KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 14 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, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

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

9. Show ALL formulae and substitutions in ALL calculations.

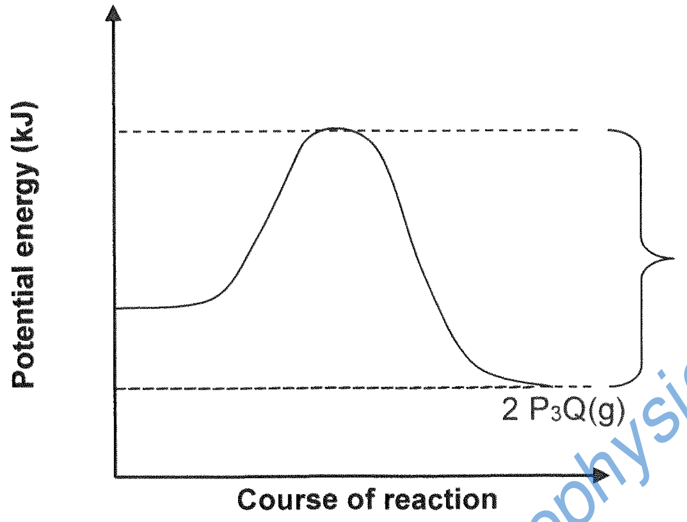
10. Round off your final numerical answers to a minimum of TWO decimal places.

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

12. Write neatly and legibly.

1.4 The graph below shows the change in potential energy for the hypothetical reaction:

$3\,P_2(g) + Q_2(g) \rightarrow 2\,P_3Q(g) \qquad \Delta H = -40\text{kJ}$



Which ONE of the following could represent the activation energy for the forward reaction when a catalyst is added to the reaction?

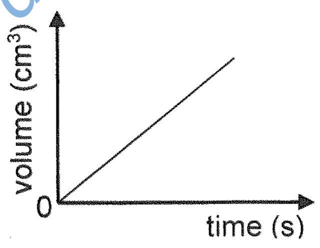
A 50 kJ
B 60 kJ
C 90 kJ
D 120 kJ (2)

1.5 The balanced equation below represents the decomposition of calcium carbonate.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Which ONE of the following volume versus time graphs represents the formation of $CO_2(g)$?

A



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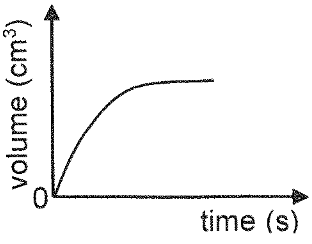
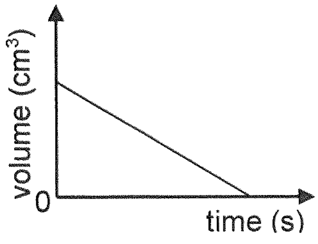
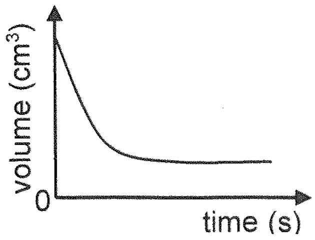


C



D



(2)

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following is the functional group of the esters?

A —OH

B —CHO

C —COOC—

D —COOH (2)

1.2 An organic compound is **incorrectly** named as 4,5-dibromo-2-ethylhexane.

The CORRECT IUPAC name for this compound is:

A 2,3-dibromo-5-ethylhexane

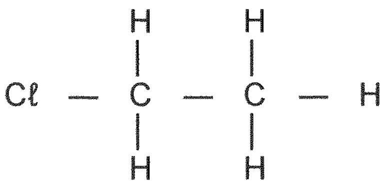
B 2,3-dibromo-5-methylheptane

C 5,6-dibromo-3-methylheptane

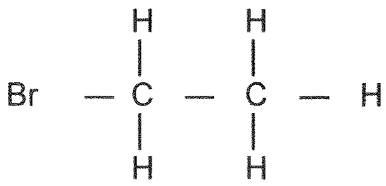
D 1,2-dibromo-1,5-dimethylhexane (2)

