



LIMPOPO

PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

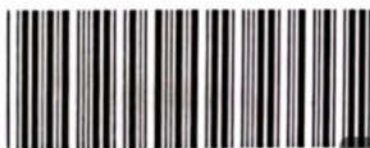
PHYSICAL SCIENCES

PAPER 2 (CHEMISTRY)

SEPTEMBER 2023

MARKS: 150

TIME: 3 hours



EPHSCP2

Stanmorephysics

This question paper consists of 20 pages including DATA SHEETS

INSTRUCTIONS AND INFORMATION

1.  The question paper consists of nine questions. Answer **ALL** the questions.
2. **Start** EACH question on a **NEW** page.
3. Number your answers correctly according to the numbering system used in this question paper.
4. Leave **ONE** line between two sub-questions, e.g., between **QUESTION 2.1** and **QUESTION 2.2**.
5. A non-programmable calculator may be used.
6. Appropriate mathematical instruments may be used.
7. Show **ALL** formulae and substitutions in **ALL** calculations.
8. Round off your **FINAL** numerical answers to a minimum of **TWO** decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached data sheets.
11. Write neatly and legibly.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following pairs represents compounds that are isomers?

- A.  CHCl_3 and CHBr_3
- B. CH_3OH and $\text{CH}_3\text{CH}_2\text{OH}$
- C. $\text{CH}_3 - \text{CH} = \text{CH}_2$ and $\text{CH}_2 = \text{CH} - \text{CH}_3$
- D. $\text{CH}_3\text{COOCH}_3$ and $\text{CH}_3\text{CH}_2\text{COOH}$ (2)

1.2 Which ONE of the following organic reactions will take place only when exposed to light?

- A. $\text{CH}_2\text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_3$
- B. $\text{CH}_3\text{CH}_3 \rightarrow \text{CH}_2\text{CH}_2 + \text{H}_2$
- C. $\text{CH}_3\text{CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{HCl}$
- D. $\text{CH}_2\text{CH}_2 + \text{Cl}_2 \rightarrow \text{CH}_2\text{ClCH}_2\text{Cl}$ (2)

1.3 What is the name of the reaction between an unsaturated hydrocarbon and hydrogen gas?

- A. halogenation
- B. hydrogenation
- C. dehydrohalogenation
- D. hydration (2)

1.4 When an alkane, containing n carbons, undergoes combustion in excess oxygen, the mole ratio of the combusted products, $\text{CO}_2 : \text{H}_2\text{O}$, will be equal to:

- A. $n : n$
- B. $n : n + 2$
- C. $n : n + 1$
- D. $n : 2n$ (2)



- 1.5 Ammonia gas $\text{NH}_3(\text{g})$ and oxygen gas, O_2 , react in a closed container at a constant temperature according to the following equation below.

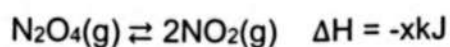


Which ONE of the combinations of pressure and temperature will result in an increase in the yield of nitrogen monoxide $\text{NO}(\text{g})$?

	Pressure	Temperature
A.	decrease	decrease
B.	decrease	increase
C.	increase	increase
D.	increase	decrease

(2)

- 1.6 Dinitrogen tetra oxide, $\text{N}_2\text{O}_4(\text{g})$ decomposes to produce nitrogen dioxide, $\text{NO}_2(\text{g})$, in a closed container according to the following balanced equation:



Consider the following statements regarding this equation:

- (i): The forward reaction is endothermic.
- (ii): The temperature of the container decreases.
- (iii): For each mole of $\text{NO}_2(\text{g})$ which is formed, $x\text{kJ}$ of energy is released

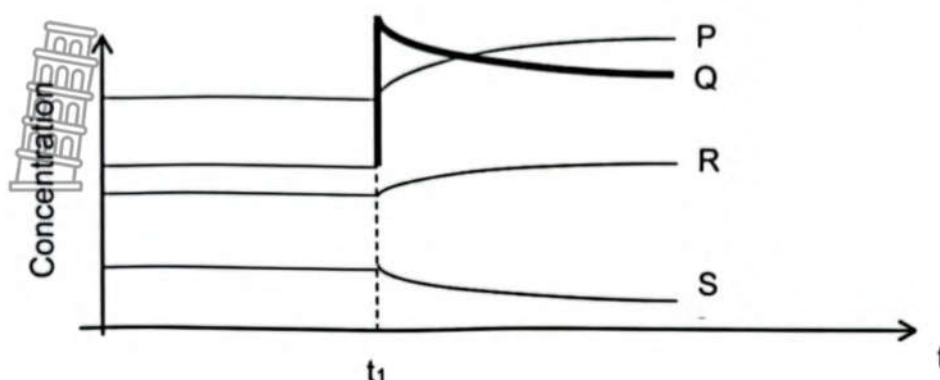
Which ONE of the following statements are/is true about this reaction?

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

(2)



- 1.7 Four gases, **P**, **Q**, **R**, and **S** are in equilibrium in a closed container. The diagram below shows their relative concentrations over a period of time. The equilibrium position is altered at t_1 by the addition of more of gas **Q**.

