basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2023

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE 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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following represents a straight chain SATURATED hydrocarbon?

A C_5H_8

B C_5H_{10}

C C_6H_{12}

D C_6H_{14} (2)

1.2 Which ONE of the following is a SECONDARY alcohol?

A $C(CH_3)_3OH$

B $CH_3(CH_2)_3OH$

C $CH_3(CH_2)_2CHO$

D $CH_3CH_2CH(OH)CH_3$ (2)

1.3 Which ONE of the following is a HYDROLYSIS reaction?

A $CH_3CH_2Br + H_2O \rightarrow CH_3CH_2OH + HBr$

B $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$

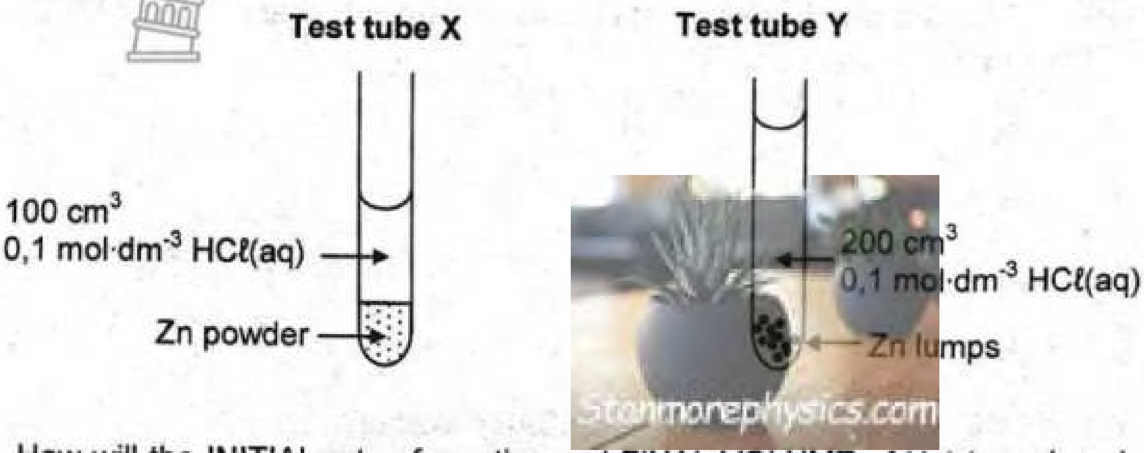
C $CH_2CH_2 + H_2O \rightarrow CH_3CH_2OH$

D $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$ (2)

1.4 Hydrochloric acid reacts with EXCESS zinc:

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

Different reaction conditions are shown in the diagrams below. The mass of zinc used is the same in both test tubes.

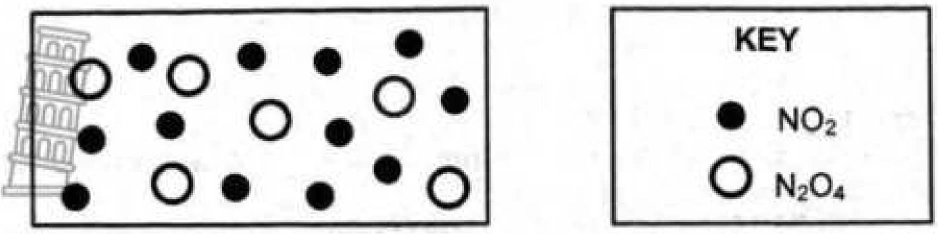


How will the INITIAL rate of reaction and FINAL VOLUME of $H_2(g)$ produced in test tube **Y** compare with that in test tube **X**?

	INITIAL RATE OF REACTION IN Y	FINAL VOLUME OF H_2(G) IN Y
A	Higher	Equal
B	Lower	More
C	Lower	Equal
D	Higher	More

(2)

1.5 The diagram below represents a mixture of $NO_2(g)$ and $N_2O_4(g)$ molecules at equilibrium in a 1 dm^3 container at T °C.



The balanced equation for this reaction is:

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

Which ONE of the following is TRUE for the value of the equilibrium constant, K_c, for the reaction at T °C?

A $K_c = 24$

B $K_c > 1$

C $K_c = 1$

D $0 < K_c < 1$ (2)

1.6 A reaction is at equilibrium in a closed container according to the following balanced equation:

$$4CuO(s) \rightleftharpoons 2Cu_2O(s) + O_2(g)$$

The volume of the container is now increased while the temperature remains constant. A new equilibrium is reached.

Which ONE of the following combinations is CORRECT for the new equilibrium?

	CONCENTRATION OF O_2	NUMBER of MOLES OF O_2	EQUILIBRIUM CONSTANT (K_c)
A	Decreases	Remains the same	Increases
B	Remains the same	Decreases	Remains the same
C	Remains the same	Increases	Remains the same
D	Decreases	Increases	Remains the same

(2)

1.7 Nitric acid, $HNO_3(aq)$, and ethanoic acid, $CH_3COOH(aq)$, of equal volumes and concentrations are compared.

Consider the following statements regarding these solutions:

(i) They have different pH values.
(ii) Both have the same electrical conductivity.
(iii) Both solutions require the same number of moles of KOH(aq) for complete neutralisation.

Which of the above statement(s) is/are TRUE?

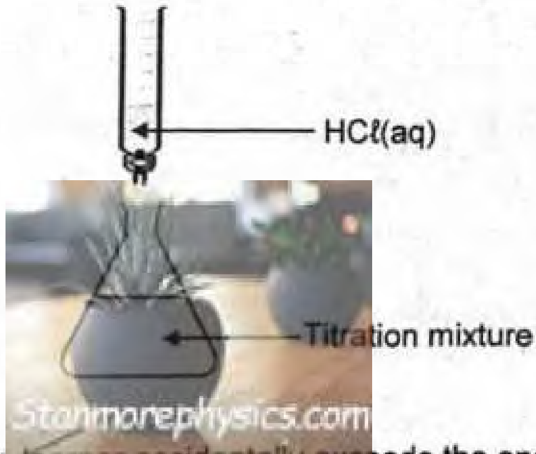
A (i) only

B (i) and (ii) only

C (i) and (iii) only

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

1.8 The apparatus in the diagram below is used for the titration between HCℓ(aq) and KOH(aq).



In a titration, the learner accidentally exceeds the endpoint. Which ONE of the following will be TRUE for the titration mixture?

A $[H^+] > [OH^-]$ and pH < 7

B $[H^+] < [OH^-]$ and pH < 7

C $[H^+] < [OH^-]$ and pH > 7

D $[H^+] > [OH^-]$ and pH > 7 (2)

1.9 The following hypothetical standard reduction potentials relate to a galvanic cell:

$$X^{2+}(aq) + 2e^- \rightarrow X(s) \qquad E^\theta = +0,10\ V$$
$$Y^{+}(aq) + e^- \rightarrow Y(s) \qquad E^\theta = -0,10\ V$$

Consider the following statements for this galvanic cell:

(i) The emf of the cell is 0,20 V under standard conditions.
(ii) Electrode **Y** is the anode.
(iii) **X** is oxidised.

Which of the above statement(s) is/are TRUE for this galvanic cell?

A (i) only

B (i) and (ii) only

C (i) and (iii) only

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

1.10 Which ONE of the half-reactions below will be the MAIN reaction at the ANODE during the electrolysis of CONCENTRATED $CuC\ell_2(aq)$?

