KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2024

MARKS : 150

TIME : 3 Hours

This question paper consists of 17 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name 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 sub-questions, for example between QUESTION 2.1 and 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 et cetera where required.

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

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. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following general formulae represents alkenes?

A C_nH_{2n}

B C_nH_{2n-1}

C C_nH_{2n+2}

D C_nH_{2n-2} (2)

1.2 Which ONE of the following compounds has the HIGHEST vapour pressure?

A $CH_3CH_2C(CH_3)_2CH_3$

B $CH_3CH_2CH(CH_3)CH_2CH_3$

C $CH_3CH_2CH_2CH_2CH_2CH_3$

D $CH_3CH(CH_3)CH_2CH_2CH_3$ (2)

1.3 A simple reaction scheme is shown below:

$$C_3H_6 \xrightarrow{HBr(g)} F \xrightarrow[NaOH(aq)]{\text{reflux with}} G + NaBr$$

The formula for G is . . .

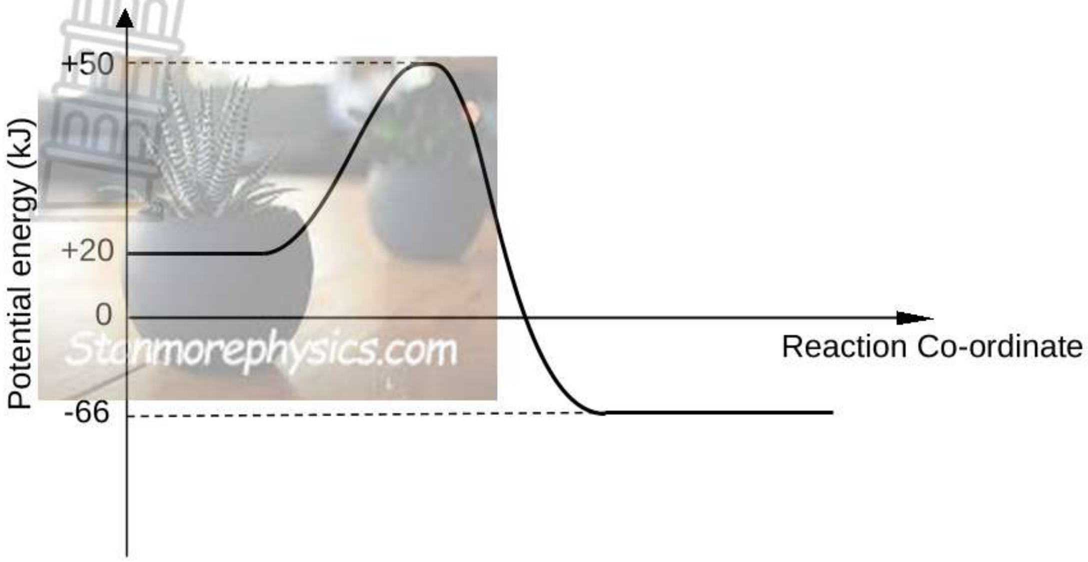
A CH_3CH_2COOH

B $CH_3CHOHCH_3$

C $CH_3CHBrCH_2OH$

D $CH_3CHOHCH_2Br$ (2)

1.4 The graph below represents the energy profile for a hypothetical reaction.



Which ONE of the following combinations for the Activation Energy of the **reverse reaction** and Heat of Reaction of the **reverse reaction** can be correctly concluded from the above energy profile?

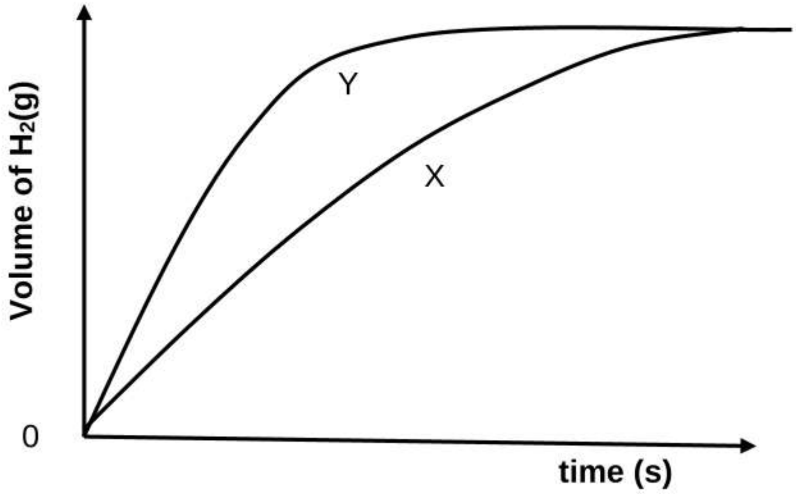
	Activation Energy (kJ)	Heat of Reaction (kJ)
A	-20	+86
B	30	+86
C	-116	-86
D	+116	+86

(2)

1.5 Curves X and Y, show the volume-time relationship for the following reaction:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Curves X and Y are produced under the SAME conditions. However, curve Y, is produced by adding an aqueous solution of copper sulphate to the reaction mixture.



Which ONE of the following correctly explains why curve Y is different from curve X?

A Copper ions act as a catalyst.

B The concentration of the sulphate ions increases.

C Zinc displaces the copper from the copper sulphate.

D The change in the concentration of sulphuric acid decreases per unit time. (2)

1.6 Dihydrogen sulphide (H_2S), dissolves in water according to the following equation:

$$H_2S \; + \; 2H_2O \rightleftharpoons \; S^{2-} \; + \; 2H_3O^+$$

When equilibrium is reached, a solution of hydrochloric acid (HCℓ) is added to the solution containing dihydrogen sulphide.

Which ONE of the following statements is correct?

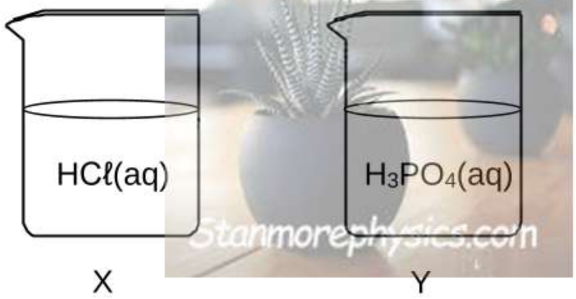
A The concentration of the sulphide ions increases.

B The concentration of the sulphide ions decreases.

C The concentration of the sulphide ions remains unchanged.