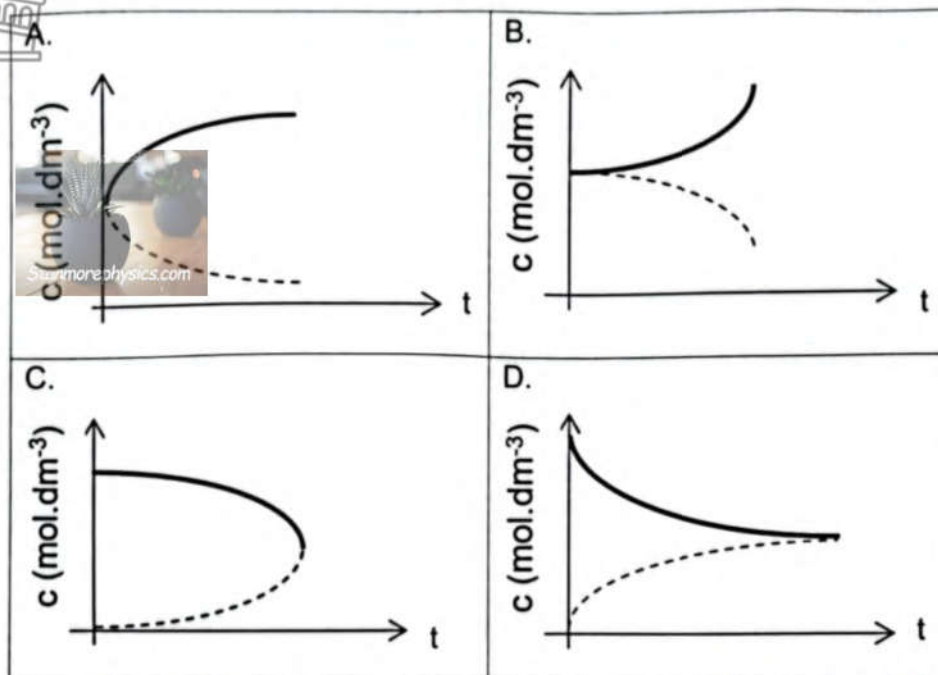


The equilibrium reaction is shown by:

- A. $P + Q \rightleftharpoons R + S$
- B. $Q + S \rightleftharpoons P + R$
- C. $P + S \rightleftharpoons Q + R$
- D. $Q \rightleftharpoons P + R + S$ (2)
- 1.8 The ionisation constant, K_w , for pure water at 25°C is:
- A. 14
- B. 7
- C. 1×10^{-7}
- D. 1×10^{-14} (2)
- 1.9 The electrode potential of the Ag^+/Ag -electrode is determined with the aid of a standard H^+/H_2 , Pt-electrode as reference electrode. The equation for the half-reaction which occurs at the ANODE of this cell, is:
- A. $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
- B. $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$
- C. $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$
- D. $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ (2)



- 1.10 An electrochemical cell, consisting of two standard half cells, is allowed to deliver current for a period. Which one of the following combinations best represents the change in CONCENTRATION of the two electrolytes over the period.



(2)

[20]



QUESTION 2 (Start on a new page.)

The table below shows six organic molecules A to F

 A. butane	B. $\text{CH}_3\text{-CH}_2\text{-OH}$
C. CH_3COOH	D. <pre> H H-C-H H H H H-C-C-C-C-H H O H H H </pre>
E. methanal	F. <pre> H H O H H-C-C-C-C-H H H H H </pre>

- 2.1 Define the term *homologous series*. (2)
- 2.2 Write down the:
- 2.2.1 Structural formula of compound **C** (2)
- 2.2.2 IUPAC name of compound **D** (3)
- 2.2.3 Homologous series to which **F** belongs (1)
- 2.2.4 Structural formula of the functional group of **E** (1)
- 2.3 For compound **A**, write down:
- 2.3.1 The general formula. (1)
- 2.3.2 The balanced equation for the oxidation reaction. (3)



- 2.4 Compound **B** reacts with another organic compound from the table to form an ester.

2.4.1 Write down the LETTER of the other organic compound that reacts with **B**. (1)

2.4.2 Write down the NAME of the ester that forms. (2)

[16]

QUESTION 3 (Start on a new page.)

The table below shows data collected for four organic compounds, represented by the letters **A**, **B**, **C** and **D**, during a practical investigation:

	Organic compound	Boiling point (°C)
A	propane	-42
B	pentane	36
C	2-methylbutane	27,8
D	pentan-1-ol	137

- 3.1 Define the term *vapour pressure*. (2)

- 3.2 Which ONE of the compounds **A** or **B** has the higher vapour pressure? (1)

- 3.3 Consider compound **C**.

3.3.1 Is compound **C** a SATURATED or UNSATURATED hydrocarbon? (1)

3.3.2 Give a reason for your answer in QUESTION 3.3.1. (1)

3.3.3 Which type of intermolecular forces are mainly present between these molecules? (1)

- 3.4 Compounds **B** and **C** are structural isomers of each other.

3.4.1 Define the term *structural isomer*. (2)

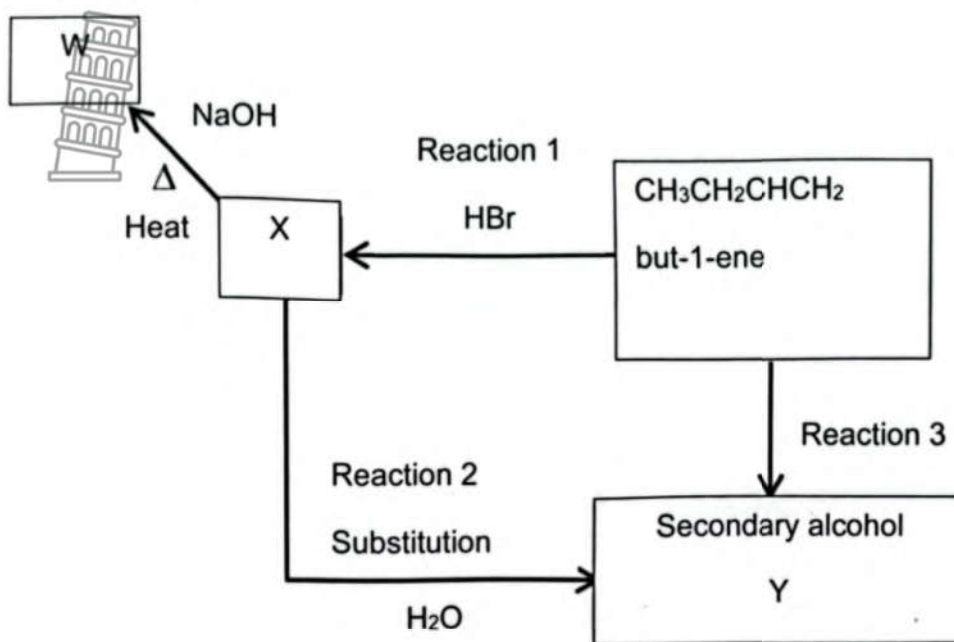
3.4.2 Refer to structure, intermolecular forces, and energy in your explanation to explain why **B** has a higher boiling point than **C** (3)