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

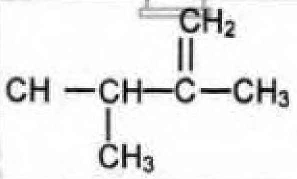
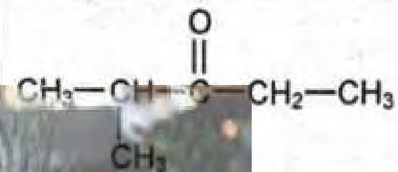
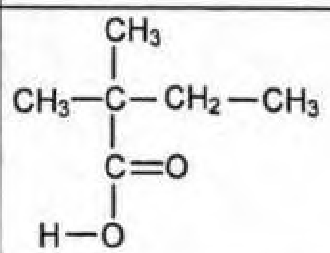
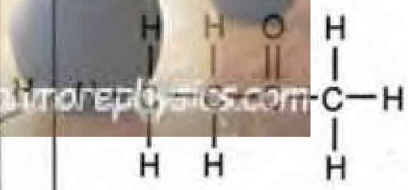
B $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

C $2H_2O(\ell) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

D $2C\ell^-(aq) \rightarrow C\ell_2(g) + 2e^-$ (2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **H** in the table below represent eight organic compounds.

A	Heptanoic acid	**B**	$CH_3(CH_2)_3COOCH_3$
C	4-ethyl-3,3-difluorohexane	**D**	Hexanoic acid
E		**F**	
G		**H**	

2.1 Define the term *organic compound.* (1)

2.2 Write down the IUPAC name of compound:

2.2.1 **E** (2)

2.2.2 **H** (2)

2.3 Write down the:

2.3.1 STRUCTURAL formula of compound **B** (2)

2.3.2 STRUCTURAL formula of compound **C** (3)

2.3.3 General formula of the homologous series to which compound **E** belongs (1)

2.3.4 STRUCTURAL formula of the FUNCTIONAL group of compound **F** (1)

2.3.5 IUPAC name of the alcohol needed to produce compound **B** (2)

2.4 Write down the letter(s) of the compound(s) that:

2.4.1 Is a FUNCTIONAL isomer of compound **G** (1)

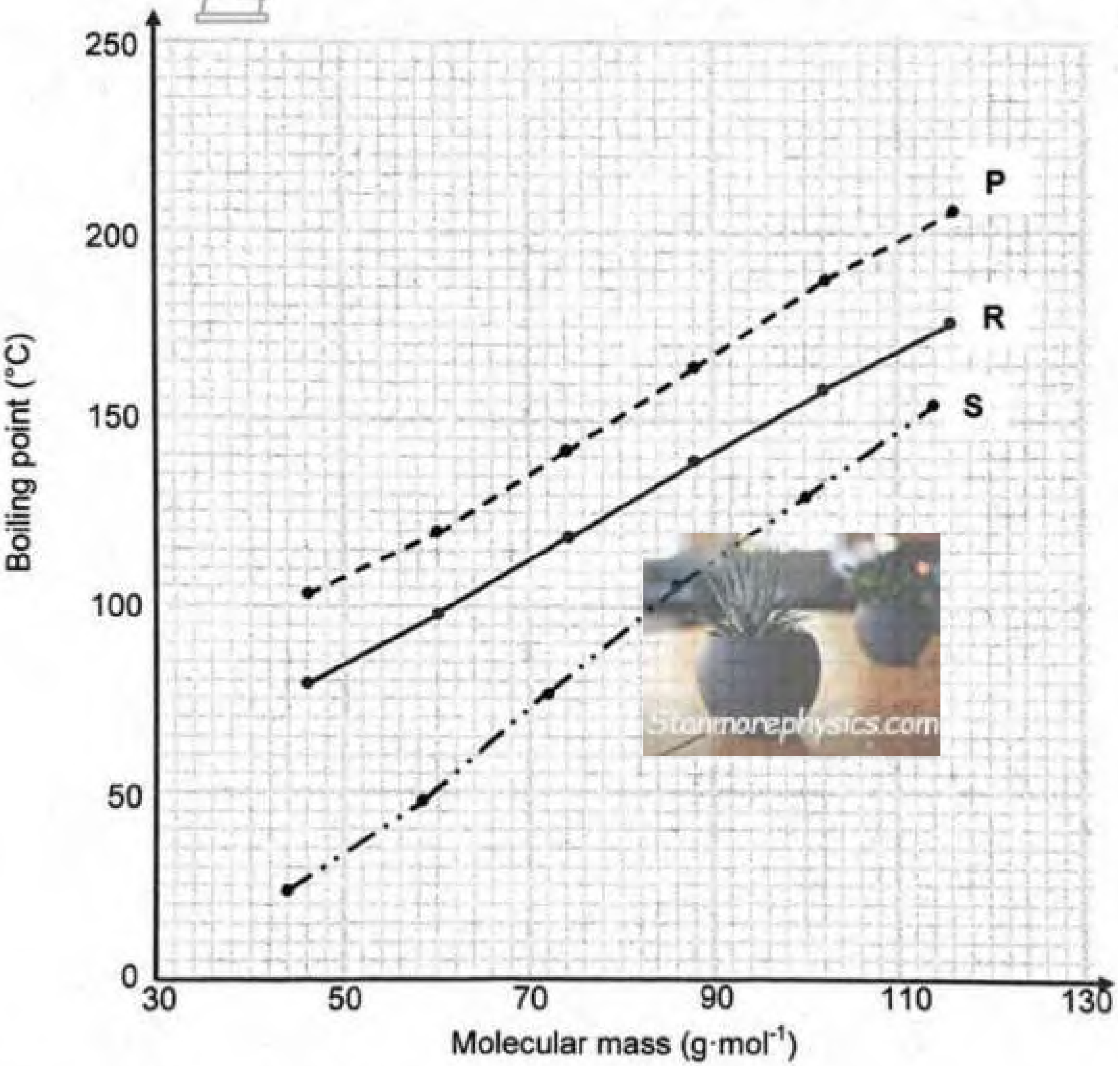
2.4.2 Are CHAIN isomers of each other (1)

[16]

QUESTION 3 (Start on a new page.)

The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves **P**, **R** and **S** are obtained. All compounds used are straight chain molecules.

GRAPH OF BOILING POINT VERSUS MOLECULAR MASS



3.1 Define the term *boiling point*. (2)

3.2 Write down the conclusion that can be made for curve **P**. (2)

3.3 Explain the answer to QUESTION 3.2 in terms of the structures of the compounds. (2)

3.4 Curve **R** represents the alcohols.

3.4.1 Which homologous series is represented by curve **S**? (1)

3.4.2 Explain the answer to QUESTION 3.4.1 by referring to the strength of intermolecular forces. (2)

3.5 For curve **R**, write down the:

3.5.1 Molecular mass of the compound with a boiling point of 97 °C (1)

3.5.2 IUPAC name of the compound in QUESTION 3.5.1 (2)

3.6 Two compounds, **A** and **B**, used in this investigation have a molecular mass of 74 $g \cdot mol^{-1}$. **A** has a boiling point of 118 °C and **B** a boiling point of 142 °C. Explain the difference in these boiling points by referring to the structures of these compounds. (3)

[15]

QUESTION 4 (Start on a new page.)

4.1 Consider the cracking reaction below.

$$C_{16}H_{34} \longrightarrow C_6H_{14} + C_6H_x + 2C_yH_z$$

4.1.1 Define *cracking*. (2)

4.1.2 Write down the values represented by **x**, **y** and **z** in the equation above. (3)

Compound C_6H_{14} undergoes complete combustion.

4.1.3 Using MOLECULAR FORMULAE, write down the balanced equation for this reaction. (3)

4.2 Consider the equations for reactions **I** to **III** below.

A and **B** represent organic compounds that are POSITIONAL ISOMERS. **X** is an inorganic product.

I	$CH_3CH_2CHCHCH_3 + HC\ell \rightarrow$ **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$

Write down the:

4.2.1 Definition of *positional isomers* (2)

4.2.2 Type of reaction represented by reaction **I** (1)

4.2.3 STRUCTURAL formula of compound **B** (3)

4.2.4 Formula of **X** (1)

4.2.5 Inorganic reagent for reaction **III** (1)

Compound **A** can be converted directly to the organic product of reaction **III**.