1.3 Which ONE of the following compounds has structural isomers?

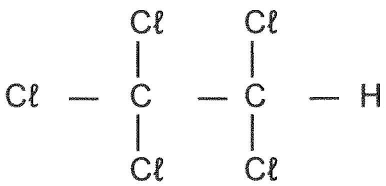
A



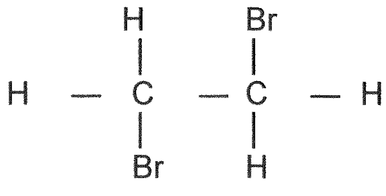
B



C



D

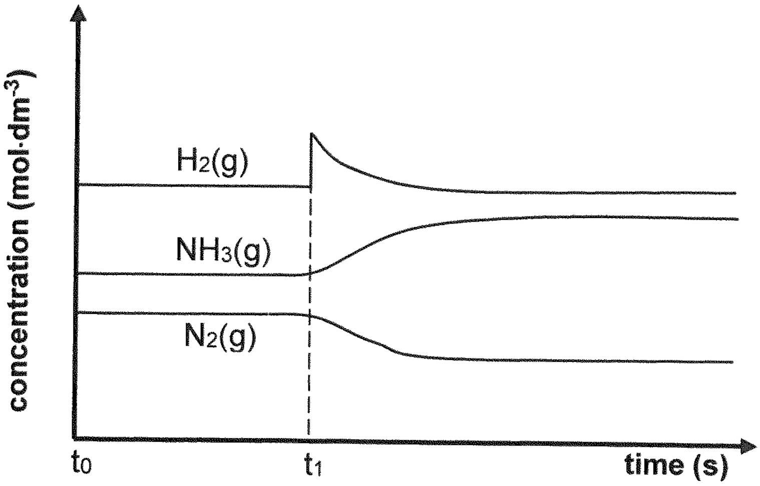


(2)

1.6 Consider the balanced equation below:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

The graph below shows a change made to the system at equilibrium in a closed container at time t_1.



Which ONE of the following changes was made at time t_1?

A A catalyst was added to the reaction.

B The volume of the container was decreased.

C The temperature of the container was increased.

D Hydrogen gas was added to the reaction container. (2)

1.7 The products formed during the hydrolysis of sodium ethanoate (CH_3COONa), are ...

A $Na^+(aq)$ and $OH^-(aq)$

B $Na^+(aq)$ and $CH_3COO^-(aq)$

C $H_3O^+(aq)$ and $CH_3COO^-(aq)$

D $OH^-(aq)$ and $CH_3COOH(aq)$ (2)

1.8 Which ONE of the following aqueous solutions will have the lowest pH at 25 °C?

	SOLUTION	**CONCENTRATION (mol.dm^{-3})**
A	HCℓ(aq)	0,3
B	NaOH(aq)	0,2
C	H_2SO_4(aq)	0,2
D	CH_3COOH(aq)	0,3

(2)

1.9 The salt bridge of a galvanic cell ...

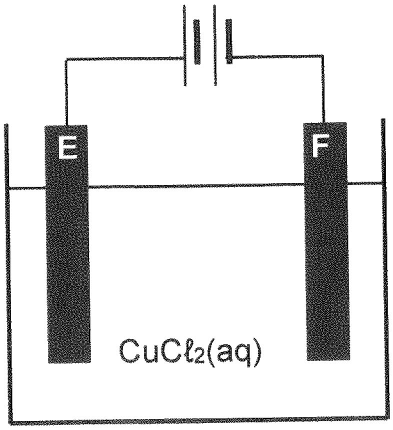
A allows electrons to flow through it.

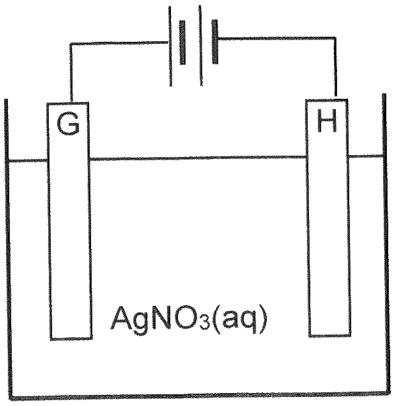
B allows anions to travel to the cathode.

C allows cations to travel to the cathode.

D provides ions to react at the anode and the cathode. (2)

1.10 The simplified diagrams below represent two electrochemical cells using electrolytes of equal concentrations and identical batteries.





The electrode that shows the LARGEST increase in mass per unit time is:

A E

B F

C G

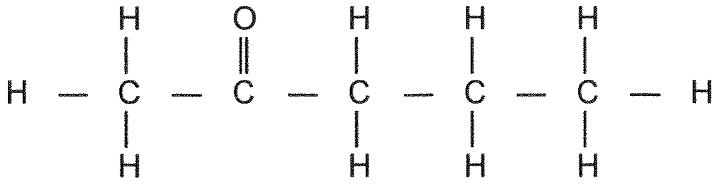
D H

(2)

[20]

QUESTION 2 (Start on a new page.)