D The extent of the ionisation of the hydrochloric acid will increase. (2)

1.7 The beakers, X and Y, below contain equal volumes of an aqueous solution of $HC\ell$ and an aqueous solution of H_3PO_4 respectively.



How will the concentration of the hydronium ions, (H_3O^+) and the pH for the two solutions compare if both solutions have the same concentration?

A The concentration of the hydronium ions and pH of Y is equal to the concentration of the hydronium ions and pH of X.

B The concentration of the hydronium ions and pH of Y is less than the concentration of the hydronium ions and pH of X.

C The concentration of the hydronium ions of Y is greater than the concentration of the hydronium ions of X, while the pH of Y is less than the pH of X.

D The concentration of the hydronium ions of Y is greater than the concentration of the hydronium ions of X, while the pH of Y is greater than the pH of X. (2)

1.8 The following equilibrium exists in pure water at 25 °C.

$$2H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq) \quad \Delta H > 0$$

At this temperature, the pH = 7 and Kw = 1×10^{-14}

The temperature of the water is increased to 90 °C.

Which ONE of the following is TRUE at the new temperature?

A pH = 7

B $[H_3O^+] = [OH^-]$

C $[H_3O^+] = 10^{-7}$ mol.dm^{-3}

D $[H_3O^+][OH^-] = 1 \times 10^{-14}$ (2)

1.9 A galvanic cell is constructed using lead (Pb) and magnesium (Mg) electrodes. The electrons flow from the . . .

A Pb half-cell to the Mg half-cell through the salt bridge.

B Pb half-cell to the Mg half-cell through the wire.

C Mg half-cell to the Pb half-cell through the salt bridge.

D Mg half-cell to the Pb half-cell through the wire. (2)

1.10 Which ONE of the half-reactions below will be the MAIN reaction at the CATHODE during the electrolysis of CONCENTRATED NaCℓ (aq)?

A $2C\ell^{-}(aq) \rightarrow C\ell_2(g) + 2e^{-}$

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

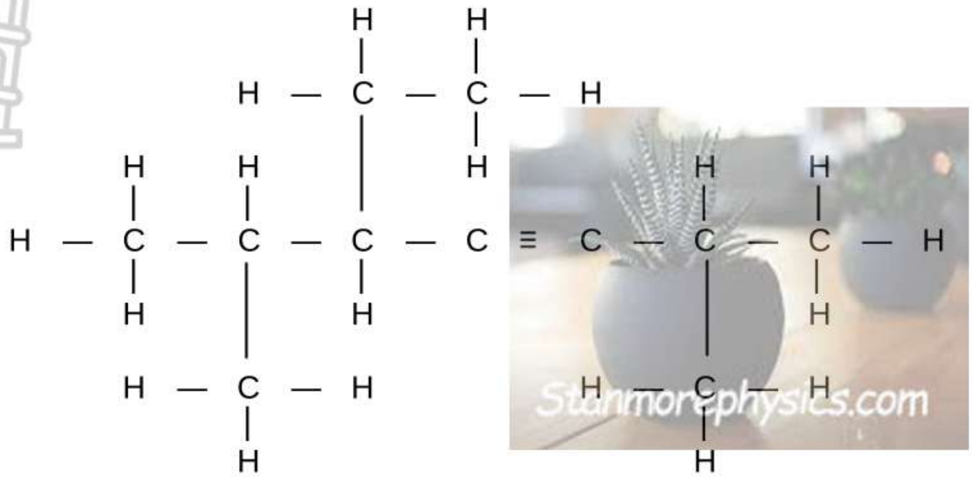
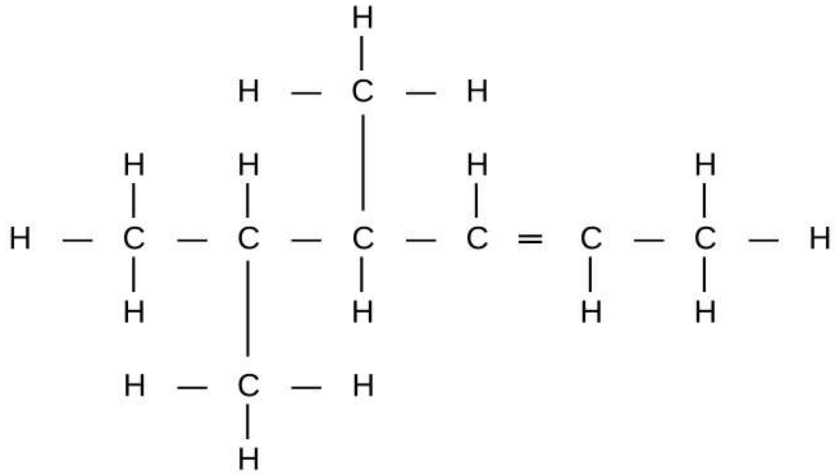
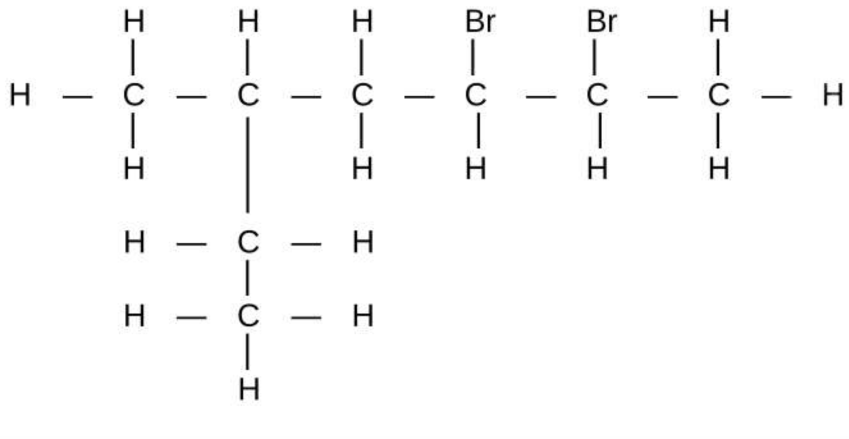
C $2H_2O(\ell) + 2e^{-} \rightarrow H_2(g) + 2OH^{-}(aq)$

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

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A					
B	C_3H_8O	**C**	C_4H_8O	**D**	$CH_3CH(CH_3)COCH_2CH_3$
E					
F					

2.1 Write down the IUPAC name of the compound:

2.1.1 **A** (3)

2.1.2 **F** (2)

2.2 Write down the:

2.2.1 STRUCTURAL formula of the FUNCTIONAL GROUP of compound **D**. (2)

2.2.2 Name of the homologous series to which compound **B** belongs. (1)

2.2.3 Letter of ONE compound that is unsaturated. Give a reason for the answer. (2)

2.3 Write down the STRUCTURAL FORMULAE of the ISOMERS of compound **C**. (4)

2.4 Name the type of isomers shown in question 2.3 (1)
[15]

QUESTION 3 (Start on a new page.)