- 3.5 Explain the difference in the boiling points of **B** and **D**. Refer to intermolecular forces and energy in your explanation. (4)

[15]

QUESTION 4 (Start on a new page.)

The flow chart below shows the preparation of various organic compounds using but-1-ene as starting material.



- 4.1 Using STRUCTURAL formulas, write down a balanced chemical equation for Reaction 1 (4)
- Write down the:
- 4.2. Name of the type of the reaction that occurs when but-1-ene is converted to compound X (1)
- 4.3 Write the structural formula and IUPAC name of the secondary alcohol, Y, that forms. (3)
- 4.4 Name the type of substitution reaction that occurs when compound X is converted to the secondary alcohol Y (1)
- 4.5 But-1-ene can be converted directly to the secondary alcohol, without the formation of the intermediate product X, with the help of a catalyst.
- 4.5.1 Except but-1-ene, write the NAME of the reactant needed for this reaction. (1)
- 4.5.2 Write down the FORMULA of the catalyst that can be used. (1)
- 4.5.3 Name the type of reaction that will occur during this direct

conversion.

(1)

- 4.6 Instead of using water as a reactant in reaction 2, concentrated sodium hydroxide is used, and the mixture is heated.



4.6.1 Write down the IUPAC name of the compound **W** that forms.

(1)

4.6.2 Name the TYPE of reaction that occurs.

(1)

[14]

QUESTION 5 (Start on a new page.)

- 5.1 The collision theory can be used to explain how different factors affect the rate of a chemical reaction.

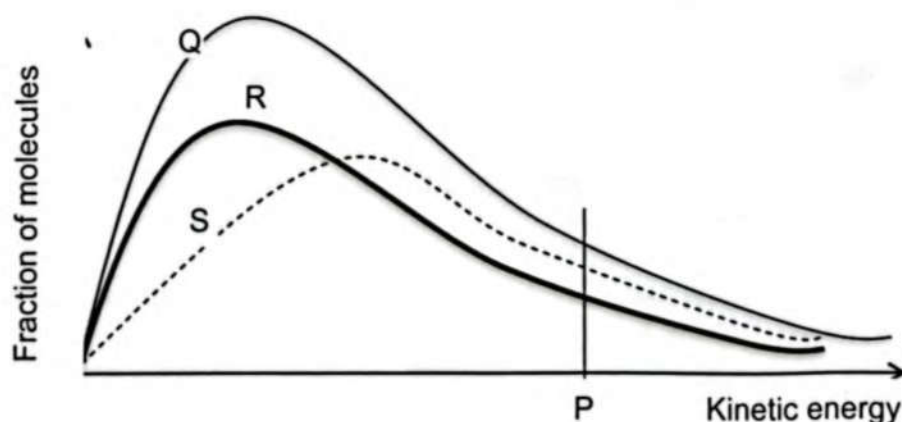
5.1.1 Name TWO conditions that determine whether a collision between two molecules will lead to a chemical reaction.

(2)

5.1.2 In terms of the collision theory, explain why the rate of a chemical reaction increases with increasing temperature.

(2)

- 5.2 Curve **R** represents the Maxwell-Boltzmann distribution curve for gas in a closed container at a certain temperature. Curve **Q** and **S** represents the curves of the same molecules at different conditions.



5.2.1 Write down the NAME of the energy represented by **P**.

(1)

5.2.2 Write down the change in the condition(s) which results in:

(a) Curve **Q**

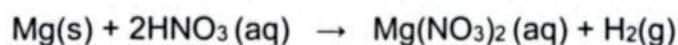
(1)

(b) Curve **S**

(1)

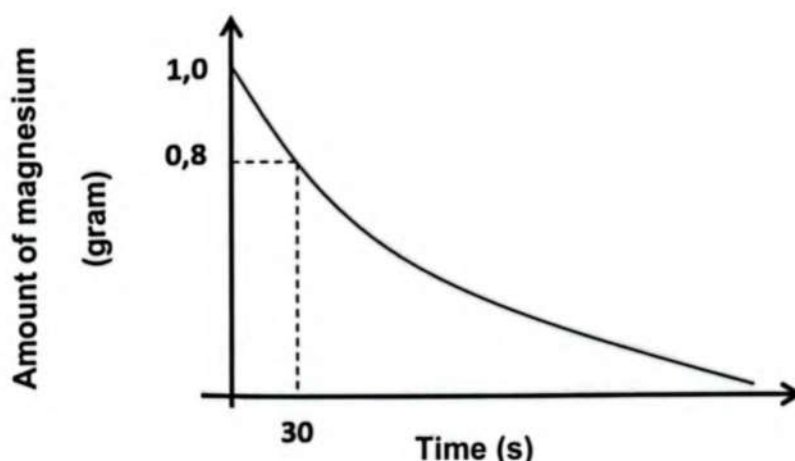


- 5.3 A teacher uses the reaction between magnesium ribbon, Mg(s) and nitric acid, $\text{HNO}_3\text{(aq)}$, to investigate ONE of the factors that influence reaction rate. The balanced equation of the reaction between Mg(s) and $\text{HNO}_3\text{(aq)}$ is given below.