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

A	5-ethyl-2,6-dimethylhept-3-yne	**B**	$CH_3CH_2CH_3$
C	$C_5H_{10}O$	**D**	$C_5H_{12}O$
E	 $\begin{array}{ccccccccccccc} & & H & & O & & H & & H & & H & & \\ & & \vert & & \Vert & & \vert & & \vert & & \vert & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & \vert & & & & \vert & & \vert & & \vert & & \\ & & H & & & & H & & H & & H & & \end{array}$		
F	C_4H_9OH		

Use the information in the table to answer the questions that follow.

2.1 For compound **A**, write down the:

2.1.1 General formula of the homologous series to which it belongs (1)

2.1.2 Structural formula (3)

2.2 Compound **C** is a FUNCTIONAL isomer of compound **E**.

2.2.1 Define the term *functional isomer* (2)

2.2.2 Write down the IUPAC name of compound **C** (2)

2.3 Compound **D** is a TERTIARY alcohol. Write down the:

2.3.1 Name of the functional group of compound **D** (1)

2.3.2 Structural formula of compound **D** (2)

2.4 Compound **F** reacts with propanoic acid in an acid catalysed reaction to produce a straight chain organic product.

2.4.1 General name given to this reaction (1)

2.4.2 Write down the IUPAC name of the organic product. (2)

[14]

QUESTION 3 (Start on a new page.)

An investigation was conducted to determine the effect of one of the factors on the boiling points of the alcohols. Three ***straight chain primary*** alcohols, **P**, **Q** and **R** were used. The results obtained are shown in the table below:

Alcohol	Formula	Boiling Point (°C)
P	C_2H_5OH	78
Q	$C_5H_{11}OH$	117
R	C_3H_7OH	97

3.1 Define *boiling point*. (2)

3.2 Is this a fair investigation? Choose from YES or NO. Give a reason for the answer. (2)

3.3 Write down a suitable conclusion for this investigation. (2)

3.4 Fully explain the answer to QUESTION 3.3 (2)

3.5 The investigation is repeated using HALF the original volume of alcohol **R**, while keeping all OTHER CONDITIONS THE SAME.

How will this change affect the boiling point of alcohol **R**? Choose from INCREASE, DECREASE or REMAINS UNCHANGED. (1)

3.6 Which ONE of the alcohols has the highest vapour pressure? Choose from **P**, **Q** or **R**.

Give a reason for the answer. (2)

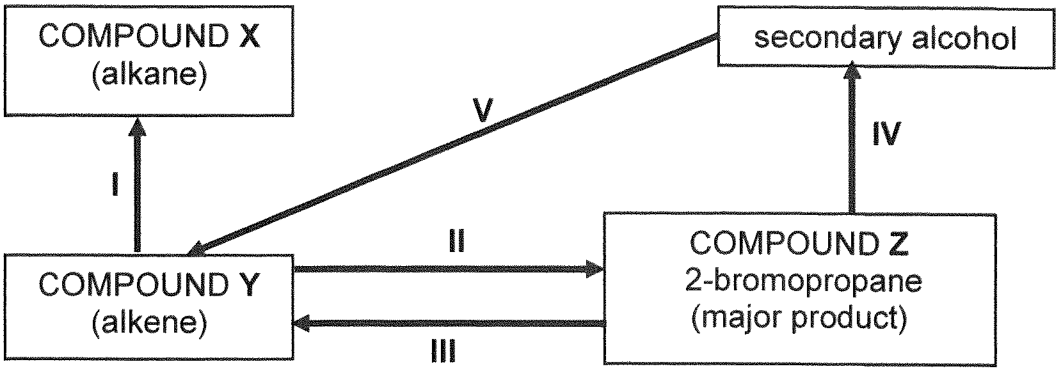
3.7 How will the boiling point of a straight chain compound, C_6H_{14}, compare to that of alcohol **Q**? Choose from GREATER THAN, LESS THAN or EQUAL TO.

Fully explain the answer. (5)

[16]

QUESTION 4 (Start on a new page.)

In the flow diagram below, **I**, **II**, **III**, **IV** and **V** represent organic reactions. Study the flow diagram and answer the questions that follow.



4.1 Name the type of addition reaction represented by **I** (1)

4.2 Name the type of addition reaction represented by **II** (1)

4.3 Which of the above reactions uses a platinum catalyst? (1)

4.4 For reactions **III** and **IV**, a base is required.

  4.4.1 Write down ONE similar property of the bases used in both reactions. (1)

  4.4.2 Describe fully how the bases used in both reactions are different. (2)

4.5 Write down a balanced equation for reaction **II**, using structural formulae. (3)

4.6 Name the TYPE of substitution reaction represented by **IV**. (1)

4.7 Using molecular formulae, write down a balanced equation for the complete combustion of compound **X**. (3)

4.8 Name the TYPE of elimination reaction represented by **V** (1)

4.9 Compound **Y** is also produced in a cracking reaction as shown

$$C_7H_{16} \rightarrow H_2 + Y + 2K$$

Write down the IUPAC name of compound K. (3)