Learners use three primary alcohols P, Q and R with the same molecular formula to investigate ONE of the factors which influences boiling points of organic compounds. The table below shows the results obtained.

ALCOHOL	BOILING POINT (°C)
P	108
Q	149
R	129

Take the atmospheric pressure as 100kPa.

3.1 Define *vapour pressure*. (2)

3.2 Write down the vapour pressure of alcohol Q at 149 °C. Explain the answer. (2)

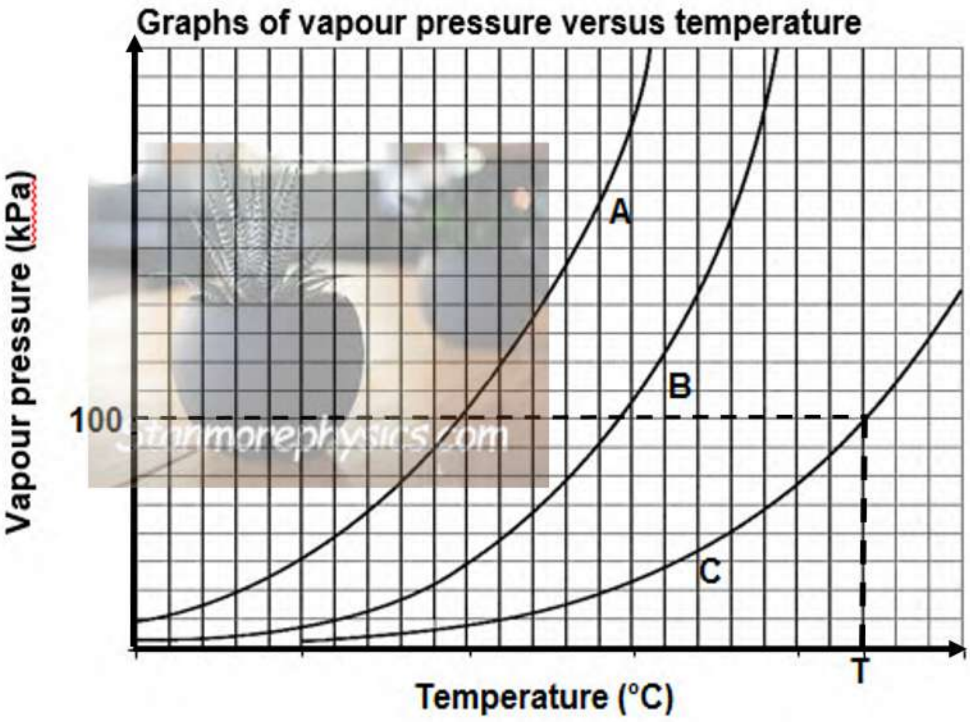
3.3 Which alcohol P or R has a higher vapour pressure than alcohol Q. Write down a reason for the answer. (2)

3.4 Name the independent variable for this investigation. (1)

3.5 Use the results given in the table to fully explain how the independent variable influences the boiling point of the alcohols. (4)

3.6 The molecular mass of alcohol Q is 88 $g.mol^{-1}$. Write down the structural formula for alcohol P. (3)

3.7 The curves A, B and C in random order represents the graph of vapour pressure versus temperature for the alcohols P, Q and R on the same set of axes.

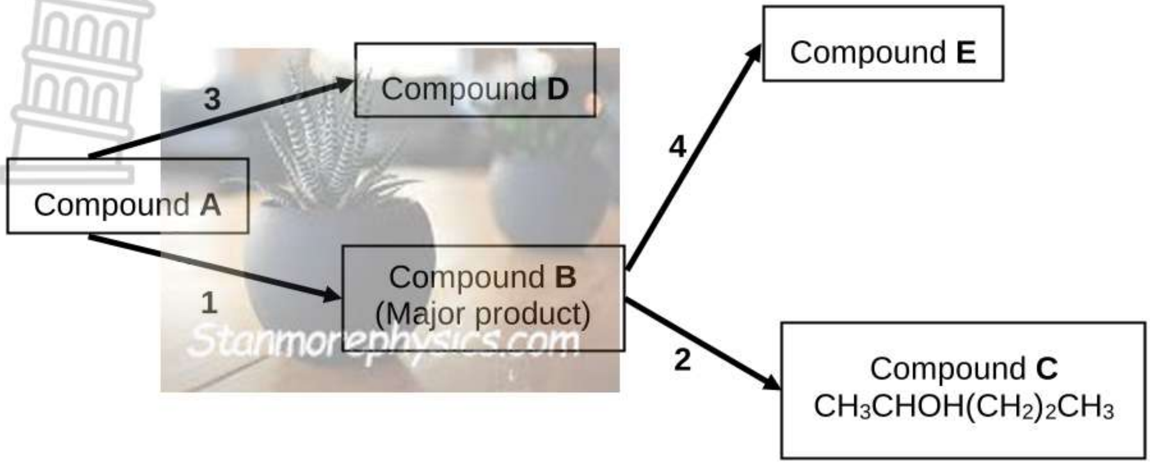


3.7.1 Write down the value of the temperature represented by the letter **T** on the graph. (1)

3.7.2 Explain the answer to question 3.7.1 by referring to both the graph and the information provided in the table. (3)
[18]

QUESTION 4 (Start on a new page.)

In the flow diagram below, **1, 2, 3,** and **4** represent organic reactions. **A**, **B, C, D** and **E** represent organic compounds.