- 5.3.1 Write down an investigative question for this investigation. (3)

The results obtained when using DILUTED nitric acid are shown on the graph below.



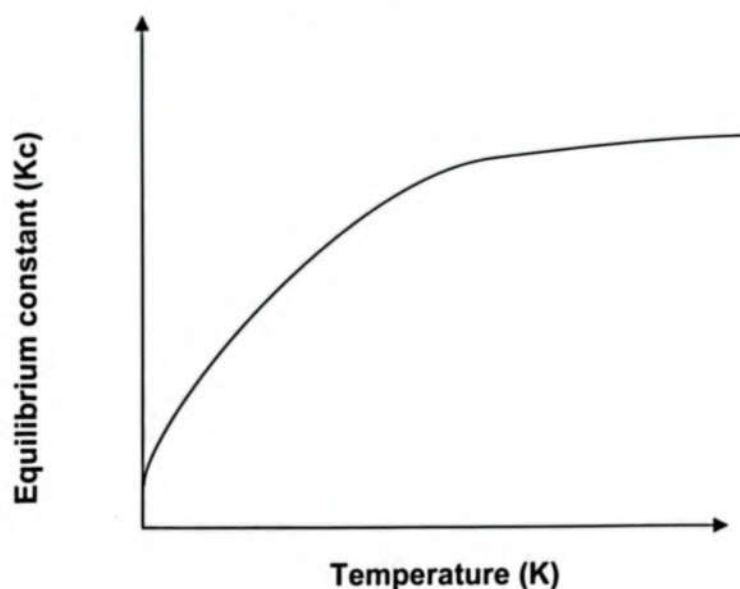
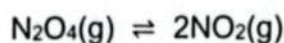
- 5.3.2 Which compound, Mg or HNO_3 , is in excess, and give a reason for your answer using the information on the graph. (2)
- 5.3.3 Calculate the average reaction rate (in grams per second) during the first 30 s. (5)
- 5.3.4 Copy the above graph in your answer book.
On the same set of axes, use a **DOTTED LINE** to show the curve that will be obtained when **CONCENTRATED** nitric acid was used.
No numerical values are required. (2)



[19]

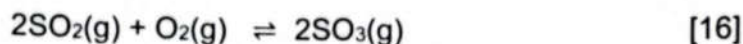
QUESTION 6 (Start on a new page.)

- 6.1 The graph below shows the effect of the temperature on the value of K_c for the following reaction taking place in a closed container.



- 6.1.1 Write down the effect of increasing temperature has on the amount of $\text{NO}_2(\text{g})$ formed. (1)
- 6.1.2 Which reaction was favoured due to an increase in temperature? Write only FORWARD or REVERSE. (1)
- 6.1.3 State Le Chatelier's Principle. (2)
- 6.1.4 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain your answer. (4)
- 6.1.5 Write down TWO changes, that can be introduced to decrease the rate of the forward reaction (2)
- 6.2 1 mol $\text{SO}_2(\text{g})$ and x mole $\text{O}_2(\text{g})$ is initially placed in an empty 2dm^3 container and sealed at a specific temperature. At equilibrium 6 mole $\text{SO}_3(\text{g})$ was present in the container. If the value for the following equilibrium at this temperature is 9, calculate x, the initial quantity $\text{O}_2(\text{g})$ that was placed in the container. (6)

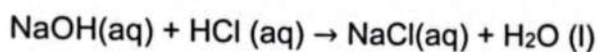


**QUESTION 7 (Start on a new page.)**

7.1 Define an acid according to Bronsted and Lowry  (2)

7.2 Explain the difference between a WEAK ACID and a DILUTE ACID. (2)

7.3 When 500 cm³ of sodium hydroxide solution, NaOH(aq) is added to 500 cm³ of 0,25 mol dm⁻³ of hydrochloric acid solution HCl(aq), the temperature rises and the pH of the solution changes to 2,3. The reaction between NaOH(aq) and HCl (aq) is as follows:



7.3.1 Is the reaction between NaOH (aq) and HCl (aq) EXOTHERMIC or ENDOTHERMIC? (1)

Calculate the:

7.3.2 Final concentration of the hydronium ions, H₃O⁺(aq) ions. (3)

7.3.3 Initial concentration of the NaOH (aq) solution in 500cm³ (8)

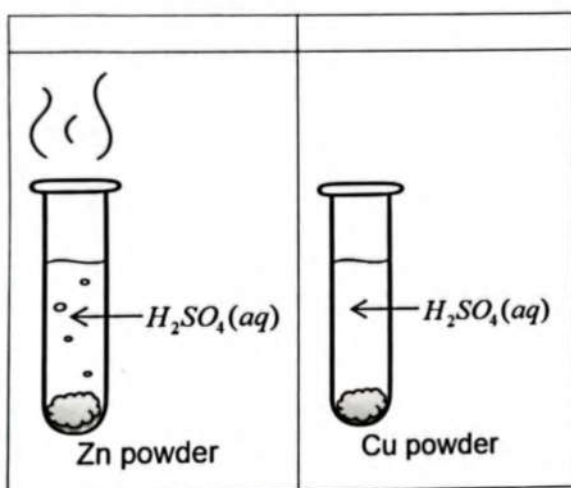
[16]



QUESTION 8 (Start on a new page.)



An investigation to compare the relative reducing ability of copper, Cu(s) and zinc, Zn (s) is carried out. The two metals are reacted with dilute sulphuric acid and the experiment set up as shown below.