[17]

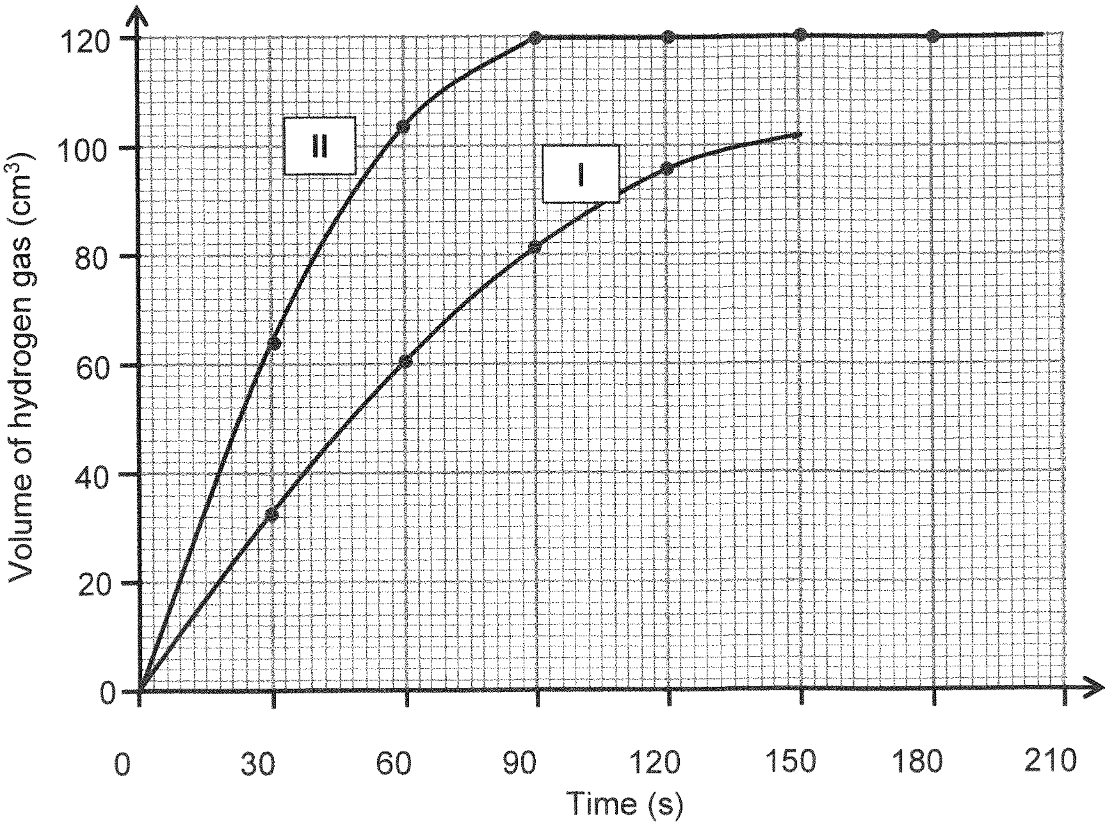
QUESTION 5 (Start on a new page)

A group of learners use the reaction of **excess** hydrochloric acid with magnesium powder to investigate ONE of the factors that influences reaction rate. The balanced equation for the reaction is:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

They use hydrochloric acid of the **SAME CONCENTRATION** and **x** g of magnesium powder in each of TWO experiments, **I** and **II**. Both experiments are carried out at 20°C.

The graph below shows curves **I** and **II** that were obtained for the TWO experiments **I** and **II** respectively. Curve **I** is INCOMPLETE.



5.1 Define *reaction rate*, in words. (2)

5.2 Calculate the average rate of reaction (in $cm^3.s^{-1}$), for experiment **II,** for the time interval 30 s to 60 s. (3)

5.3 Which ONE of the experiments, **I** or **II**, took place at a slower rate? Give a reason by referring to the graphs. (2)

5.4 Write down the factor responsible for the difference in the rate of the reactions. (1)

5.5 Using the collision theory, fully explain how the factor in QUESTION 5.4 affects the rate of the reaction. (3)

5.6 Calculate the mass of magnesium powder remaining in the container at 150s for experiment **I**. Take the molar gas volume to be $24040\ cm^3.mol^{-1}$ at 20 °C. (8)

[19]

QUESTION 6 (Start on a new page)

Consider the reaction represented by the balanced equation below:

$$4HC\ell(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2C\ell_2(g)$$

Initially, 1 mole of HCℓ (g) and an UNKNOWN mass of O_2 (g) were mixed in a sealed 5 dm^3 container. At 600 °C equilibrium was established and 28,40 g of $C\ell_2$ (g), was present in the container.