4.1 Compound **B** belongs to a homologous series that has a general formula C_nH_{2n+2}

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

4.1.2 Apart from heat, write down ONE other reaction condition for this reaction. (1)

4.2 Compound **C** is formed when compound **A** is treated with HBr in reaction **1**. Reaction **1** is classified as an ADDITION reaction. Write down:

4.2.1 The structural formula of compound **A**. (2)

4.2.2 TWO terms that describe reaction **2**. (2)

4.2.3 TWO properties of the base used in reaction **2**. (2)

4.3 With the aid of a catalyst, compound **A** can be converted directly to compound **D** without the formation of the intermediate compound **C**. Write down the:

4.3.1 Name or formula of the inorganic REACTANT needed for this direct conversion (1)

4.3.2 Name or formula of a catalyst that can be used (1)

4.3.3 Type of addition reaction that takes place. (1)

4.4 In reaction **4**, compound **B** is treated with concentrated sodium hydroxide, and the mixture is heated.

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

4.4.2 Using molecular formulae, write a balanced equation for reaction **4**. (3)

[15]

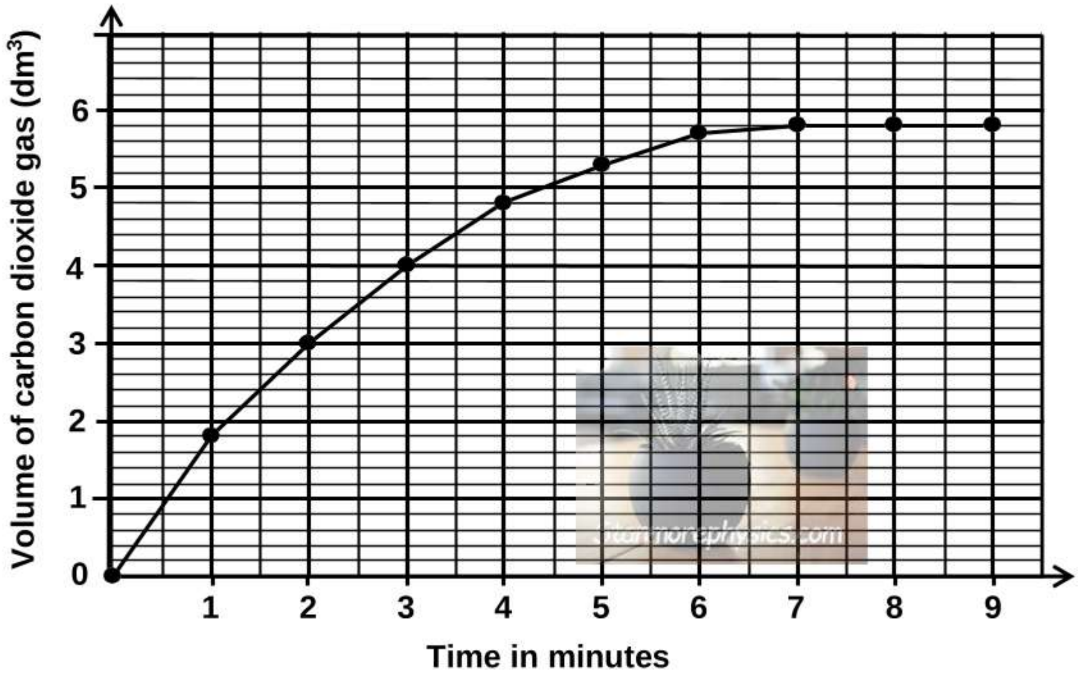
QUESTION 5 (Start on a new page.)

Learners use the reaction of powdered calcium carbonate with EXCESS dilute hydrochloric acid of equal volumes and concentrations, to investigate the rate of a chemical reaction. The balanced equation for the reaction is:

$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell) \quad \Delta H < 0$

REACTION	Mass of $CaCO_3$ in grams	
I	22,57	Pure
II	22,57	Impure

The graph below shows one of the results obtained.



The molar gas volume is 25,7 dm^3.

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

5.2 It is observed that once the reaction starts, the **initial rate** of the reaction increases. Use the collision theory to fully explain the increase in the **initial rate** of the reaction. (3)

5.3 Calculate the average rate at which carbon dioxide gas is produced for the interval 1 minute to 3 minutes. (3)

5.4 How will the average rate at which carbon dioxide gas is produced for the interval 4 minutes to 6 minutes compare with the interval 1 minute to 3 minutes? Choose from GREATER THAN, EQUAL TO, or LESS THAN. Explain the answer using the collision theory. (3)

5.5 Perform the necessary calculations to explain whether the graph represents the results of reaction I or reaction II. (7)

5.6 Sketch the above graph in your answer book and label it as F. On the same set of axes sketch the curve that would be obtained for the other reaction. Label it G. (2)
[20]

QUESTION 6 (Start on a new page.)

Consider the balanced equation for a reaction that takes place in a sealed 2 dm^3 container.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

6.1 What information in the equation indicates that the above reaction is reversible? (1)

6.2 State Le Chatelier's Principle. (2)

The pressure in the container is INCREASED without changing the temperature.

6.3 Will the number of moles of $SO_3(g)$ produced, INCREASE or DECREASE? Use Le Chatelier's Principle to explain the answer. (3)

The reaction represented in the equation above reaches equilibrium at a temperature T in the same sealed 2 dm^3 container.

On analysis of the equilibrium mixture, it is found that 0,6 mol of $SO_2(g)$, 0,5 mol of $O_2(g)$, and 0,4 mol of $SO_3(g)$ are present in the container.

The container's temperature is NOW decreased, and the reaction is allowed to reach equilibrium for the second time. When a new equilibrium is established, it is found that there are 25,6 g of $SO_2(g)$ present in the container.

6.4 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Use Le Chatelier's Principle to explain the answer. (4)

6.5 Calculate the equilibrium constant for this reaction at the NEW temperature. (8)
[18]

QUESTION 7 (Start on a new page.)

7.1 The hydrogen carbonate ion, (HCO_3^-), is an ampholyte.

7.1.1 Define an ampholyte. (2)

7.1.2 Write a balanced equation to show the reaction that occurs when the hydrogen carbonate ion reacts with water. (3)

7.2 A flask contains 20 cm³ of dilute sulphuric acid, $H_2SO_4(aq)$ of concentration 0,15 mol.dm⁻³.

7.2.1 Calculate the pH of the dilute sulphuric acid. (3)

To obtain a final pH of 12,96 a learner adds 30 cm³ of dilute sodium hydroxide, NaOH(aq) of concentration 0,25 mol.dm⁻³ to the flask according to the following balanced equation:

$$H_2SO_4(aq) + 2\,NaOH(aq) \rightarrow Na_2SO_4(aq) + 2\,H_2O(\ell)$$

An unknown volume of dilute barium hydroxide ($Ba(OH)_2$) of concentration 0,10 mol.dm⁻³ is then added to the flask to obtain the pH of 12,96.

Assume that the volumes are additive and that both sodium hydroxide, NaOH(aq) and barium hydroxide ($Ba(OH)_2$) are strong bases.

7.2.2 Calculate the volume of barium hydroxide that was added. (8)
[16]

QUESTION 8 (Start on a new page.)