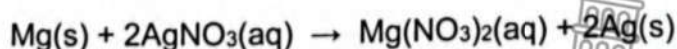


- 8.1 In test tube A, bubbles of gas are observed whilst in test tube B no bubbles are observed.
8.1.1 Write down the name of the gas produced in test tube A (1)

- 8.1.2 Refer to the relative reducing abilities of Cu and Zn to explain why no bubbles of gas are produced in test tube B (3)

- 8.1.3 Use the STANDARD REDUCTION POTENTIAL TABLE to write down a balanced equation of the reaction which takes place in test tube A (3)

- 8.2 An electrochemical cell is set up using a redox reaction given below.



- 8.2.1 Write the cell notation of this cell. (3)



- 8.2.2 Write down the conditions needed for the cell to operate under standard conditions. (2)

- 8.2.3 Calculate the initial emf of the cell under standard conditions (4)

This cell is now connected to a light bulb which is marked 3 V; 6 W. In theory, the bulb should glow, but in practice it doesn't.

- 8.2.4 Without any calculation, give an explanation for this. (1)

The volume of the electrolyte in each standard half-cell is $0,4 \text{ dm}^3$.

- 8.2.5 Calculate the maximum loss of mass that can occur at the anode. (6)

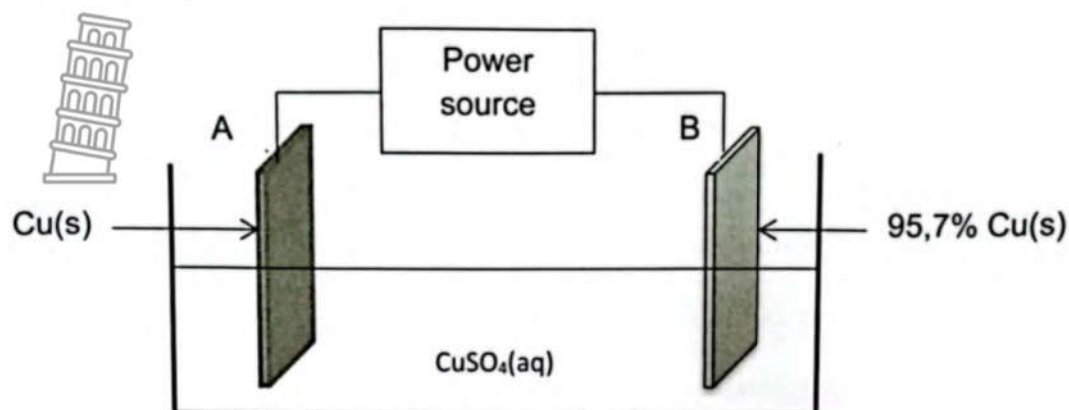
[23]



QUESTION 9 (Start on a new page.)

The electrolytic cell shown below is used to purify IMPURE copper.

Copper sulphate solution, $\text{CuSO}_4(\text{aq})$, is used as the electrolyte. Electrode B contains 95,7% Cu by mass.



- 9.1 Is electrode A, the POSITIVE or NEGATIVE electrode? (1)
- 9.2 Pure copper is used to make electrical wires. Give one reason why the copper must be purified first before it is used in electrical wires. (2)
- 9.3 Will the mass of electrode B INCREASE or DECREASE when the cell is operating?
Write down the relevant half-reaction to support your answer. (3)
- 9.4 If 2 moles of electrons are transferred from the anode to the cathode during electrolysis, calculate the mass of the IMPURE copper sample. (5)

[11]**TOTAL: 150**

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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
(I)	(II)	(III)										(III)	(IV)	(V)	(VI)	(VII)	(VIII)
1 H 1	3 Li 7	4 Be 9															
11 Na 23	12 Mg 24																
19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 56	27 Co 59	28 Ni 59	29 Cu 63.5	30 Zn 65	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	35 Br 80	36 Kr 84
37 Rb 86	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 92	42 Mo 96	43 Tc 98	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	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	81 Tl 204	82 Pb 207	83 Bi 209	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	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 231	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

2 He 4	10 Ne 20	18 Ar 40	36 Kr 84	54 Xe 131	86 Rn 222
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Atomic number Atoomgetal	29	Symbol Simbool
Electronegativity Elektronegatiwiteit	Cu 63.5	

Approximate relative atomic mass Benaderde relatiewe atoommassa	29
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KEY/SLEUTEL

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

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
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	- 2,36
$Na^+ + e^- \rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	- 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	- 2,93
$Li^+ + e^- \rightleftharpoons Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reducerende vermoë

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

Half-reaction/Halfreaksie	E^0 (V)
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2,38
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1,86
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}(\text{l})$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2,87

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)
DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at / by } 298 \text{ K}$ $\text{pH} = -\log[\text{H}_3\text{O}^+]$	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta / E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$ or / of $E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta / E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$ or / of $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta / E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduceermiddel}}^\theta$	



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA



DEPARTMENT OF
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

**PHYSICAL SCIENCES
PAPER 2 (CHEMISTRY)
MARKING GUIDELINES
SEPTEMBER 2023**

MARKS: 150



This marking guideline consists of 9 pages including THE COVER PAGE

QUESTION 3

- 3.1  The pressure exerted by a vapor at equilibrium with its liquid in a closed system. ✓✓ (2)
- 3.2 A ✓ (1)
- 3.3.1 SATURATED ✓ (1)
- 3.3.2 Only single bonds between C- atoms. ✓ (1)
- 3.3.3 London forces ✓ / dispersion forces / induced dipole forces (1)
- 3.4.1 Compounds with the same molecular formula, ✓ but different structural formulae. ✓ (2)
- 3.4.2
- 2-methylbutane is a spherical molecule that offers a smaller surface area to other molecules. ✓// Pentane is a linear molecule which offers a larger surface area to other molecules.
 - Less/smaller surface area where intermolecular forces (London forces) can interact with other molecules. ✓// Greater/larger surface area where intermolecular forces (London forces) can interact with other molecules.
 - Less energy required to overcome the intermolecular forces. ✓// More energy required to overcome the intermolecular forces. (3)
- 3.5
- pentan-1-ol (D): H-bonds are stronger ✓ than the weaker London forces ✓ in (B), alkanes.
 - Therefore, more energy is required to ✓ overcome the stronger intermolecular forces in (D).
 - Consequently (D) has a higher boiling point. ✓ (4)