4.2.6 Besides heat, write down the reaction condition needed for this conversion. (1)

4.2.7 Write down TWO terms that describe this type of reaction. (2)

[19]

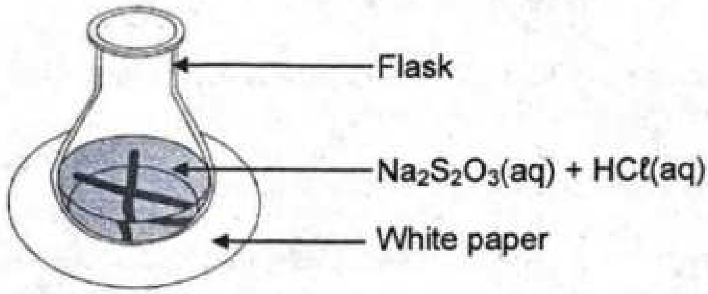
QUESTION 5 (Start on a new page.)

The reaction between EXCESS dilute hydrochloric acid and sodium thiosulphate is used to investigate factors that influence reaction rate.

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

The concentration of $HC\ell(aq)$ used is 1 mol·dm^{-3}. The same volume of $HC\ell(aq)$ is used in each run.

The time taken for the cross on the paper under the flask to become invisible is measured.



The table below summarises the reaction conditions and results of the experiment.

RUN	VOLUME $Na_2S_2O_3(aq)$ (cm^3)	VOLUME $H_2O(\ell)$ ADDED (cm^3)	CONCENTRATION $Na_2S_2O_3(aq)$ (mol·dm^{-3})	TIME (s)
1	50	0	0,13	20,4
2	40	10	0,10	26,7
3	30	20	**P**	33,3

5.1 Define *reaction rate*. (2)

5.2 Write down the independent variable for this investigation. (1)

5.3 Calculate the value of **P** in the table. (3)

5.4 When 0,21 g of sulphur has formed in Run **1**, the cross becomes invisible.

Calculate the average reaction rate with respect to sodium thiosulphate, $Na_2S_2O_3(aq)$, in g·s^{-1}. (5)

Another investigation is performed at different temperatures.

5.5 Sketch the Maxwell-Boltzmann distribution curve for the reaction at 20 °C. Label this curve as **A**. On the same set of axis, draw the curve that will be obtained at 35 °C and label it as **B**. (4)

5.6 Explain the effect of temperature on reaction rate in terms of the collision theory. (4)

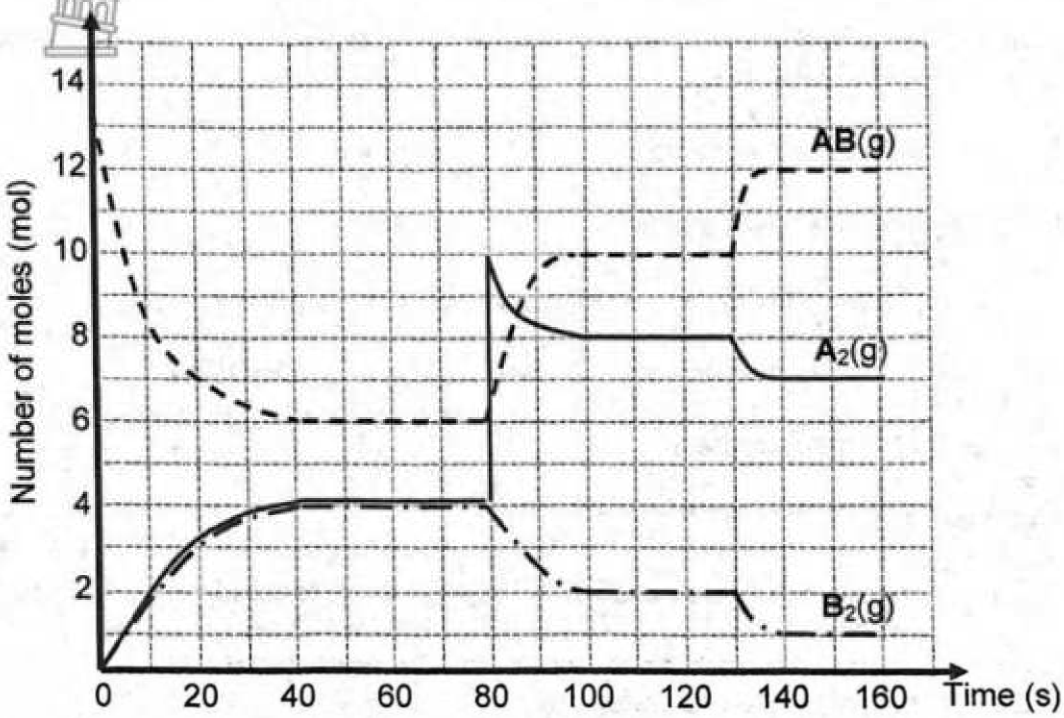
[19]

QUESTION 6 (Start on a new page.)

Consider the following hypothetical reaction reaching equilibrium in a 4 dm^3 closed container at 150 °C.

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

The graph below shows the changes in the amounts of reactants and products over time.



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

6.2 State Le Chatelier's principle. (2)

6.3 A change was made to the equilibrium mixture at t = 80 s.

6.3.1 Write down the change made at t = 80 s. (1)

6.3.2 Use Le Chatelier's principle to explain how the system reacts to this change. (2)

6.4 Calculate the equilibrium constant, K_c, at t = 120 s. (4)

6.5 At t = 130 s the temperature of the system is decreased to 100 °C.

6.5.1 Draw a potential energy diagram for this reaction. (3)

6.5.2 Will the equilibrium constant, K_c, at 100 °C be GREATER THAN, LESS THAN or EQUAL TO the K_c at 150 °C? Explain the answer. (3)

6.6 The initial reaction now takes place in the presence of a catalyst at 150 °C.

Describe the changes that will be observed on the graph between t = 0 s and t = 60 s. (3)

[19]

QUESTION 7 (Start on a new page.)

To identify metal **M** in an unknown metal carbonate, $\mathbf{M}CO_3$, the following procedure is carried out:

Step 1: 0,198 g of IMPURE $\mathbf{M}CO_3$ is reacted with 25 cm^3 of 0,4 $mol{\cdot}dm^{-3}$ nitric acid, $HNO_3(aq)$.

Step 2: The EXCESS $HNO_3(aq)$ is then neutralised with 20 cm^3 of 0,15 $mol{\cdot}dm^{-3}$ barium hydroxide, $Ba(OH)_2(aq)$.

Assume that the volumes are additive.

The following reactions take place:

$$2HNO_3(aq) + \mathbf{M}CO_3(s) \rightarrow \mathbf{M}(NO_3)_2(aq) + CO_2(g) + H_2O(\ell)$$

$$2HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2H_2O(\ell)$$

7.1 Define the term *strong base*. (2)

7.2 Calculate the:

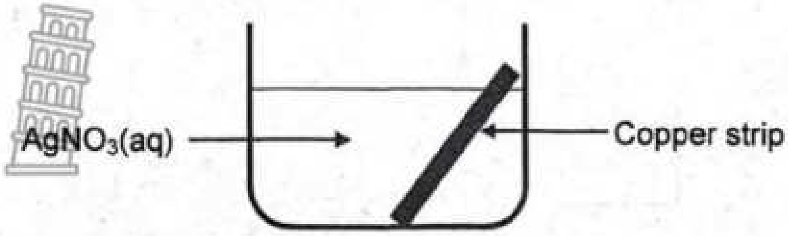
7.2.1 Number of moles of $Ba(OH)_2(aq)$ that reacted with the excess $HNO_3(aq)$ (3)

7.2.2 pH of the solution after Step 1 (5)

7.3 The percentage purity of the $\mathbf{M}CO_3(s)$ in the sample is 85%. Identify metal **M**. (8)
[18]

QUESTION 8 (Start on a new page.)

A cleaned pure copper strip, Cu(s), is placed in a beaker containing a colourless silver nitrate solution, $AgNO_3$(aq), at 25 °C, as shown below.



After a while, it is observed that the solution in the beaker becomes blue.