The table below shows a half-cell A and an unknown half-cell B used to assemble an electrochemical cell under STANDARD CONDITIONS.

Half-cell A	$Ag^+(aq) \mid Ag(s)$
Half-cell B	Unknown

The following observations were made while the cell was in operation:

(I) Cations from the salt bride move into the electrolyte of half-cell A.

(II) The initial emf of the cell is 0,03 V.

8.1 Calculate the E^θ value for half-cell B. (4)

8.2 Write down the:

8.2.1 Half-reaction for half-cell B. (2)

8.2.2 Cell notation for this cell. (3)

8.2.3 TWO standard conditions for this cell. (2)

8.2.4 Energy conversion that takes place when this cell is in operation. (1)

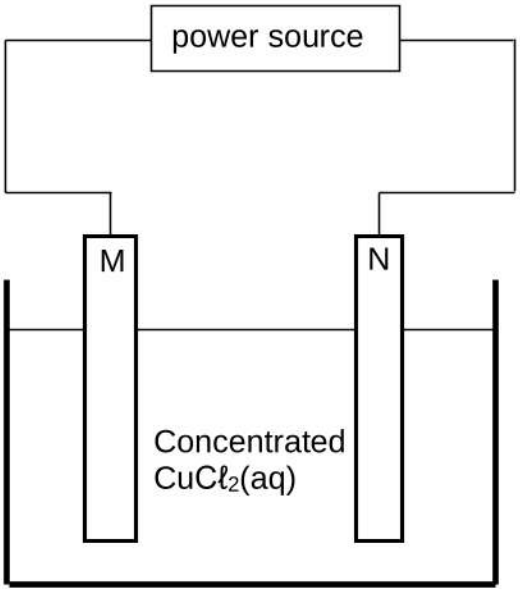
The concentration of the Ag^+ is increased in half-cell A.

8.4 What effect will an increase in the concentration of the Ag^+ in half-cell A have on the initial emf of the cell? Choose from INCREASES, DECREASES, or REMAINS THE SAME. (1)

[13]

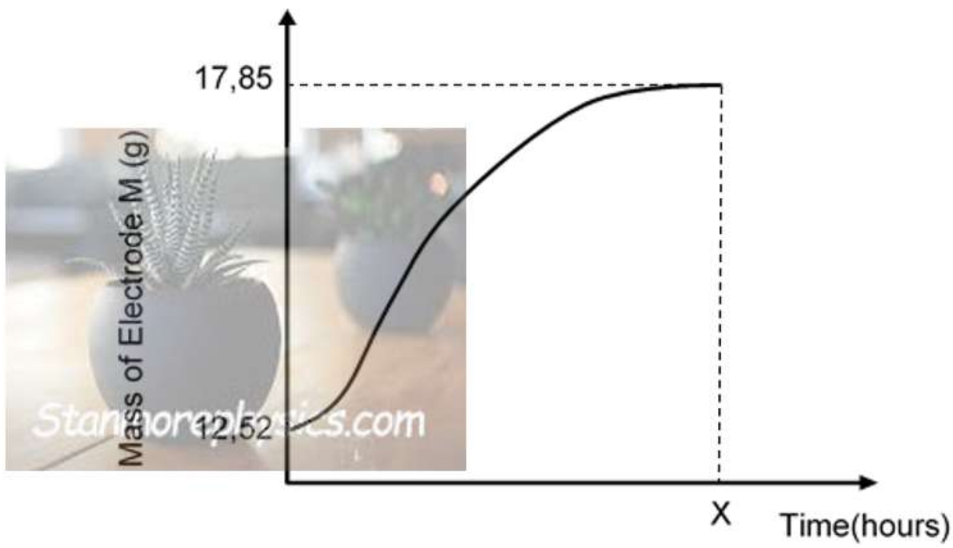
QUESTION 9 (Start on a new page.)

The diagram below shows a simplified electrolytic cell used to electroplate an iron bar with copper.



9.1 Define the term *electrolyte*. (2)

The graph below, NOT drawn to scale, represents the changes in the mass of electrode M during the electroplating process.



9.2 Which electrode M or N represents the iron bar?
Write down a half-reaction to support your answer. (3)

9.3 It is observed that the concentration of the electrolyte remains constant during the electrolytic process.
Write down the name or formula of electrode N. Explain the answer. (3)

9.4 Calculate the value X as shown on the graph if a constant current of 1,5 A passes through the cell. (5)

The copper used in this electrolytic cell is NOT PURE. It contains a small percentage of zinc.

9.5 It is observed that iron bar is not coated with zinc. Explain this observation in terms of the relative oxidising strengths of the substances. (2)
[15]

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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{e}$ 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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

FINAL

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

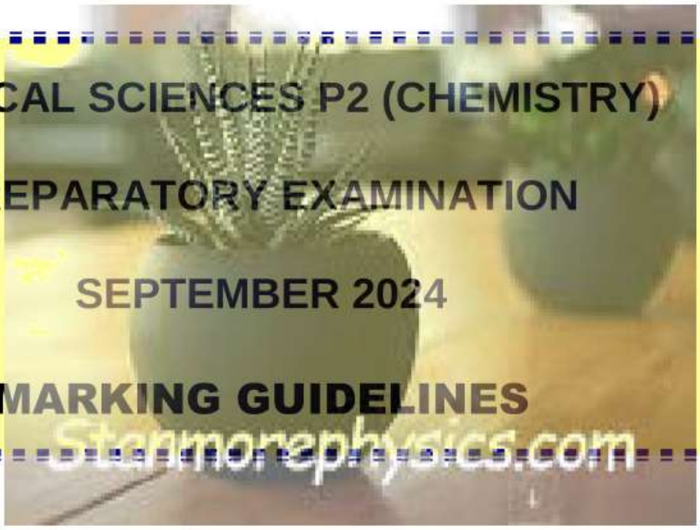
NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2024

MARKING GUIDELINES



MARKS: 150

These Marking Guidelines consist of 14 pages.