OR

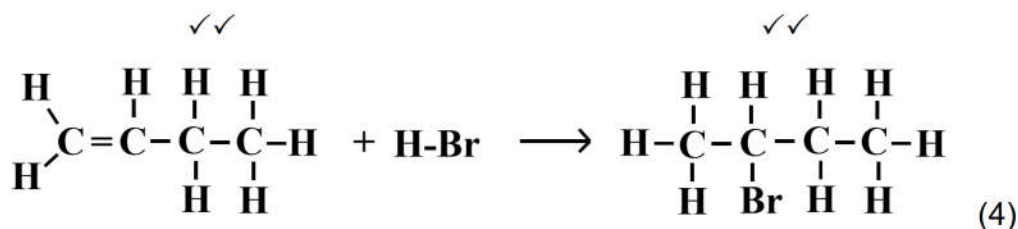
- Pentane (B): London forces are weaker in alkanes than the stronger H-bonds in alcohols in (D).
- Less energy is required to overcome the forces of attraction in (B).

Consequently (B) has a lower boiling point.

[15]

QUESTION 4

4.1



4.2

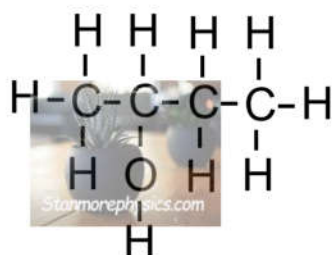
addition / hydrohalogenation ✓

(1)

4.3

butan-2-ol ✓ / 2-butanol

Hydroxyl group on the 2 nd carbon.	✓
Whole structure correct.	✓



4.4

hydrolysis ✓

(3)

(1)

4.5.1

Water ✓

(1)

4.5.2

 H_2SO_4 ✓ / HCl / H_3PO_4

(1)

4.5.3

hydration ✓ (accept addition)

(1)

4.6.1

but-2-ene / 2-buten ✓

(1)

4.6.2

dehydrohalogenation ✓ / elimination

(1)

QUESTION 5

5.1.1

Sufficient kinetic energy (molecules move fast enough) during the collisions. ✓

Molecules must be correctly orientated. ✓

(2)

5.1.2

Increased temperature:

More molecules move fast enough or have sufficient E_k . ✓
 There are more effective collisions per unit time ✓ / $E_k \geq$
 activation energy.

5.2.1

Activation energy ✓

(2)

5.2.2

(a) Increase in the concentration of one or both reactants. ✓

(1)

(b) Increase in temperature. ✓

(1)

5.3.1

How will a change in
 concentration
 affect the reaction rate?

OF

What is the relationship between
 the concentration and reaction
 rate?

- Identify dependent and independent variable. ✓ ✓
- Ask a question (?) about the relationship between dependent and independent variable. ✓

5.3.2

 HNO_3 ✓ / Nitric acid

(3)

The magnesium is used up. / Magnesium is the limited reagent. ✓

5.3.3

Opsie 1

$$\Delta n = 1,0 - 0,8 \checkmark = 0,2 \text{ mol}$$

$$n = \frac{m}{M}$$

$$0,2 = \frac{m}{24} \checkmark$$

$$\therefore m = 4,8 \text{ g}$$

$$\begin{aligned} \text{Gem. reaksietempo} &= \frac{\Delta m}{\Delta t} \\ &= \frac{4,8 \checkmark}{30 - 0 \checkmark} \\ &= 0,16 \text{ g} \cdot \text{s}^{-1} \checkmark \end{aligned}$$

Opsie 2

$$n = \frac{m}{M}$$

$$n = \frac{m}{M}$$

$$1 = \frac{m}{24} \checkmark$$

$$0,8 = \frac{m}{24} \checkmark$$

$$\therefore m = 24 \text{ g}$$

$$\therefore m = 19,2 \text{ g}$$

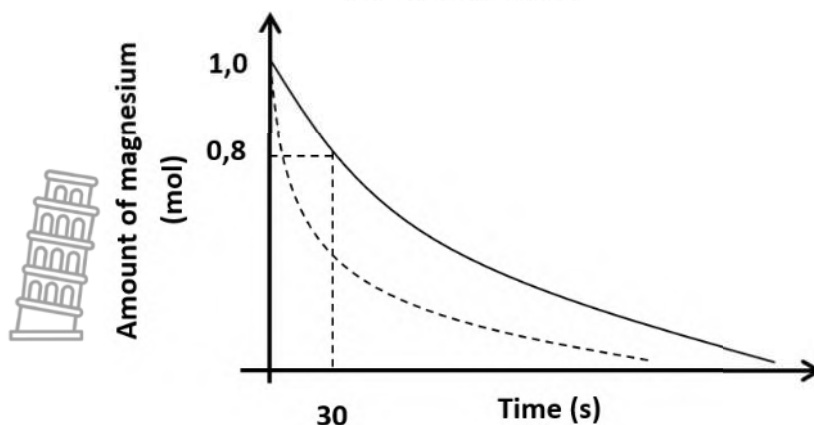
$$\begin{aligned} \text{Gem. reaksietempo} &= \frac{\Delta m}{\Delta t} \\ &= \frac{19,2 - 24 \checkmark}{30 - 0 \checkmark} \\ &= 0,16 \text{ g} \cdot \text{s}^{-1} \checkmark \end{aligned}$$

(5)

5.3.4

- Steeper slope below original graph. ✓
- Intercept x-axis earlier. ✓



(2)
[19]