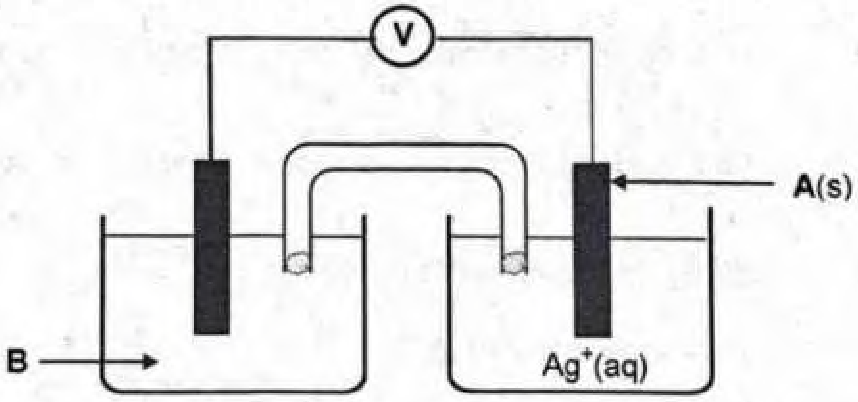
8.1 Write down:

8.1.1 ONE other OBSERVABLE change, besides the solution turning blue (1)

8.1.2 The NAME or FORMULA of the oxidising agent (1)

8.2 Explain the answer to QUESTION 8.1.1 by referring to the relative strengths of the oxidising agents or reducing agents. (3)

A galvanic cell is now set up using Cu and Ag strips as electrodes. A simplified diagram of the cell is shown below.



8.3 Write down the:

8.3.1 NAME or FORMULA of electrode **A** (1)

8.3.2 NAME or FORMULA of solution **B** (1)

8.3.3 Overall (net) balanced equation for the cell reaction (3)

8.4 The salt bridge contains potassium nitrate, KNO_3(aq).

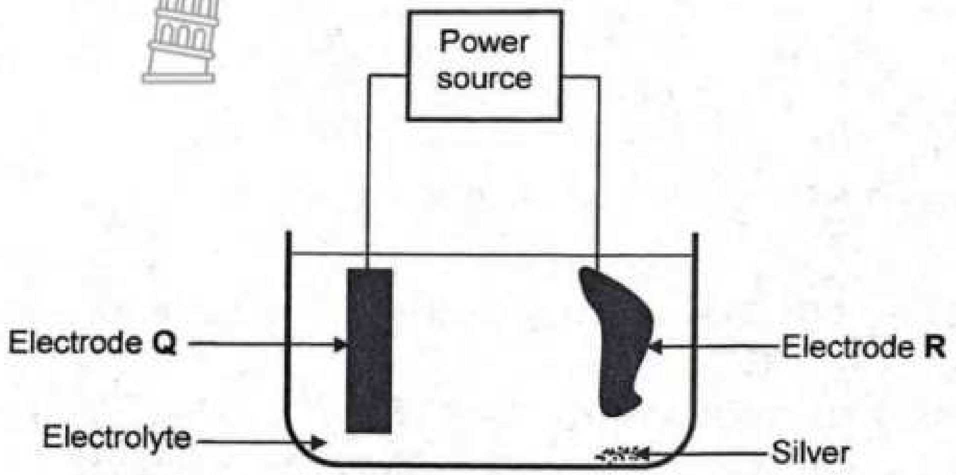
Write down the FORMULA of the ion in the salt bridge that will move into the silver ion solution. Choose from K^+(aq) or NO_3^-(aq).

Give a reason for the answer. (2)

[12]

QUESTION 9 (Start on a new page.)

An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode **R** is impure copper.



9.1 Define the term *electrolysis*. (2)

9.2 Write down the reaction taking place at electrode **Q**. (2)

9.3 In which direction do the electrons flow in the external circuit? Choose from **Q** to **R** or **R** to **Q**. (1)

9.4 Calculate the current needed to form 16 g of copper when the cell operates for five hours. (5)

9.5 During this electrolysis, only copper and zinc are oxidised.

Give a reason why the silver is not oxidised. (2)
[12]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidisingagent} - E^\theta_{reducingagent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{q_e}$ where n is the number of electrons/ *waar n die aantal elektrone is*

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

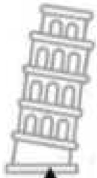
KEY/*SLEUTEL*

Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
1,9	29	Cu	63,5

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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



Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels*

Half-reactions/*Halfreaksies*			E^θ (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 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
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	− 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels*

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

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels* (↓)

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* (↑)

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

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 2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages.
Hierdie nasienriglyne bestaan uit 19 bladsye.

QUESTION 1/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 D ✓✓ (2)

1.3 A ✓✓ (2)

1.4 B ✓✓ (2)

1.5 D ✓✓ (2)

1.6 C ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

1.9 B ✓✓ (2)

1.10 D ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 Molecules containing carbon atoms. ✓
Molekule wat koolstofatome bevat. (1)

2.2

2.2.1 2,3-dimethyl✓but-1-ene✓/2,3-dimethyl-1-butene
2,3-dimetielbut-1-een/2,3-dimetiel-1-buteen

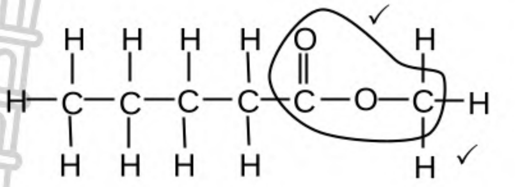
Marking criteria:	***Nasienkriteria:***
• Correct stem i.e. but-1-ene. ✓ • IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓	• *Korrekte stam d.i.* but-1-ene. ✓ • *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(2)

2.2.2 Butan-2-one/2-butanone/butanone ✓✓
Butan-2-oon/2-butanoon/butanoon (2)

2.3

2.3.1

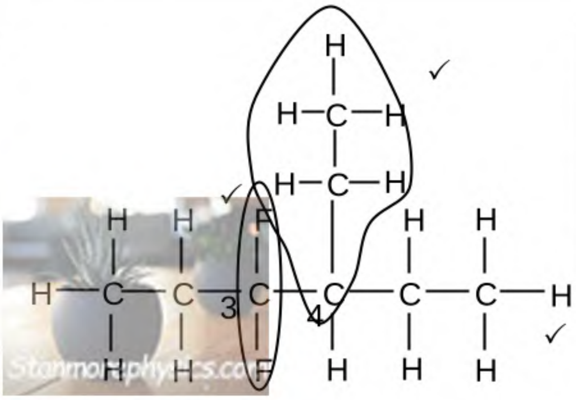


Marking criteria/*Nasienkriteria:*
- Functional group correct✓
  Funksionele groep korrek.
- Whole structure correct. ✓
  Hele struktuur korrek.

IF/*INDIEN*
- More than one functional group/wrong functional group:
  Meer as een funksionele groep/foutiewe funksionele groep: $^0/_2$
- If condensed structural formulae used/*Indien gekondenseerde struktuurformules gebruik:* Max./*Maks.* $^1/_2$

(2)

2.3.2

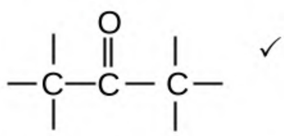


Marking criteria/*Nasienkriteria:*
- Six C atoms in longest chain. ✓
  Ses C-atome in langste ketting.
- Two F atoms on third C atom. ✓
  Twee F-atome op die derde C-atoom.
- Ethyl substituent on fourth C atom. ✓
  Etielsubstituent op die vierde C-atoom.