QUESTION 1

1.1	A ✓✓	(2)
1.2	A ✓✓	(2)
1.3	B ✓✓	(2)
1.4	D ✓✓	(2)
1.5	A ✓✓	(2)
1.6	B ✓✓	(2)
1.7	C ✓✓ **Do not mark**	(2)
1.8	B ✓✓	(2)
1.9	D ✓✓	(2)
1.10	C ✓✓	(2)

[20]

QUESTION 2

2.1.1 5 – ethyl – 2,6 - dimethylhept – 3 – yne✓✓✓

<u>**Marking criteria:**</u>
- correct stem i.e. hept – 3 – yne ✓
- substituents correctly identified i.e. ethyl, dimethyl✓
- IUPAC name completely correct including numbering, sequence and hyphen ✓

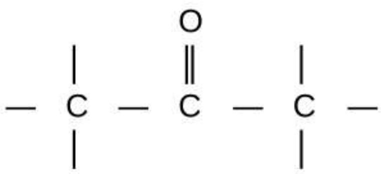
(3)

2.1.2 2,3 – dibromo – 5 – methylheptane✓✓

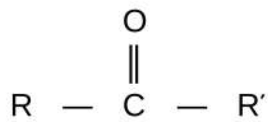
<u>**Marking criteria:**</u>
- correct stem and substituents i.e. dibromo, methyl and heptane✓
- IUPAC name completely correct including numbering, sequence and hyphen ✓

(2)

2.2.1



ACCEPT



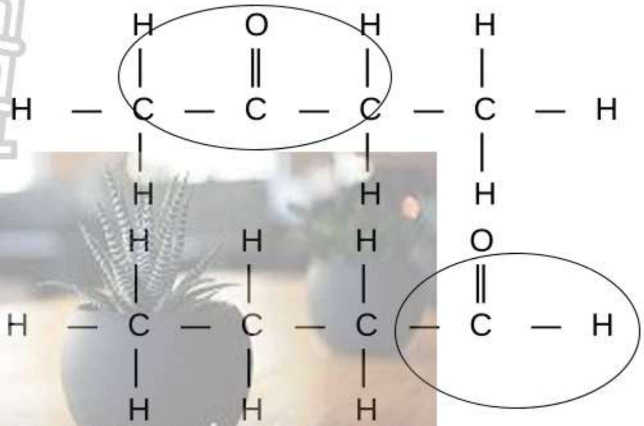
✓✓

(2)

2.2.2 alcohols✓ accept alkanols (1)

2.2.3 A or E✓ (2)
Has multiple bonds between atoms of carbon. ✓

2.3



Marking criteria:

- functional group of first isomer correctly drawn✓
- functional groupof second isomer correctly drawn✓
- Whole structure of first isomer correctly drawn✓
- Whole structure of second isomer correctly drawn ✓

(4)

2.4 Functional isomers✓ (1)
[15]

QUESTION 3

3.1 The <u>pressure exerted by a vapour</u> at <u>equilibrium with its liquid</u> in a <u>closed system.</u> ✓✓

Marking criteria:

If any one of the underlined key words/phrases in the correct context (vapour pressure) is omitted, deduct 1 mark.

(2)

3.2 100 kPa✓ <u>At the boiling point(149°C), the vapour pressure equals the atmospheric pressure.</u> ✓ (2)

3.3 P. ✓ P has a lower boiling point than R. ✓ (2)

3.4 Chain Length /branching/surface area ✓ (1)

3.5

Marking criteria:

- Relate boiling point with length of carbon chain/branching/number of side chains/surface area. ✓✓
- Compare the strength of the intermolecular forces. ✓
- Compare the energy required to overcome the intermolecular forces. ✓

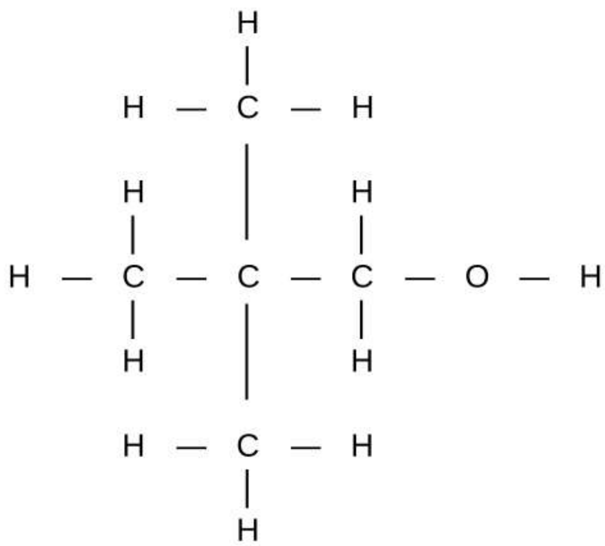
P has the lowest boiling point ✓ and therefore has the shortest carbon chain/most number of branches/smallest surface area over which the intermolecular forces act. ✓
Weakest/least intermolecular forces/Van der Waals forces/London forces✓
Least energy needed to overcome the intermolecular forces✓

OR

Q has the highest boiling point ✓ and therefore has the longest carbon chain/least number of branches/largest surface area over which the intermolecular forces act. ✓
Strongest/most intermolecular forces/Van der Waals forces/London forces✓
Most energy needed to overcome the intermolecular forces✓

(4)

3.6



Marking criteria:

- Functional group on first carbon✓
- 3 carbons in the longest chain ✓
- 2 – methyl groups on the second carbon ✓

(3)

3.7.1 149 (°C) ✓ (1)

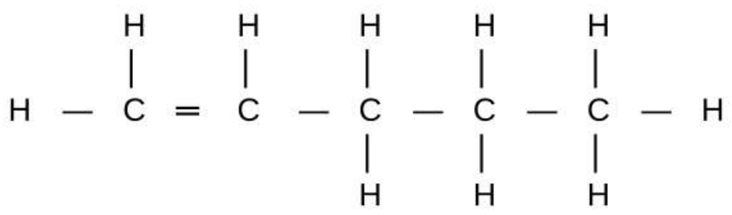
3.7.2 At 100 kPa, the vapour pressure corresponds to the atmospheric pressure✓
T represents the highest boiling point. ✓✓ (3)
[18]

QUESTION 4: DO NOT MARK

4.1.1 Hydrogenation✓ (1)

4.1.2 Requires a catalyst/Pt/Pd/Ni✓ (1)

4.2.1



Marking criteria:
• double bond on first carbon✓ • Whole structure correct ✓

(2)

4.2.2 substitution ✓
hydrolysis✓ (2)

4.2.3 Dilute✓
strong✓ (2)

4.3.1 H_2O/water✓ (1)

4.3.2 Sulphuric acid/H_2SO_4/phosphoric acid/H_3PO_4✓ (1)

4.3.3 Hydration✓ (1)

4.4.1 Elimination/dehydrohalogenation✓ (1)

4.4.2 $C_5H_{11}Br + NaOH \rightarrow C_5H_{10} + NaBr + H_2O$ LHS✓ RHS✓ Bal✓ (3)
[15]

QUESTION 5

5.1
- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass ✓ of products/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)**

(2)

5.2
- Reaction is exothermic/Temperature increases. ✓
- At a higher temperature particles move faster/have higher average kinetic energy.