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

6.2 Give a reason why the reaction above is homogenous. (1)

6.3 Calculate the initial mass of O_2 (g) if the equilibrium constant, Kc, is 800 at 600°C. (8)

6.4 State *Le Chatelier's principle*. (2)

6.5 The volume of the container is now decreased to 2,50 dm^3, while the temperature is kept at a constant 600 °C.

How will each of the following be affected?
Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.5.1 The value of Kc. (1)

6.5.2 The mass of $C\ell_2$ (g) in the container. (1)

6.6 Explain the answer to QUESTION 6.5.2 by referring to *Le Chatelier's Principle*. (2)

6.7 The temperature of the container is now increased. When equilibrium is re-established the value of Kc is 450.

6.7.1 Is the heat of the forward reaction, (ΔH), POSITIVE or NEGATIVE? (1)

6.7.2 Explain the answer to QUESTION 6.7.1 by referring to Le Chatelier's Principle. (3)

[21]

ESTION 7 (Start on a new page.)

Consider the following reaction:

$$H_2SO_4(aq) \; + \; H_2O(\ell) \; \rightarrow \; HSO_4^-(aq) \; + \; H_3O^+(aq)$$

7.1.1 Define an *ampholyte*. (2)

7.1.2 Apart from $H_2O(\ell)$, which substance in the above equation can act as an ampholyte? (1)

A solution of hydrochloric acid has a concentration of 0,1 mol.dm^{-3}.

7.2.1 Calculate the pH of this solution. (3)

A flask contains 200 cm^3 of an aqueous solution of sodium hydroxide (NaOH), of concentration 0,1 mol.dm^{-3}. To this flask, 50 cm^3 of an aqueous solution of barium hydroxide, $Ba(OH)_2$, of UNKNOWN concentration is added, giving a total volume of 250 cm^3.

In a titration, 20 cm^3 of this mixture is completely neutralized by 30 cm^3 of a hydrochloric acid solution of concentration of 0,1 mol.dm^{-3}.

The ionic reaction is represented by the following equation:

$$H_3O^+(aq) \; + \; OH^-(aq) \; \rightarrow \; H_2O(\ell)$$

7.2.2 What is the pH of the solution when the endpoint of the titration is reached?
Choose from LESS THAN 7, EQUAL TO 7 or GREATER THAN 7. (1)

7.2.3 Calculate the number of moles of hydroxide ions (OH^-) present in 20 cm^3 of the mixture of sodium hydroxide and barium hydroxide solutions. (4)

7.2.4 Calculate the initial concentration of the barium hydroxide, $Ba(OH)_2$, solution that was added to the solution of sodium hydroxide. (7)

[18]

QUESTION 8 (Start on a new page.)

The equation below represents a reaction that takes place under standard conditions in an electrochemical cell.

$$Fe^{2+}(aq) \quad + \quad X^{+}(aq) \quad \rightarrow \quad Fe^{3+}(aq) \quad + \quad X(s)$$

X is an unknown metal. The initial emf of this cell is + 0,03 V. The cell uses a platinum electrode.

8.1 Write down the type of electrochemical cell in which the above reaction takes place. (1)

8.2 State TWO standard conditions for the above cell. (2)

8.3 Is the above reaction spontaneous or non-spontaneous? Give a reason for the answer. (2)

8.4 Write down the:

8.4.1 Cell notation for the above cell (3)

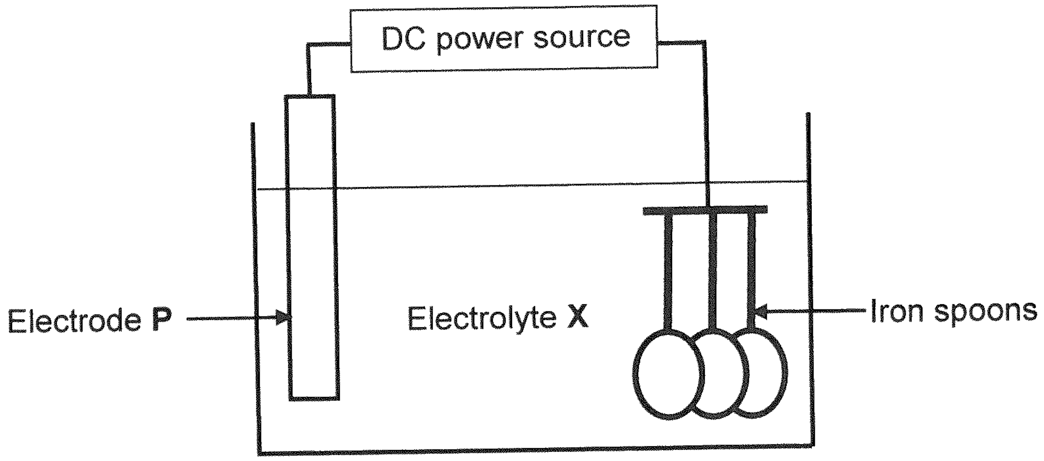
8.4.2 Half reaction that takes place at the cathode in the above electrochemical cell (2)

8.5 Identify metal X, with the aid of a calculation. (4)

[14]

ESTION 9 (Start on a new page.)

