$n(NO_2) = cV = (13,88)(0,08)$ ✓ = 1,11 mol ✓ (8)

OPTION 6 / *OPSIE 6*

	NO_2	N_2O_4
Initial concentration ($mol \cdot dm^{-3}$) *Aanvangskonsentrasie ($mol \cdot dm^{-3}$)*	x	0
Change ($mol \cdot dm^{-3}$) ✓ *Verandering ($mol \cdot dm^{-3}$)*	x – 0,2	$\frac{x-0,2}{2}$ ✓
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x-0,2}{2}$

ratio ✓ *verhouding*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{\frac{x-0,2}{2}}{(0,2)^2}$ ✓

$\therefore$ x = 13,88 $mol \cdot dm^{-3}$

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

$n(NO_2) = cV = (13,88)(0,08)$ ✓ = 1,11 mol ✓ (8)

6.3

6.3.1 Concentration (of the gases) increases. / Molecules become more condensed or move closer to each other. ✓
Konsentrasie (van die gasse) verhoog. / Molekule word meer saamgepers of beweeg nader aan mekaar. (1)

6.3.2
- Increase in pressure favours the reaction that leads to smaller number of moles / volume of gas. ✓
  Toename in druk bevoordeel die reaksie wat tot die kleiner getal mol / volume gas lei.
- Forward reaction is favoured. / *Voorwaartse reaksie word bevoordeel.* ✓
- Number of moles/amount of N_2O_4 / colourless gas increases.✓
  Aantal mol/hoeveelheid N_2O_4 / kleurlose gas neem toe.

OR / *OF*
Number of moles/amount of NO_2 / brown gas decreases. ✓
Aantal mol/hoeveelheid NO_2 / bruin gas neem af. (3)

6.4

6.4.1 Darker / *Donkerder* ✓ (1)

6.4.2 Decreases / *Verlaag* ✓ (1)
[16]

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QUESTION 7/ *VRAAG 7*

PENALISE ONCE FOR THE INCORRECT CONVERSION OF UNITS.
PENALISEER EENMALIG VIR VERKEERDE OMSKAKELING VAN EENHEDE.

7.1
7.1.1 Ionises / dissociates completely (in water) ✓
Ioniseer / dissosieer volledig (in water). (1)

7.1.2 NO_3^- / Nitrate ion / *Nitraatioon* ✓ (1)

7.1.3 $pH = -\log[H_3O^+] / -\log[H^+]$ ✓
$= -\log(0,3)$ ✓
$= 0,52$ ✓ (3)

Notes/*Aantekeninge:*
- If no/incorrect formula/*Indien geen/foutiewe formule*: Max./*Maks:* 2/3
- If no substitution step: 2 marks for correct answer./*Indien geen substitusie stap: 2 punte vir korrekte antwoord.*

7.2
7.2.1 $c = \frac{n}{V}$ ✓
$2 = \frac{n}{0,1}$ ✓
$\therefore$ n(HCℓ) = 0,2 mol ✓ (3)

7.2.2 Burette / *Buret* ✓ (1)

7.2.3 B ✓
Titration of strong acid and strong base. ✓✓
Titrasie van sterk suur en sterk basis.

OR/*OF*
The endpoint will be approximately at pH = 7 which is in the range of the indicator.
Die eindpunt sal ongeveer by pH = 7 wees wat in die gebied van die indikator is. (3)

7.2.4 The number of moles of acid in the flask remains constant. ✓
Die getal mol van die suur in die fles bly konstant. (1)

7.2.5 $c = \frac{n}{V}$ ✓

$0,2 = \frac{n}{0,021}$ ✓

$n = 4,2 \times 10^{-3}$ mol ✓

n(HCℓ in excess/*in oormaat*):
n(HCℓ) = n(NaOH)
$= 4,2 \times 10^{-3}$ mol (3)

7.2.6 **POSITIVE MARKING FROM QUESTION 7.2.1 AND 7.2.5.**
POSITIEWE NASIEN VAN VRAAG 7.2.1 EN 7.2.5.