OR

- More molecules have enough/sufficient kinetic energy for an effective collision.

OR

- More molecules have kinetic energy/Ek equal to or greater than the activation energy. ✓
- More effective collisions per unit time/second. ✓

OR

- Frequency of effective collisions increases.

Reaction rate increases.

(3)

5.3

Marking criteria
- Equation✓
- Substitute $\frac{4-1{,}8}{3-1}$ in equation ✓
- Final answer: 1,1 $dm^3.min^{-1}$✓

$$\text{rate} = \frac{\text{change in volume of } CO_2(g)}{\Delta t} \checkmark$$
$$= \frac{4 - 1{,}8}{3 - 1} \checkmark$$
$$= 1{,}1\ dm^3.min^{-1} \checkmark$$

(3)

5.4 LESS THAN.✓
Less reactant particles per unit volume/lower concentration of HCl/Smaller surface of $CaCO_3$ ✓
Less effective collisions per unit time/Lower frequency of effective collisions.✓

(3)

5.5 **Marking criteria:**

- Formula: $n = \frac{V}{V_m}$ ✓ to calculate $n(CO_2)$produced
- Correct substitution ($\frac{5,8}{25,7}$) in the above formula ✓
- Ratio: $n(CaCO_3)$ used equals $n(CO_2)$ produced ✓
- Substitution of $n(CaCO_3)$ to get n✓
- Use $n = \frac{m}{M}$ to calculate $m(CaCO_3)$initial ✓
- Final answer = reaction I ✓

Greater mass of impure $CaCO_3$ is required to produce the same volume of CO_2/22,57 g of impure $CaCO_3$ will produce less CO_2✓

$n(CO_2)$produced $= \frac{V}{V_m}$ ✓

$= \frac{5,8}{25,7}$ ✓

$= 0,22568$ mol

$n(CaCO_3)$ used $= n(CO_2)$ produced✓

$= 0,22568$ mol ✓

$n(CaCO_3) = \frac{m}{M}$

$0,22568 = \frac{m}{100}$ ✓

$m(CaCO_3) = 22,57$ g

We can also calculate number of moles of pure $CaCO_3$

$n(CaCO_3) = \frac{m}{M}$

$= \frac{22,57}{100} = 0,2257$ mol

Use the ratio

reaction I ✓

All of the $CaCO_3$ reacted. ✓

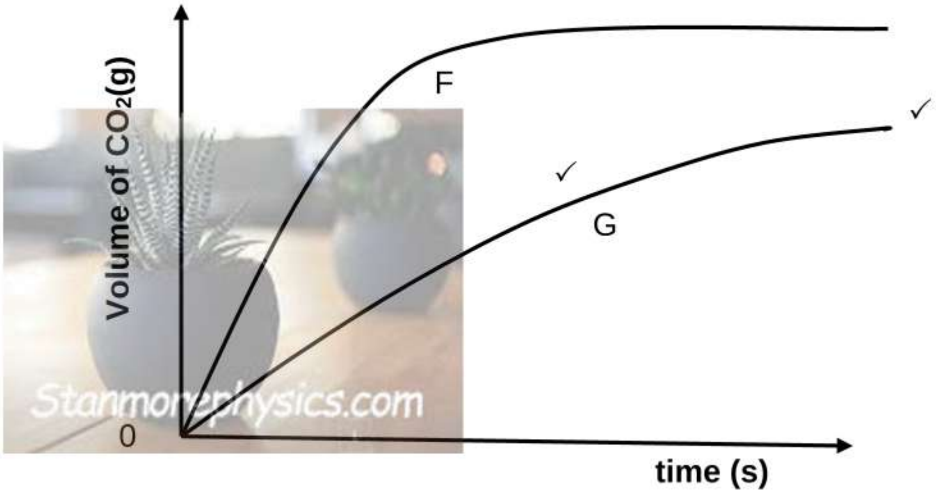
OR

Greater mass of impure $CaCO_3$ is required to produce the same volume of CO_2/22,57 g of impure $CaCO_3$ will produce less CO_2

(7)

5.6

Marking criteria:
- Gradient of G is smaller/less steep✓
- Curve G produces a smaller volume of $CO_2(g)$ ✓



NB: If graphs are not labelled = 0/2

(2)
[20]

QUESTION 6

6.1 Double arrow in the equation. ✓ (1)

6.2

Marking criteria:

If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark.
The underlined phrase must be in the correct context.

When the <u>equilibrium in a closed system is disturbed</u>, the system will <u>re-instate a new equilibrium</u> by favouring the reaction that will oppose the disturbance. ✓✓

(2)

6.3 INCREASE. ✓
According to Le Chatelier's Principle when the pressure increases, the reaction that leads to a decrease in the number of moles will be favoured. ✓
In this case the forward reaction is favoured/equilibrium position shifts to the right.✓ (3)

6.4 EXOTHERMIC.✓
Number of moles/mass of reactant decreased.✓
Forward reaction favoured.✓
A decrease in temperature favours the EXOTHERMIC REACTION.✓ (4)

6.5

Marking criteria:
- Initial quantities of all substances✓
- Quantity of SO_2 at equilibrium✓
- Using the correct mol ratio✓
- Calculating the quantity(mol) at equilibrium of O_2 and SO_3 substances ✓
- Divide number of moles at equilibrium by 2 dm^3✓
- K_c expression✓
- Correct substitution of equilibrium concentrations into K_c expression ✓

	SO_2	O_2	SO_3	
Initial quantity (mol)	0,6	0,5	0,4	✓
Change (mol)	0,2	0,1	0,2	✓
Quantity at equilibrium (mol)	0,4✓	0,4	0,6	✓
Equilibrium concentration ($mol.dm^{-3}$)	0,2	0,2	0,3	✓

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

$$\therefore \quad = \frac{[0,3]^2}{[0,2]^2[0,2]} \checkmark$$

$$= 11,25 \checkmark$$

No K_c expression, correct substitution. $\frac{7}{8}$
Wrong K_c expression $\frac{6}{8}$

(8)

[18]