QUESTION 6

6.1.1 Increases ✓ (1)

6.1.2 Forward ✓ (1)

6.1.3 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓ (2)

6.1.4 Increase in temperature increases K_c . ✓
Increase in K_c indicates that the forward reaction has been favoured. ✓
Increase in temperature favours the endothermic reaction. ✓
Therefore, the forward reaction is endothermic. ✓ (4)

6.1.5 Add a catalyst. ✓ Decrease pressure OR
Increase the volume of the container. ✓ (2)

6.2

	2SO_2	O_2	2SO_3
Initial mol	8	y	0
Mol reacted	-2x	-x	+2x ✓
Mol at eq	2	y-3 ✓	6
[] at eq	1	$\frac{y-3}{2}$	3 ✓ (÷2)

$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]} \quad \checkmark \quad \text{correct } K_c \text{ expression}$$

$$9 = \frac{(3)^2}{(1)^2 \left(\frac{y-3}{2}\right)} \quad \checkmark \quad \text{correct substitution}$$

$$Y = 5 \text{ mol } \checkmark$$

(6)

[16]

QUESTION 77.1  A proton donor (H^+ ion donor). ✓✓ (2)7.2  WEAK ACIDS: ionizes incompletely in water to form only a few H_3O^+ ions. ✓
DILUTED ACIDS: contains a large amount of water added to it. ✓7.3.1 EXOTHERMIC ✓ (2)
(1)7.3.2 $pH = -\log[H_3O^+]$ ✓
 $2,3 \checkmark = -\log[H_3O^+]$
 $\therefore [H_3O^+] = 10^{-2,3}$
 $= 0,005 \text{ mol.dm}^{-3}$ ✓ (3)7.3.3 $n(\text{HCl}) \text{ initial} = cV$ ✓
 $= 0,25(0,5)$ ✓
 $= 0,125 \text{ mol}$ ✓
 $n(\text{HCl}) \text{ after addition} = cV$
 $= 0,005(1)$ ✓
 $= 0,005 \text{ mol}$ ✓Number of moles of HCl reacted with NaOH:
 $= 0,125 - 0,005 = 0,12 \text{ mol}$ ✓

So 0.12 mol of NaOH reacted with 0.12 mol of HCl:

$$[NaOH]_{\text{initial}} = \frac{n}{V}$$
$$= \frac{0,12}{0,5} \checkmark$$
$$= 0,24 \text{ mol.dm}^{-3} \checkmark$$
  (8)

[16]

QUESTION 8

8.1.1 Hydrogen ✓ (1)

8.1.2

In terms of the reducing agent:

- Cu is a weaker reducing agent ✓ than H₂ ✓ and will not reduce H⁺ (to H₂). ✓

(3)

In terms of the oxidizing agent:

- H⁺ is a weaker oxidising agent than Cu²⁺ and will not oxidise Cu (to Cu²⁺).

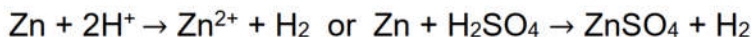
(NOTE: Compare the two reducing agents in the two half reactions OR the two oxidizing agents in the two half reactions.)

OR

H⁺ (H₂SO₄) is a weaker oxidizing agent than Cu (to Cu²⁺).

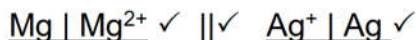
(NOTE: No marks if referring to the relative positions on the table.)

8.1.3



(3)

8.2.1



(3)

8.2.2

25 °C ✓ / 298K and 1mol dm⁻³ ✓

(2)

8.2.3

$$\begin{aligned} E^\theta_{\text{cell}} &= E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} \quad \checkmark \\ &= 0,8 - (-2.36) \\ &= 3,16\text{V} \quad \checkmark \end{aligned}$$

(4)

8.2.4

$$I = \frac{P}{V} = \frac{6\text{W}}{3\text{V}} = 2\text{A},$$

The light bulb is manufactured to work effectively when connected to a 3 V source that can deliver a current of 2 A. This cell produces a large enough potential difference, but the current is probably too small ✓ due to a very large internal resistance.

(1)

8.2.5

Anode: Mg is oxidized and therefore forms the anode.

The amount of AgNO₃ available determines how much of the anode (Mg) will go into solution.

1 mol Mg reacts with 2 mol Ag⁺

$$\begin{aligned} n(\text{AgNO}_3) &= cV \quad \checkmark \\ &= 1(0,4) \quad \checkmark \\ &= 0,4 \text{ mol} \end{aligned}$$

$$\begin{aligned}\therefore n(\text{Mg}) &= \frac{1}{2} n(\text{Ag}^+) \\ &= \frac{1}{2}(0,4) \checkmark \\ &= 0,2 \text{ mol}\end{aligned}$$



$$\begin{aligned}\therefore \text{maximum loss in mass} &= nM \checkmark \\ &= 0,2(24) \checkmark \\ &= 4,8 \text{ g Mg} \checkmark\end{aligned}$$

(6)
[23]

QUESTION 9

9.1 NEGATIVE $\checkmark$ (1)

9.2 To improve electrical conductivity. $\checkmark \checkmark$ (2)

9.3 Decrease $\checkmark$
 $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^- \checkmark \checkmark$ (3)

9.4 $n(\text{Cu}) = \frac{1}{2}(2) \checkmark$ $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
 $= 1 \text{ mol}$