Marking criteria / *Nasienriglyne:*

- n(HCℓ reacted) = initial (from Q7.2.1) – excess (from Q7.2.5).✓
  n(HCℓ reageer) = begin (van Q7.2.1) – oormaat (van Q7.2.5).
- Use mol ratio of acid: base = 2 : 1. ✓
  Gebruik molverhouding suur : basis = 2 : 1.
- Substitute / *Vervang* 40 into / in $n = \frac{m}{M}$ ✓
- $\frac{m(MgO\ reacted / reageer)}{4,5} \times 100$. ✓
- Final answer / *Finale antwoord:* 87,11 % ✓

OPTION 1 / *OPSIE 1*

n(HCℓ reacted/*gereageer*):
0,2 – $4,2 \times 10^{-3}$ ✓ = 0,196 mol

n(MgO reacted/*gereageer*):
½n(HCℓ) = ½(0,196)
$= 9,8 \times 10^{-2}$ mol ✓

n(MgO reacted/*gereageer*) = $\frac{m}{M}$

$\therefore 0,098 = \frac{m}{40}$ ✓
$\therefore m = 3,92$ g

% purity/ *suiwerheid* = $\frac{3,92}{4,5} \times 100$ ✓
= 87,11% ✓

(Accept range*:* 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %)*

OPTION 2 / *OPSIE 2*

n(HCℓ reacted/*gereageer*):
0,2 – $4,2 \times 10^{-3}$ ✓ = 0,196 mol

n(HCℓ reacted/*gereageer*) = $\frac{m}{M}$

$0,196 = \frac{m}{36,5}$
$\therefore$ m(HCℓ reacted/*gereageer*) = 7,154 g

40 g MgO ✓ ..... 73 g HCℓ ✓
x g MgO ..... 7,154 g
$\therefore x = 3,92$ g

% purity/*suiwerheid* = $\frac{3,92}{4,5} \times 100$ ✓
= 87,11% ✓

(Accept range*:* 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %)*

(5)
[21]

QUESTION 8 / *VRAAG 8*

8.1
- Pressure: <u>1 atmosphere (atm)</u> / 101,3 kPa / 1,013 x 10^5 Pa ✓
  Druk: <u>1 atmosfeer (atm)</u> / 101,3 kPa / 1,013 x 10^5 Pa
- Temperature/*Temperatuur*: <u>25 °C</u> / 298 K ✓ (2)

8.2
- Platinum is inert / does not react with the H^+ ions OR acid. ✓
  Platinum is onaktief / reageer nie met die H^+-ione OF suur nie.
- Platinum is a conductor (of electricity). ✓
  Platinum is 'n geleier (van elektrisiteit). (2)

8.3

8.3.1 Salt bridge / *Soutbrug* ✓ (1)

8.3.2 -0,31 V ✓ (1)

8.3.3 $2H^+ + 2e^- \rightarrow H_2$ ✓✓

Marking guidelines / *Nasienriglyne:*

- $2H^+ + 2e^- \rightleftharpoons H_2$ $\frac{1}{2}$ $H_2 \rightleftharpoons 2H^+ + 2e^-$ $\frac{0}{2}$
  $H_2 \leftarrow 2H^+ + 2e^-$ $\frac{2}{2}$ $H_2 \rightarrow 2H^+ + 2e^-$ $\frac{0}{2}$ (2)

8.4

8.4.1 **POSITIVE MARKING FROM QUESTION 8.3.2.**
POSITIEWE NASIEN VAN VRAAG 8.3.2.

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
2,05 ✓ = -0,31 ✓– $E^\theta_{M/M^{2+}}$
$E^\theta_{M/M^{2+}}$ = -2,36 (V) ✓

M is magnesium/ Mg. ✓

Notes / *Aantekeninge:*
Accept any other correct formula from the data sheet.
Aanvaar enige ander korrekte formule vanaf gegewensblad.