QUESTION 7

7.1.1 A substance that can act as an acid and a base. ✓✓ (2)

7.1.2 HCO_3^- + H_2O ⇌ CO_3^{2-} + H_3O^+ LHS✓ RHS✓ Balancing✓
OR
HCO_3^- + H_2O ⇌ H_2CO_3 + OH^- (3)

7.2.1

Marking criteria:
- Formula: $pH = -\log[H_3O^+]$✓
- Substitute $c(H_3O^+)$ in the formula $pH = -\log[H_3O^+]$✓
- Final answer✓

$$\begin{aligned} pH &= -\log[H_3O^+] \checkmark \\ &= -\log\underline{(2x0,15)} \checkmark \\ &= 0,52 \checkmark \end{aligned}$$

(3)

7.2.2

Marking criteria:
- Calculate $n(H^+)$ from H_2SO_4 ✓✓
- Substitute for c and V in n = cV to calculate $n(OH^-)$ from NaOH ✓
- Substitute 12,96 into pH = - log$[H_3O^+]$ to calculate $[H^+]$ ✓
- Substitute $[H^+]$ in $[H_3O^+][OH^-] = 1 \times 10^{-14}$ to calculate $[OH^-]$ in excess ✓
- Subtract $n(H^+)$ from $n(OH^-)_{TOTAL}$ and relate to $n(OH^-)_{EXCESS}$. Marks are awarded for substitution. LHS ✓ RHS ✓
- Final answer ✓

$$n(H^+) \text{ from } H_2SO_4 = cV \times 2 = \underline{(0,15)(0,02) \times 2} \checkmark = 0,006 \text{ mols} \checkmark$$

$$n(OH^-) \text{ from NaOH} = cV = \underline{(0,25)(0,03)} \checkmark = 0,0075 \text{ mols}$$

$$pH = -\log[H_3O^+]$$
$$\underline{12,96 = -\log[H_3O^+]} \checkmark$$
$$[H_3O^+] = 1,096 \times 10^{-3} \text{ mol.dm}^{-3}$$
$$[H_3O^+][OH^-] = 1 \times 10^{-14}$$
$$\underline{(1,096 \times 10^{-3})[OH^-] = 1 \times 10^{-14}} \checkmark$$
$$[OH^-] = 0,091 \text{ mol.dm}^{-3}$$
$$n(OH^-)_{excess} = cV = (0,091)\frac{(50 + X)}{1000}$$
$$n(OH^-)_{excess} = n(OH^-)_{TOTAL} - n(H^+) \text{ from } H_2SO_4$$

$$(0,091)\frac{(50 + X)}{1000} \checkmark = (0,0075) + \frac{(0,1)(X)}{1000} - 0,006 \checkmark$$
$$X = 27,98 \text{ cm}^3 \checkmark$$

(8)

[16]

QUESTION 8

8.1

Notes

- Accept any other correct formula from the data sheet.

Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions Max: $\frac{3}{4}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓

$0{,}03$ ✓ $= 0{,}80$ ✓ $- E^{\theta}_{oxidation}$

$E^{\theta}_{oxidation} = 0{,}77\ V$ ✓

(4)

8.2.1 $Fe^{2+} \rightarrow Fe^{3+} + e^-$ ✓✓ (2)

Notes

- **Ignore phases**
- $Fe^{2+} \leftarrow Fe^{3+} + e^-$ $(\frac{0}{2})$ $Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ $(\frac{0}{2})$

  $Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$ $(\frac{1}{2})$ $Fe^{3+} + e^- \leftarrow Fe^{2+}$ $(\frac{2}{2})$
- Ignore if charge on electron omitted.

  If a charge of an ion is omitted eg. $Fe^{3+} + e^- \rightarrow Fe^{2+}$ Max: $(\frac{0}{2})$

8.2.2 $\underline{Pt(s)/Fe^{2+}(aq)(1\ mol{\cdot}dm^{-3})/Fe^{3+}(aq)(1\ mol.dm^{-3})}$ ✓ //✓ $\underline{Ag^+(aq)(1\ mol.dm^{-3})/Ag(s)}$ ✓ (3)

NB: Award full marks even if the phases and concentrations are not shown

8.2.3 Temperature 25°C or 298 K ✓

Concentration of electrolytes = 1 $mol.dm^{-3}$ ✓ (2)

8.2.4 From chemical to electrical✓ (1)

8.4. INCREASES✓ (1)

[13]

QUESTION 9

9.1 A substance of which the aqueous solution contains ions/ A substance that dissolves in water to give a solution that conducts electricity/A solution/ dissolved substance that conducts an electric current through the movement of ions. ✓✓ (2)

9.2 M ✓
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓
Ignore phases

Notes			
• $Cu \leftarrow Cu^{2+} + 2e^-$	$(^2/_2)$	$Cu^{2+} + 2e^- \rightleftharpoons Cu$	$(^1/_2)$
$Cu^{2+} + 2e^- \leftarrow Cu$	$(^0/_2)$	$Cu^{2+} + 2e^- \rightleftharpoons Cu$	$(^0/_2)$
• Ignore if charge on electron omitted.			
• If a charge of an ion is omitted eg. $Cu + 2e^- \leftarrow Cu$		Max: $(^1/_2)$	

(3)

9.3 Cu/copper✓
Copper is being plated on the metal M✓✓ (3)

9.4 **Marking criteria:**

- Calculate gain in mass of the bar i.e. 17,85 - 12,52 and substitute 63,5 in the formula: $n = \frac{m}{M}$ ✓
- Substitute $6,02 \times 10^{23}$ ✓
- Ratio of number of mols of e to number of moles of Cu: 2 : 1✓
- Substitute in $Q = I\Delta t$, Calculate charge✓

Final answer 3 hours✓

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

$: \ n = \frac{17,85 - 12,52}{63,5}$ ✓

$n(e) = 2(\frac{5,33}{63,5})$✓

$= 0,168$ mols

$n(e) = n = nN_A$

$= \underline{0{,}168 \times 6{,}02 \times 10^{23}}$ ✓
$= 1{,}011 \times 10^{23}$
$Q = ne$
$= \underline{(1{,}011 \times 10^{23})(1{,}6 \times 10^{-19})}$ ✓
$= 16\ 176\ C$

$Q = I\Delta t$
$\underline{16\ 176 = 1{,}5(\Delta t)}$
$\Delta t = 10\ 784\ s$ (5)
$X = 3\ hr$ ✓

9.5 Zn^{2+} is a weaker oxidising agent than Cu^{2+} ✓ and will not be reduced. ✓ (2)

OR

Cu^{2+} is a stronger oxidising agent than Zn^{2+} ✓, Cu^{2+} will be reduced to Cu. ✓

[15]
TOTAL: 150

NOTE:
The paper should be marked out 133 and then converted to 150.