(3)

2.3.3 C_nH_{2n} ✓ (1)

2.3.4



(1)

2.3.5 Methanol/*Metanol* ✓✓ (2)

2.4.1 B ✓ (1)

2.4.2 D and/*en* G ✓ (1)

[16]

QUESTION 3/*VRAAG 3*

3.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.* The underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk van die stof gelyk is aan atmosferiese druk. (2)

3.2

Marking criteria/*Nasienkriteria:*
• Dependent and independent variables correctly identified. ✓ *Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.*
• Correct relationship between dependent and independent variables stated. ✓ *Korrekte verwantskap tussen die afhanklike en onafhanklike veranderlikes gestel*

The higher the molecular mass the higher the boiling point. / As the molecular mass increases the boiling point increases. / The longer the C-chain length the higher boiling point / The boiling point and the molecular mass are proportional. ✓✓
Hoe hoër die molekulêre massa hoe hoër die kookpunt./Soos die molekulêre massa toeneem, neem die kookpunt ook toe. / Hoe langer die C-kettinglengte hoe hoër is die kookpunt. / Die kookpunt en die molekulêre massa is eweredig. (2)

3.3

Marking criteria:
• Compare the strength of intermolecular forces. ✓
• Compare the energy required to overcome intermolecular forces. ✓
Nasienkriteria:
• *Vergelyk die sterkte van intermolekulêre kragte.* ✓
• *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓

- Strength of the intermolecular forces increases / More sites for London forces with increase of molar mass/chain length. ✓
- More energy is needed to overcome/break intermolecular forces. ✓

OR

- Strength of the intermolecular forces decreases / Less sites for London forces with decrease in molar mass/chain length. ✓
- Less energy is needed to overcome/break intermolecular forces. ✓

- *Sterkte van die intermolekulêre kragte verhoog / Meer punte vir Londonkragte met 'n toename in molêre massa/kettinglengte.* ✓
- *Meer energie benodig om intermolekulêre kragte te oorkom/breek.* ✓

OF

- *Sterkte van die intermolekulêre kragte verlaag / Minder punte vir Londonkragte met afname in molêre massa/kettinglengte.* ✓
- *Minder energie benodig om intermolekulêre kragte te oorkom/breek.* ✓

(2)

3.4.1 Aldehyde / *Aldehiede* ✓ (1)

3.4.2

Marking criteria: • Comparing the strength of intermolecular forces of aldehydes with alcohols and/or carboxylic acids. ✓ • Linking the intermolecular forces to boiling point. ✓ ***Nasienkriteria:*** • *Vergelyk die sterkte van die intermolekulêre kragte van aldehiede met alkohole en/of karboksielsure.* ✓ • *Trek die verband tussen die intermolekulêre kragte en die kookpunte.* ✓

- The strength of the intermolecular forces in aldehydes is weaker than in alcohols / carboxylic acids. ✓
- Therefore aldehydes have lower boiling points than alcohols / carboxylic acids ✓

OR

- Carboxylic acids and alcohols have stronger intermolecular forces than aldehydes.
- Therefore carboxylic acids and/or alcohols have higher boiling points than aldehydes.

- *Die sterkte van die intermolekulêre kragte tussen aldehiede is swakker as tussen alkohole / karboksielsure.* ✓
- *Dus het aldehiede 'n laer kookpunt as alkohole / karboksielsure.* ✓

OF

- *Karboksielsure en alkohole het sterker intermolekulêre kragte as aldehiede*
- *Dus het alkohole / karboksielsure 'n hoër kookpunt as aldehiede.* (2)

3.5

3.5.1 60 ($g \cdot mol^{-1}$) ✓ (1)

3.5.2 **POSITIVE MARKING FROM QUESTION 3.4/*POSITIEWE NASIEN VAN VRAAG 3.4***

Propan-1-ol/1-propanol ✓✓

Marking criteria:	***Nasienkriteria:***
• Correct chain length, 3 C-atoms ✓ • Correct IUPAC name ✓	• *Korrekte stamlengte, 3 C-atome.* ✓ • *Korrekte IUPAC-naam.* ✓

(2)

3.6

Marking criteria: • State that carboxylic acids have two sites for hydrogen bonding. ✓ • State that alcohols have one site for hydrogen bonding. ✓ • Comparing the strength of IMF's / the energy needed to overcome IMF's. ✓ ***Nasienkriteria:*** • *Stel dat karboksielsure twee plekke het vir waterstofbindings.* • *Stel dat alkohole een plek het vir waterstofbinding.* • *Vergelyk die sterkte van die IMK's / energie benodig om IMK's te oorkom.*

- Carboxylic acids/B have, in addition to London forces and dipole-dipole forces, two sites for hydrogen bonding between molecules. ✓

OR

Carboxylic acids can form dimers due to strong hydrogen bonding between molecules.

- Alcohols/A have, in addition to London forces and dipole-dipole forces, one site for hydrogen bonding between molecules. ✓
- Intermolecular forces in carboxylic acids are stronger./More energy needed to overcome/break intermolecular forces in carboxylic acid/B. ✓

- *Karboksielsure het, in toevoeging tot Londonkragte en dipool-dipoolkragte, twee punte vir waterstofbinding tussen molekule.*

OF

Karboksielsure kan dimere vorm as gevolg van sterk waterstofbindings tussen molekule.

- *Alkohole het, in toevoeging tot Londonkragte en dipool-dipoolkragte, een punt vir waterstofbinding tussen molekule.*
- *Intermolekulêre kragte in karboksielsure is sterker./Meer energie word benodig om intermolekulêre kragte in karboksielsure te oorkom/breek.*

(3)
[15]

QUESTION 4/*VRAAG 4*

4.1

4.1.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.* The underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

The chemical process in which longer chain hydrocarbon molecules are broken down to shorter (more useful) molecules. ✓✓
Die chemiese proses waarin langer kettingkoolwaterstof-molekule afgebreek word in korter, (meer bruikbare), molekules. (2)

4.1.2 X = 12 ✓
Y = 2 ✓
Z = 4 ✓ (3)

4.1.3

Marking criteria/*Nasienkriteria*
• Reactants ✓ products ✓ / *Reaktanse produkte*
• Balancing✓/*Balansering*

$2C_6H_{14} + 19O_2$ ✓ → $12CO_2 + 14H_2O$ ✓ Bal ✓

Notes/*Aantekeninge:*
• Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
• Marking rule 6.3.10/*Nasienreël 6.3.10.*
• If condensed structural formulae used:/*Indien gekondenseerde struktuurformules gebruik:* Max/*Maks.* $\frac{2}{3}$

(3)

4.2

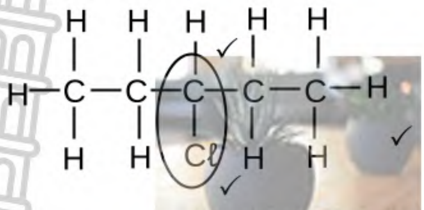
4.2.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.* The underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

Compounds with the same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain. ✓✓
Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting, substituente of funksionele groepe op die stamketting. (2)

4.2.2 Addition/hydrohalogenation/hydrochlorination ✓
Addisie/hidrohalogenering/hidrochlorinering (1)

4.2.3



<u>Marking criteria/*Nasienkriteria*:</u>
- Chlorine atom bonded to any C-atom ✓
  Chlooratoom gebind aan enige C-atoom
- Correct functional group on third C-atom ✓
  Korrekte funksionele groep op derde C-atoom
- Whole structure correct ✓
  Hele struktuur korrek

(3)

4.2.4 HCℓ ✓ (1)

4.2.5 <u>Concentrated sulphuric acid/</u>H_2SO_4(conc./gek.) ✓
<u>*Gekonsentreerde swawelsuur*</u> (1)

4.2.6 <u>Concentrated strong base</u> ✓
OR
<u>Concentrated</u> NaOH/KOH/LiOH/sodium hydroxide/ potassium hydroxide/ lithium hydroxide
OR
<u>Strong base</u>/NaOH/KOH/LiOH/sodium hydroxide/ potassium hydroxide/lithium hydroxide <u>in ethanol</u>.