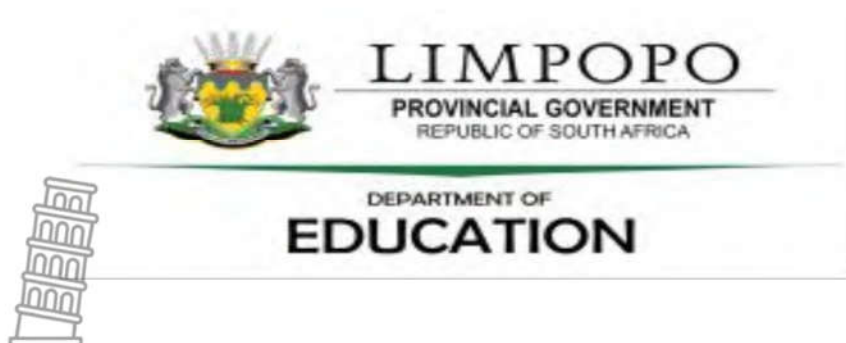
$$\begin{aligned}m(\text{Cu}) &= nM \\ &= 1(63,5) \checkmark \\ &= 63,5 \text{ g}\end{aligned}$$

$$\begin{aligned}\% \text{ purity} &= \frac{m_{\text{pure}}}{m_{\text{impure}}} \times 100 \\ &= \frac{63,5 \checkmark}{95,7 \checkmark} \times 100 \\ &= 66,35 \text{ g} \checkmark\end{aligned}$$

(5)
[11]

TOTAL: 150





PAPER 2: THE PAPER SHOULD BE MARKED OUT OF 140.

QUESTION 1

1.6 Removed.

- 2 marks

QUESTION 2

2.2.2 2-methylbutan-2-ol

Marking criteria:

Correct stem : butan-2-ol ✓

Correct substituent : 2-methyl✓

IUPAC name correct including hyphens✓

(3)

QUESTION 3

3.3.2 No multiple bonds between C- atoms. ✓

(1)

QUESTION 4

4.6.1 **Correct spelling** is but-2-ene

QUESTION 5

5.3.1 Accept any of the following factors for the **independent variable**:

- Change the surface area of Mg.
- Add a catalyst.
- Change in the temperature for the reactants.



E.g How will a Change the surface area of Mg affect the reaction rate? ✓✓

(2)

5.3.2 Removed.

- 2 marks

5.3.3 $Average\ rate = - \frac{\Delta m}{\Delta t} \checkmark$



$$= - \frac{0,8 \checkmark - 1,0 \checkmark}{30 - 0 \checkmark}$$

$$= 6,67 \times 10^{-3} g \cdot s^{-1} \checkmark$$

(5)

QUESTION 6

6.1.4 Endothermic. $\checkmark$

- Increase in temperature increases K_c $\checkmark$
- Increase in K_c indicates that the forward reaction is favoured $\checkmark$
- Increase in temperature favours the endothermic reaction $\checkmark$ (4)

- 6.1.5
- Decrease pressure $\checkmark$
 - Decrease temperature $\checkmark$ (2)

6.2 Removed

- 6 marks

QUESTION 7

7.2 Weak acids ionize incompletely in water to form low concentration of H_3O^+ $\checkmark$

Dilute acids contain large amount of water. $\checkmark$ (2)

7.3.3 **POSITIVE MARKING FROM 7.3.2**

Marking criteria:

- Formula $n(HCl)_{initial} = cV$ $\checkmark$
- Substitution of $c(HCl)_{initial} = 0,25$ and $V = 0,5$ $\checkmark$
- Substitution of $c(HCl)_{after\ addition} = 0,005$ and $V = 1$ $\checkmark$
- Calculation of $n(HCl)_{reacted}$ $\checkmark$
- Ratio $NaOH : HCl$ $\checkmark$
- Substitution in the formula for $[NaOH]$ $\checkmark$
- Final answer $\checkmark$



$$\begin{aligned}n(\text{HCl})_{\text{initial}} &= c V \checkmark \\&= 0,25 (0,5) \checkmark \\&= 0,125 \text{ mol}\end{aligned}$$


$$\begin{aligned}n(\text{HCl})_{\text{after addition}} &= c V \\&= 0,005 (1) \checkmark \\&= 0,005 \text{ mol} \checkmark\end{aligned}$$

Number of moles of HCl reacted with NaOH :

$$= 0,125 - 0,005 = 0,12 \text{ mol} \checkmark$$

Ratio: 0,12 mol HCl : 0,12 mol NaOH $\checkmark$

$$\begin{aligned}[\text{NaOH}]_{\text{initial}} &= \frac{n}{V} \\&= \frac{0,12}{0,5} \checkmark \\&= 0,24 \text{ mol} \cdot \text{dm}^{-3} \checkmark\end{aligned} \quad (8)$$

QUESTION 8

8.1.2 H₂ is a stronger reducing agent $\checkmark$ than Cu $\checkmark$ and Cu will not
reduce H⁺ (to H₂)

ACCEPT

Zn is a stronger reducing agent than Cu, $\checkmark$ therefore Zn will be oxidized.

Cu is a weak reducing agent, $\checkmark$ than Zn therefore will not undergo oxidation and will not produce gas. $\checkmark$

(3)

8.2.2 Temperature of 25°C / 298K $\checkmark$

Concentration of 1 mol · dm⁻³ $\checkmark$ (2)

8.2.4 **OR**

Voltage drop due to the internal resistance. $\checkmark$ (1)

8.2.5 **MARK ALLOCATION**

Remove 1 mark from

$$n(\text{AgNO}_3) = cV$$

allocate it in the ratio



QUESTION 9

9.4 $n(\text{Cu}) = \frac{1}{2} (2) \checkmark$
 $= 1 \text{ mol}$

$m(\text{Cu}) = n M$
 $= 1 (63,5) \checkmark$
 $= 63,5 \text{ g}$



POSITIVE MARKING

$\% \text{ purity} = \frac{m_{\text{pure}}}{m_{\text{impure}}} \times 100$
 $= \frac{63,5 \checkmark}{95,7 \checkmark} \times 100$
 $= 66,35 \text{ g} \checkmark$

(5)

TOTAL MARKS : 140