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



1 Define the term *electrolyte*. (2)

2 Identify the anode in this cell. Choose between electrode P and the iron spoons. (1)

3 Write down the equation for the half reaction that results in the plating of the spoon. (2)

4 The polarity of the DC source is reversed. How will the mass of the electrode **P** be affected? Choose from INCREASES, DECREASES or REMAINS the same.

Give a reason for the answer. (2)

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

9.5.1 Write down the NAME or FORMULA of TWO cations present in the electrolyte. (2)

9.5.2 It is observed that the iron spoons are not coated with zinc. Explain this observation in terms of the relative oxidising strengths of the substances (2)

[11]

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 electron*	E	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$

$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K

$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}\ /\ E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$

or/*of*

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}\ /\ E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$

or/*of*

$E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}\ /\ E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$

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

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*: 29

Electronegativity / *Elektronegatiwiteit*: 1,9

Symbol / *Simbool*: Cu

Approximate relative atomic mass / *Benaderde relatiewe atoommassa*: 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 oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

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 reducing ability/*Toenemende reduserende vermoë* ↑

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKING GUIDELINE

PREPARATORY EXAMINATION

SEPTEMBER 2022

MARKS: 150

This marking guideline consists of 13 pages.

QUESTION 1

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 A ✓✓ (2)

1.5 B ✓✓ (2)

1.6 D ✓✓ (2)

1.7 D ✓✓ (2)

1.8 A ✓✓ (accept C) (2)

1.9 C ✓✓ (2)

1.10 D ✓✓ (2)

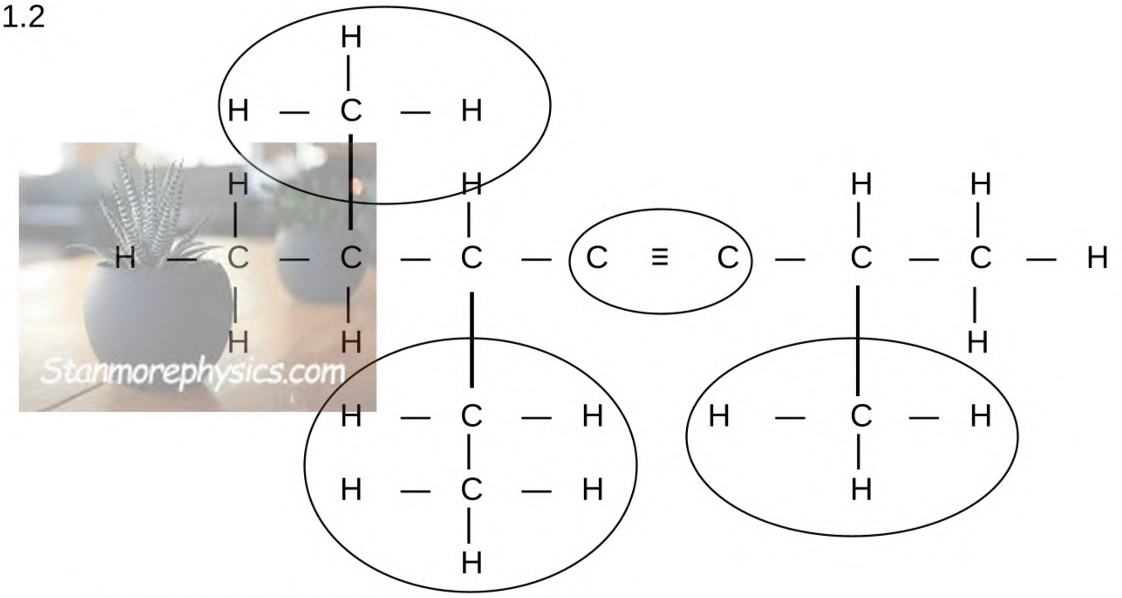
[20]

QUESTION 2

2.1

2.1.1 C_nH_{2n-2} ✓ (1)

2.1.2



Marking criteria:

- functional group✓
- All the substituents(2 methyl groups and 1 ethyl group) correct ✓
- Whole structure correct✓ $\frac{3}{3}$

(3)

2.2

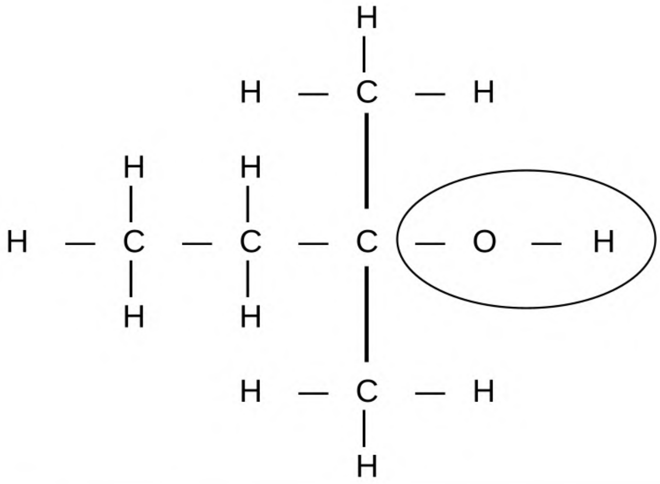
2.2.1 Organic compounds having the <u>same molecular formula</u>✓, but <u>different functional groups</u>✓ (underlined words must be in correct contexts) (2)

2.2.2 Pentanal/2-methylbutanal/3-methylbutanal/2,2-dimethylpropanal ✓✓ (2)
(functional group –anal ✓
Everything correct ✓)
(If wrong functional group 0/2)

2.3

2.3.1 hydroxyl✓ (1)

2.3.2



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

- Only functional group correct*:* Max: $\frac{1}{2}$
- Whole structure correct: $\frac{2}{2}$

(2)

2.4

2.4.1 esterification ✓ (1)

2.4.2 butyl✓ propanoate✓ (2)

[14]

QUESTION 3

3.1 The temperature at which the vapour pressure equals atmospheric (external) pressure. ✓✓ (2 or 0) (2)

3.2 YES. ✓
P, Q and R are straight chain primary alcohols/only ONE independent variable. ✓ (2)

3.3 Boiling point increases ✓ with increase in chain length/molecular mass. ✓ (2)

3.4
- Intermolecular forces/Van der Waals forces/London forces/dispersion forces increase (becomes stronger) with increase in chain length✓
- More energy needed to <u>overcome/break intermolecular forces as chain length increases.</u> ✓ (2)

3.5 REMAINS UNCHANGED✓ (1)

3.6 P✓
<u>Any One</u>
P has the lowest boiling point ✓ **OR**
P has the weakest intermolecular forces✓ (2)

3.7 LESS THAN✓
- Intermolecular forces between molecules of alcohols are hydrogen bonding (in addition to London forces/dispersion forces). ✓
- Intermolecular forces between molecules of C_6H_{14} are only London forces/dispersion forces. ✓
- London forces/dispersion forces are weaker than hydrogen bonding / Intermolecular forces in C_6H_{14} are weaker/ Intermolecular forces in Q are stronger. ✓
- Less energy needed to overcome/break intermolecular forces in C_6H_{14}/ more energy needed to overcome Intermolecular forces in Q.✓ (5)

[16]

QUESTION 4

4.1 Hydrogenation. ✓ (1)

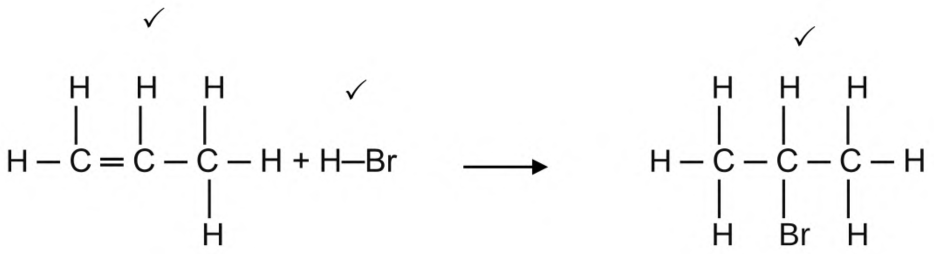
4.2 Hydrogenation/hydrobromination ✓ (1)

4.3 I✓ (1)

4.4.1 Strong bases✓ (1)

4.4.2 Reaction IV, base is dilute✓
Reaction III base is concentrated (in ethanol). ✓ (2)

4.5



(3)

4.6 hydrolysis ✓ (1)

4.7 $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$
reactants ✓ products ✓ balancing ✓ (3)

4.8 dehydration✓ (1)