<u>*Gekonsentreerde sterk basis*</u>
OF
<u>*Gekonsentreerde NaOH*</u> */KOH/ LiOH /natriumhidroksied/ kaliumhidroksied/ litiumhidroksied*
OF
<u>*Sterk basis*</u>*/NaOH /KOH/ LiOH / natriumhidroksied/kaliumhidroksied/litium-hidroksied* <u>*in etanol*</u> (1)

4.2.7 Elimination ✓
Dehydrohalogenation/dehydrochlorination ✓

Eliminasie
Dehidrohalogenering/dehidrohalogenasie/dehidrochlorinasie/ dehidrochlonering (2)

[19]

QUESTION 5/*VRAAG 5*

5.1 **ANY ONE:**

- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- Rate of change in concentration/amount/number of moles/volume/ mass.✓✓ **(2 or 0)**

ENIGE EEN:

- *Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.*
- *Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.*
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.*
- *Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa.* ***(2 of 0)*** (2)

5.2 Concentration (of $Na_2S_2O_3$)/*Konsentrasie van* ($Na_2S_2O_3$) ✓ (1)

5.3

Marking criteria/*Nasienkriteria*:

- Substitute/*Vervang* 0,03 x 0,13 / 30 x 0,13✓
- Substitute/*Vervang* 50 OR/*OF* 0,05 ✓
- Final correct answer/*Finale korrekte antwoord*: 0,078 mol·dm^{-3} ✓
  Range 0,075 to 0,08 mol·dm^{-3}

OPTION 1/*OPSIE 1*

$c = \frac{n}{V}$

$0,13 = \frac{n}{0,03}$ ✓

n = 3,9 x 10^{-3} moles/*mol*

$c = \frac{n}{V}$

$c = \frac{3,9 \times 10^{-3}}{0,05}$ ✓

= 0,078 mol·dm^{-3} ✓

OPTION 2/*OPSIE 2*

$c_1V_1 = c_2V_2$

(0,13)(0,030) ✓ = c_2 (0,50) ✓

c_2 = 0,078 mol·dm^{-3} ✓

OPTION 3/*OPSIE 3*

Marking criteria/*Nasienkriteria*:

- Substitute/*Vervang* 0,05 x 0,13 OR/*OF* 50 x 0,13 ✓
- Substitute/*Vervang* 50 OR/*OF* 0,05 ✓
- Final correct answer/*Finale korrekte antwoord*: 0,078 mol·dm^{-3} ✓
  Range 0,075 to 0,08 mol·dm^{-3}

$c = \frac{n}{V}$

$0,13 = \frac{n}{0,05}$ ✓

n = 6,5 x 10^{-3} moles/*mol*

$V_2 : V_1$

3 : 5

3,9 x 10^{-3} : 6,5 x 10^{-3}

$c = \frac{n}{V}$

$c = \frac{3,9 \times 10^{-3}}{0,05}$ ✓

= 0,078 mol·dm^{-3} ✓

OR/*OF*

$c = \frac{n}{V}$

$0,10 = \frac{n}{0,05}$ ✓

n = 5 x 10^{-3} moles/*mol*

$V_2 : V_1$

3 : 4

3,75 x 10^{-3} : 5 x 10^{-3}

$c = \frac{n}{V}$

$c = \frac{3,75 \times 10^{-3}}{0,05}$ ✓

= 0,075 mol·dm^{-3} ✓

OPTION 4/*OPSIE 4*

$\frac{3}{5}$ ✓ x 0,13 ✓ = 0,078 mol·dm^{-3} ✓

(3)

5.4

Marking criteria:	***Nasienkriteria***:
• Substitute to calculate n(S): $\frac{0,21}{32}$ ✓ • Use mol/M ratio: n(S) = n($Na_2S_2O_3$) ✓ • Substitute M = 158 g·mol^{-1} in formula n($Na_2S_2O_3$) = $\frac{m}{M}$ ✓ • Substitute t = 20,4 s into rate formula. ✓ • Final correct answer: 0,051 (g·s^{-1}) ✓ Range: 0,050 to 0,080 (g·s^{-1})	• *Vervang om te bereken* n(S): $\frac{0,21}{32}$ ✓ • *Gebruik mol/M-verhouding:* n(S) = n($Na_2S_2O_3$) ✓ • *Vervang* M = 158 g·mol^{-1} in formula n($Na_2S_2O_3$) = $\frac{m}{M}$ ✓ • *Vervang t = 20,4 s in tempo formule.* ✓ • *Finale korrekte antwoord*: 0,051 (g·s^{-1})✓ Range/*Gebied: 0,050 to 0,080* (g·s^{-1})

OPTION 1/*OPSIE 1*

$$n(S) = \frac{m}{M}$$
$$= \frac{0,21}{32} \checkmark$$
= 0,00656 moles/*mol* (6,56x10^{-3})

n(S) = n($Na_2S_2O_3$)
= 0,00656 moles/*mol* ✓

$$n(Na_2S_2O_3) = \frac{m}{M}$$
$$0,00656 = \frac{m}{158} \checkmark$$
m($Na_2S_2O_3$) = 1,04 g

OPTION 2/*OPSIE 2*

158 g $Na_2S_2O_3$ ✓ → 32 g S ✓
x g → 0,21 g ✓
x = 1,04 g

$$\text{Rate/}\textit{Tempo} = \frac{\Delta m}{\Delta t}$$
$$= \frac{1,04}{20,4} \checkmark$$
= 0,051 (g·s^{-1}) ✓

ACCEPT/*AANVAAR:*

$$c = \frac{n}{V}$$
$$0,13 = \frac{n}{0,05}$$
= 0,00656

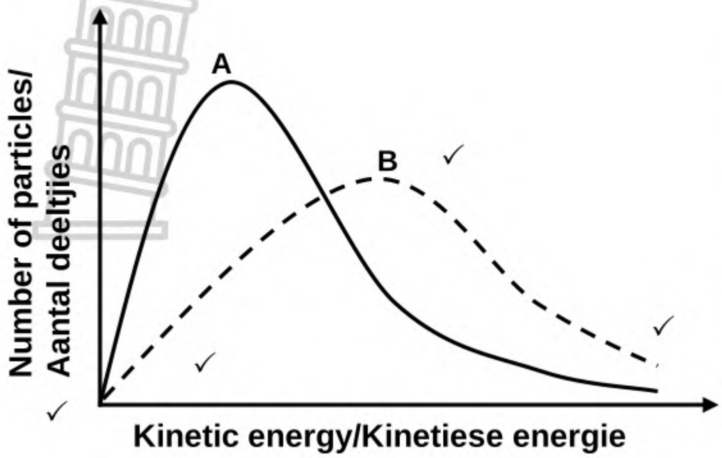
$$n(Na_2S_2O_3) = \frac{m}{M}$$
$$0,00656 = \frac{m}{158} \checkmark$$
= 1,03 g (1,027)

$$\text{Rate/}\textit{Tempo} = \frac{\Delta m}{\Delta t}$$
$$= \frac{1,03}{20,4} \checkmark$$
= 0,05 (g·s^{-1}) ✓

Max/*Maks.* $^3/_5$

(5)

5.5



Marking criteria/*Nasienkriteria:*

- Both axis labelled correctly. ✓
  Beide asse korrek benoem
- Both curves start at origin and have correct shape. ✓
  Beide kurwes begin by die oorsprong en het dieselfde vorm.
- Peak of curve B must be lower than curve A. ✓
  Maksimum van kurwe B moet laer wees as kurwe A.
- Peak of curve B must have higher kinetic energy than curve A up to end of curve. ✓
  Maksimum van kurwe B moet hoër wees as kinetiese energie van kurwe A tot by die einde.

(4)

5.6

- At a higher temperature particles move faster/have higher kinetic energy. ✓
- More molecules have enough/sufficient kinetic energy for an effective collision. ✓

OR More molecules have kinetic energy/E_k equal to or greater than the activation energy.

- More effective collisions per unit time/second. ✓

OR Frequency of effective collisions increases.