Option 2/ *Opsie 2*

✓ { $M \rightarrow M^{2+} + 2e^-$ E° = 2,36 (V)
  $X^{2+} + 2e^- \rightarrow X$ E° = -0,31 (V) ✓
  E° = 2,05 V ✓

Thus/*Dus:* $E^\theta_{reduction}$ = - 2,36 (V) ✓
M is magnesium/ Mg. ✓

Any other formula using unconventional abbreviations, e.g. $E^\theta_{cell} = E^\theta_{OA} - E^\theta_{RA}$ followed by correct substitutions: $\frac{4}{5}$
Enige ander formule wat onkonvensionele afkortings gebruik bv. $E^\phi_{sel} = E^\phi_{OM} - E^\phi_{RM}$
gevolg deur korrekte vervangings: $\frac{4}{5}$

Notes / *Aantekeninge*
Give mark for Mg / magnesium ONLY if concluded from -2,36 V.
Ken punt vir Mg / magnesium slegs toe indien afgelei uit -2,36 V (5)

8.4.2 Exothermic / *Eksotermies* ✓ (1)

8.5 The cell reaction reaches equilibrium. ✓
Die selreaksie bereik ewewig.

Notes / *Aantekeninge:*
Accept: One or more of reactants are used up. / The cell reaction has run to completion. ***Aanvaar:*** *Een of meer van reaktanse word opgebruik. / Die selreaksie het volledig verloop.*

(1)
[15]

QUESTION 9 / *VRAAG 9*

9.1 Electrolytic / *Elektrolities* ✓ (1)

9.2 Q ✓ & T ✓

$Cu^{2+} + 2e \rightarrow Cu$ ✓✓

Notes / *Aantekeninge:*
IF more than TWO electrodes, mark first two. ***Indien*** *meer as TWEE elektrodes, sien eerste twee na.*

Marking guidelines / *Nasienriglyne*	
$Cu^{2+} + 2e \rightleftharpoons Cu$ $(1/2)$	$Cu \rightarrow Cu^{2+} + 2e^-$ $(0/2)$
$Cu \leftarrow Cu^{2+} + 2e$ $(2/2)$	$Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(0/2)$

(4)

9.3

9.3.1 $C\ell_2$ / chlorine (gas) / *chloor(gas)* ✓ (1)

9.3.2 Cu^{2+} (ions) / copper(II) ions / $CuC\ell_2$ / copper(II) chloride ✓
Cu^{2+} (ione) / k*oper(II)-ione* / $CuC\ell_2$ / *koper(II)chloried* (1)

9.4 Cu is a stronger reducing agent ✓ than $C\ell^-$ (ions) ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
Cu is 'n sterker reduseermiddel as Cℓ^-(-ione) en Cu sal geoksideer word (na Cu^{2+}).

OR/*OF*

$C\ell^-$ (ions) is a weaker reducing agent ✓ than Cu ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
Cℓ^-(-ione) is 'n swakker reduseermiddel as Cu en Cu sal geoksideer word (na Cu^{2+}). (3)
[10]

QUESTION 10 / *VRAAG 10*

10.1

10.1.1 Nitrogen / N_2 / *Stikstof* ✓
Hydrogen / H_2 / *Waterstof* ✓ (2)

10.1.2 $NH_3 + HNO_3$ ✓ $\rightarrow NH_4NO_3$ ✓ Bal. ✓

Notes / *Aantekeninge:*		
• Reactants ✓	Products ✓	Balancing: ✓
Reaktanse	*Produkte*	*Balansering*
• Ignore double arrows. / *Ignoreer dubbelpyle.*		
• Marking rule 6.3.10. / *Nasienreël 6.3.10.*		

(3)

10.2

Marking criteria / *Nasienriglyne:*

- Use ratio / *gebruik verhouding:* $\frac{3}{9}$ ✓
- x 20 kg ✓
- x 36 / 36 % ✓
- Final answer / *Finale antwoord:* 2,4 kg ✓

OPTION 1 / *OPSIE 1*:	**OPTION 2 / *OPSIE 2:***	**OPTION 3 / *OPSIE 3*:**
% N = $\frac{3}{9}$ ✓ (x 36) ✓ = 12 % $\therefore$ m(N) : $\frac{12}{100}$ (× 20 ✓ kg) = 2,4 kg ✓	m(nutrients/*voedingstowwe*): $\frac{36}{100}$ ✓ (x 20 ✓) = 7,2 kg $\therefore$ m(N) = $\frac{3}{9}$ ✓ x 7,2 = 2,4 kg ✓	m(N): $\frac{3}{9}$ ✓ × (× 20 ✓) (× $\frac{36}{100}$ ✓) = 2,4 kg ✓

(4)
[9]

TOTAL/*TOTAAL*: 150

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