- Reaction rate increases. ✓

- *By 'n hoër temperatuur beweeg die deeltjies vinniger/het die deeltjies hoër kinetiese energie.* ✓
- *Meer molekule het genoeg/voldoende kinetiese energie/E_k vir 'n effektiewe botsing.* ✓

OF *Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.*

- *Meer effektiewe botsings per eenheidtyd/sekonde.* ✓

OF *Frekwensie van effektiewe botsings verhoog.*

- *Reaksietempo neem toe.* ✓

(4)
[19]

QUESTION 6/*VRAAG 6*

6.1 A reaction is reversible when products can be converted back to reactants (and vice versa). ✓
'n Reaksie is omkeerbaar wanneer produkte terug na reaktanse, en (omgekeerd), omgeskakel kan word. (1)

6.2

Marking criteria/*Nasienkriteria:* If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die* ***korrekte konteks*** *uitgelaat is, trek 1 punt af.* The underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk. (2)

6.3.1 The amount of $A_2(g)$ was increased./A_2 was added into the container. ✓
Die hoeveelheid $A_2(g)$ is verhoog./A_2 is bygevoeg in die houer. (1)

6.3.2
- Increase in A_2 favours the reaction that uses or decreases the amount/concentration of A_2. ✓
- The reverse reaction is favoured/amount or concentration of products decreases/amount or concentration of reactants increases. ✓

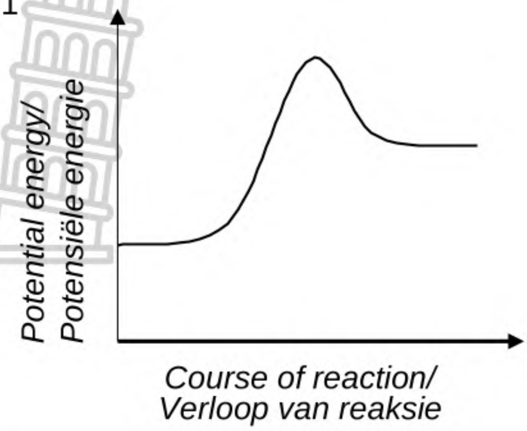
- *'n Toename in A_2 bevoordeel die reaksie wat die hoeveelheid/konsentrasie van A_2 verlaag*
- *Die terugwaartse reaksie is bevoordeel/hoeveelheid of konsentrasie van die produkte neem af/die hoeveelheid of konsentrasie van die reaktante neem toe.* (2)

6.4

Marking criteria/*Nasienkriteria:*	OPTION 1/*OPSIE 1*
• Correct Kc expression./ *Korrekte K_c -uitdrukking.* ✓ • Substitution of $[A_2]$ and $[B_2]$ at equilibrium. ✓ *Substitusie van $[A_2]$ en $[B_2]$ by ewewig.* • Substitution of [AB] at equilibrium. ✓ *Substitusie van [AB] by ewewig.* • Final correct answer/*Finale korrekte antwoord*: 0,16✓ **IF/INDIEN:** Wrong or no K_c expression: *Verkeerde of geen K_c- uitdrukking*: *Max./Maks.* $^2/_4$ Moles substituted/*Mol vervang* *Max./Maks.* $^2/_4$	$Kc = \frac{[A_2][B_2]}{[AB]^2}$ ✓ $= \frac{\left(\frac{8}{4}\right)\left(\frac{2}{4}\right)}{\left(\frac{10}{4}\right)^2}$ ✓ ✓ $= 0,16$ ✓ **OPTION 2/*OPSIE 2*** $Kc = \frac{[A_2][B_2]}{[AB]^2}$ ✓ $= \frac{(2)(0,5)}{(2,5)^2}$ ✓ ✓ $= 0,16$ ✓

(4)

6.5.1



Marking criteria/*Nasienkriteria:*

- Both axes correctly labelled and correct shape of Ep curve. ✓
  Asse korrek benoem en korrekte vorm van Ep-kurwe
- Shape of Ep curve for endothermic reaction as shown. ✓✓
  Vorm van kurwe vir endotermiese reaksie soos getoon.

(3)

6.5.2

- Smaller than ✓

- Products/B_2/A_2 amount/concentration decreases. ✓
- Reactants/AB amount/concentration increases. ✓

OR

The reverse reaction is favoured. / Equilibrium (position) shifts to the left.✓✓

- *Kleiner as*

- *Produkte/B_2/A_2 hoeveelheid/ konsentrasie neem af.*
- *Reaktanse/AB hoeveelheid/konsentrasie neem toe.*

OF

Die terugwaartse reaksie word bevoordeel./Die ewewigs(posisie) skuif na links. (3)

6.6

- Both forward and reverse reaction rates increase equally. / Gradient of three curves will be steeper. ✓✓
- Reaches equilibrium sooner/less than 40 s. / The graph becomes horizontal sooner. ✓

- *Beide die voorwaartse en terugwaartse reaksietempo verhoog dieselfde. / Gradiënt van al drie kurwes is steiler.*
- *Ewewig word vinniger/korter tyd/minder as 40 s bereik. / Grafiek neem korter tyd om horisontaal te word.*

(3)
[19]

QUESTION 7/VRAAG 7

7.1 A strong base <u>ionises/dissociates completely</u> ✓ <u>in water</u>. ✓
Sterk basis <u>ioniseer/dissosieer volledig</u> <u>in water</u>. (2)

7.2.1 $n(Ba(OH)_2) = cV$ ✓
$= 0,15 \times 0,02$ ✓
$= 0,003$ mol ✓ (3)

7.2.2 **<u>POSITIVE MARKING FROM QUESTION 7.2.1/</u>**
<u>POSITIEWE NASIEN VAN VRAAG 7.2.1</u>

<u>Marking citeria:</u>	***<u>Nasienkriteria:</u>***
(a) Use ratio: $2nBa(OH)_2$ (7.2.1) = $nHNO_3$ ✓	***(a)*** *Gebruik verhouding: $2nBa(OH)_2$ (7.2.1) = $nHNO_3$* ✓
(b) Substitute nH_3O^+ or $nHNO_3$ and 0,045 dm^3 in $c = \frac{n}{V}$ ✓	***(b)*** *Vervang nH_3O^+ of $nHNO_3$ en 0,045 dm^3 in $c = \frac{n}{V}$* ✓
(c) Formula: $pH = -log[H_3O^+]$ ✓	***(c)*** *Formule: $pH = -log[H_3O^+]$* ✓
(d) Substitute $[H_3O^+]$ in pH formula ✓	***(d)*** *Vervang $[H_3O^+]$ in pH formule* ✓
(e) Final correct answer: 0,89 ✓ Range: 0,88 to 0,89	***(e)*** *Finale korrekte antwoord: 0,89* ✓ Gebied: 0,88 tot 0,89

$nHNO_{3\ reacted} = 2nBa(OH)_2$
$= 2(0,003)$ ✓**(a)**
$= 0,006$ mol

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

$n(H_3O^+) = n(HNO_3)$
$= 0,006$ mol

$[H_3O^+] = \frac{n}{V}$
$= \frac{0,006}{0,045}$ ✓**(b)**
$= 0,13$ mol·dm^{-3}

<u>OPTION 2/*OPSIE 2*</u>

$[HNO_3] = \frac{n}{V}$
$= \frac{0,006}{0,045}$ ✓**(b)**
$= 0,13$ mol·dm^{-3}

$[H_3O^+] = [HNO_3]$
$= 0,13$ mol·dm^{-3}

$pH = -log[H_3O^+]$ ✓**(c)**
$= -log(0,13)$ ✓**(d)**
$= 0,89$ ✓**(e)** (5)

7.3 **POSITIVE MARKING FROM QUESTION 7.2.2/**
POSITIEWE NASIEN VAN VRAAG 7.2.2

Marking citeria:	***Nasienkriteria*:**
(a) Substitute $[HNO_3] = 0,4\ mol \cdot dm^{-3}$ and $0,025\ dm^3$ ✓	**(a)** *Vervang:* $[HNO_3] = 0,4\ mol \cdot dm^{-3}$ *en* $0,025\ dm^3$ ✓
(b) Subtract: $n(HNO_3)_{ini} - n(HNO_3)_{excess}$ (7.2.2) ✓ ✓	**(b)** *Trek af:* $n(HNO_3)_{aanv} - n(HNO_3)_{oormaat}$ (7.2.2) ✓✓
(c) Use of ratio $n(MCO_3) = ½n(HNO_3)$ ✓	**(c)** *Gebruik verhouding:* $n(MCO_3) = ½n(HNO_3)$ ✓
(d) Calculate the pure $m(MCO_3)$ ✓	**(d)** *Bereken suiwer* $m(MCO_3)$ ✓
(e) Substitute $n(MCO_3)$ and $m(MCO_3)$ in $n = \frac{m}{M}$ ✓	**(e)** *Vervang* $n(MCO_3)$ *en* $m(MCO_3)$ *in* $n = \frac{m}{M}$ ✓
(f) Calculation of $24\ g \cdot mol^{-1}$ ✓	**(f)** *Berekening van* $24\ g \cdot mol^{-1}$ ✓
(g) Correct answer: Mg ✓	**(g)** *Korrekte antwoord: Mg* ✓

$n(HNO_3)_{ini} = cV$
$= 0,4 \times 0,025$ ✓ **(a)**
$= 0,01$ mol

$n(HNO_3)_{react} = n(HNO_3)_{ini} - n(HNO_3)_{excess}$
$= 0,01 - 0,006$ ✓✓ **(b)**
$= 0,004$ mol

$n(MCO_3) = ½n(HNO_3)$
$= ½(0,004)$ ✓**(c)**
$= 0,002$ mol

$m(MCO_3) = \frac{85}{100} \times 0,198$ ✓**(d)**
$= 0,168$ g

$n(MCO_3) = \frac{m}{M}$
$0,002 = \frac{0,168}{M}$ ✓**(e)**
$M(MCO_3) = 84\ g \cdot mol^{-1}$

Molar mass (M) = 84 - 60 ✓**(f)**
$= 24\ g \cdot mol^{-1}$
Therefore metal M is Mg ✓**(g)** (8)
[18]

QUESTION 8/*VRAAG 8*

8.1.1 Copper strip becomes thinner/decreases in mass/solid/silver coloured particles in solution/the copper becomes plated with silver ✓
Koper plaatjie word dunner/massa neem af/vaste stof/silwer-kleurige deeltjies in oplossing. (1)

8.1.2 Ag^+ ion/*-ioon* / Silver ion/Silwer-ioon ✓ (1)

8.2 Ag^+ ion is a stronger oxidising agent ✓ than Cu^{2+} ion ✓ and will oxidise Cu to (blue) Cu^{2+} ion. ✓

OR

Cu^{2+} ion is a weaker oxidising agent ✓ than Ag^+ ion ✓ and Cu will be oxidised to Cu^{2+} ion. ✓

OR

Cu/Copper is a stronger reducing agent ✓ than Ag/Silver ✓ and will reduce silver ions to silver. ✓

Ag^+ -ioon is 'n sterker oksideermiddel as Cu^{2+} -ioon en sal Cu na (blou) Cu^{2+} - ioon oksideer.

OF

Cu^{2+} -ioon is 'n swakker oksideermiddel as Ag^+ -ioon en daarom sal Cu na (blou) Cu^{2+} -ioon geoksideer word.

OF

Cu/Koper is 'n sterker reduseermiddel as Ag/Silwer en sal silwer-ione na silwer reduseer. (3)

8.3

8.3.1 Silver/Ag/*Silwer* ✓ (1)

8.3.2 $CuSO_4$/Cu^{2+} /Copper (II) ions/copper(II) sulphate/*Koper(II)-ione/ koper(II)sulfaat* ✓ (1)

ACCEPT/*AANVAAR*:
Any soluble copper(II) salt/*Enige oplosbare koper(II)sout*

8.3.3 $2Ag^+(aq) + Cu(s)$ ✓ $\rightarrow$ $2Ag(s) + Cu^{2+}(aq)$ ✓ Bal ✓

<u>Marking criteria/*Nasienkriteria:*</u>

- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing: ✓ *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Ignore phases./*Ignoreer fases.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

(3)

8.4 K^+ ✓
The positive ions move to the silver ion solution to maintain the ion balance/electrical neutralitity/[Ag^+] decreases. ✓
OR
It is the cathode.
OR
Positive charges decrease.

Die positiewe ione beweeg na die silwerioon-oplossing om ioon-balans/elektriese neutralitiet te handhaaf/[Ag^+] neem af.
OF
Dit is die katode.
OF
Positiewe ladings verminder. (2)
[12]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE/*ENIGE EEN:***

- The chemical process in which electrical energy is converted to chemical energy. ✓✓
  Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.
- The use of electrical energy to produce a chemical change.
  Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.
- Decomposition of an ionic compound by means of electrical energy.
  Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.
- The process during which an electric current passes through a solution/ionic liquid/molten ionic compound.
  Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg. (2)

9.2 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓
Ignore phases/*Ignoreer fases*

Marking criteria/*Nasienkriteria:*

- $Cu(s) \leftarrow Cu^{2+}(aq) + 2e^-$ $(\frac{2}{2})$ $Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$ $(\frac{1}{2})$
  $Cu^{2+}(aq) + 2e^- \leftarrow Cu(s)$ $(\frac{0}{2})$ $Cu(s) \rightleftharpoons Cu^{2+}(aq) + 2e^-$ $(\frac{0}{2})$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Cu^{2+}/*Indien lading (+) weggelaat op* Cu^{2+}:
  Example/*Voorbeeld:* $Cu^2(aq) + 2e^- \rightarrow Cu(s)$ Max./*Maks:* $\frac{1}{2}$

(2)

9.3 R to/*na* Q ✓ (1)

9.4

Marking criteria:	***Nasienkriteria:***
(a) Substitution of 63,5 into $n = \frac{m}{M}$ ✓	**(a)** *Vervang 63,5 in* $n = \frac{m}{M}$ ✓
(b) N(electrons) = N(Cu atoms) x 2 ✓	**(b)** *N(elektrone) = N(Cu-atome) x 2* ✓
(c) Substitute $1,6 \times 10^{-19}$ C in $n = \frac{Q}{e}$ ✓	**(c)** *Vervang* $1,6 \times 10^{-19}$ *C in* $n = \frac{Q}{e}$ ✓
(d) Substitute (5)(60)(60) in $I = \frac{Q}{\Delta t}$ ✓	**(d)** *Vervang (5)(60)(60) in* $I = \frac{Q}{\Delta t}$ ✓
(e) Final correct answer: 2,68 A ✓ Range: 2,68 *to 2,70* A	**(e)** *Finale korrekte antwoord: 2,68 A* ✓ *Gebied: 2,68 tot 2,70 A*

$n(Cu) = \frac{m}{M}$

$n(Cu) = \frac{16}{63,5}$ ✓**(a)**

$= 0,25$ mol

n atoms(Cu) $= \frac{N}{N_A}$

$0,25 = \frac{N}{6,02 \times 10^{23}}$

$= 1,5 \times 10^{23}$ atoms

N electrons $= (1,5 \times 10^{23})(2)$ ✓**(b)**

$= 3 \times 10^{23}$ electrons

N electrons $= \frac{Q}{e}$ **OR/*OF*** $\frac{Q}{q_e}$

$3 \times 10^{23} = \frac{Q}{1,6 \times 10^{-19}}$ ✓**(c)**

$= 48\ 160$ C

$I = \frac{Q}{\Delta t}$

$= \frac{48\ 160}{(5)(60)(60)}$ ✓**(d)**

$= 2,68$ A ✓**(e)**

(5)

9.5 Ag/silver is a weaker reducing agent ✓ than Cu/coper or Zn/zinc ✓ and will not be oxidised.
Ag/silwer is 'n swakker reduseermiddel as Cu/koper of Zn/sink en sal nie geoksideer word nie.
Voltage of power source is not effective enough to oxidise Ag/silver./ ✓✓
Die potensiaalverskil van die energiebron is nie effektief genoeg om die Ag/silwer te oksideer nie. (2)

[12]

TOTAL/*TOTAAL*: 150