4.9 ethene ✓✓✓ (3)

[17]

QUESTION 5

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

5.2

$$\text{average rate} = \frac{\Delta V}{\Delta t}$$

$$= \frac{(104 - 64)\ ✓}{(60 - 30)\ ✓}$$

$$= 1{,}33\ ✓\ (\ \text{cm}^3.\text{s}^{-1}\ )$$

(3)

5.3 **I**✓
The gradient / m / slope of graph I is less steep than II. ✓ or
Took a longer time for rection to reach completion. ✓ (2)

5.4 Catalyst✓ (1)

5.5
- A catalyst provides an alternate pathway of lower activation energy.✓
- More particles will have sufficient energy for an effective collision/ more molecules have kinetic energy equal to or greater than the activation energy.✓
- Number of effective collisions per unit time increases/frequency of effective collisions increases.✓ (3)

5.6 **Marking criteria:**

- Ratio: n(Mg) initial equals n(H_2) final produced in reaction **II**. ✓
- Formula: $n = \frac{V}{V_m}$ ✓
- Correct substitution ($\frac{0{,}12}{24{,}04}$) in the above formula✓
- To calculate n(Mg) used(reacted) in reaction **I** in 150 s✓
- n(Mg)initial - n(Mg)used/reacted ✓
- Formula: m = nM✓
- Correct substitution of 24 with n Mg in the above formula. ✓
- Final answer = 0,018 g. ✓

OPTION 1

n(Mg)initial = n(H_2)produced in EXP II

$= \frac{V}{V_m}$ ✓

$= \frac{0,12}{24,04}$ ✓

Either ✓ Either ✓

= 4,99 x 10^{-3} mol

n(Mg)used in EXP I = n(H_2)produced in EXP I

$= \frac{V}{V_m}$

$= \frac{0,102}{24,04}$ ✓

= 4,24 x 10^{-3} mol

n(Mg) remaining = 4,99 x 10^{-3} - 4,24 x 10^{-3}✓

= 0,75 x 10^{-3} mols

m(Mg) = nM✓

= $\underline{(0,75 \times 10^{-3})(24)}$ ✓

= 0,018 g✓

OPTION 2

nH_2 still to be produced = nMg ✓

$n = \frac{V}{V_m}$ ✓✓ ✓

$= \frac{0,12 - 0,102}{24,04}$ (1 mark for subtraction)

$= 7,49 \times 10^{-4}$ mol

m = n x M ✓

= $\underline{7,49 \times 10^{-4} \times 24}$ ✓

= 0,018g ✓ (8)

[19]

QUESTION 6

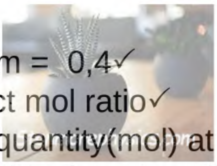
6.1 The rate of forward reaction equals the rate of reverse reaction. ✓✓

Notes

IF: Forward reaction equals reverse reaction. $\frac{1}{2}$ (2)

6.2 Reactants and products are ALL in the same phase. ✓ (1)

6.3 **Marking criteria:**



- $n(C\ell_2)$ equilibrium = 0,4✓
- Using the correct mol ratio✓
- Calculating the quantity(mol) at equilibrium of all three substances ✓
- Divide number of moles at equilibrium by 5 dm^3✓
- K_c expression✓
- Correct substitution of equilibrium concentrations into K_c expression ✓
- Substitute $n(O_2)$ initial and $M(O_2)$ into m = nM✓
- Final answer 9,60 g ✓

OPTION 1

	$HC\ell$	O_2	H_2O	$C\ell_2$	
Ratio	4	1	2	2	
Initial quantity (mol)	1	x	0	0	Using ratio ✓
Change (mol)	0,8	0,2	0,4	0,4	
Quantity at equilibrium (mol)	1 - 0,8	x – 0,2	0 + 0,4 ✓	0,4✓	
Equilibrium concentration ($mol{\cdot}dm^{-3}$)	0,04	$\frac{x-0,2}{5}$	0,08	0,08	Divide by 5 ✓

$$K_c = \frac{[H_2O]^2[C\ell_2]^2}{[HC\ell]^4[O_2]} \checkmark$$

$$\therefore 800 = \frac{(0,08)^2(0,08)^2}{(0,04)^4\left(\frac{x-0,2}{5}\right)} \checkmark$$

$$x = 0,3 \text{ mols}$$

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

Wrong K_c expression $\frac{6}{8}$

$n(O_2)$ = nM
= (0,3) (32) ✓
= 9,60 g✓ (range 9,595312 to 9,60) (8)

OPTION 2

	$HC\ell$	O_2	H_2O	$C\ell_2$	
Ratio	4	1	2	2	
Initial quantity (mol)	1	0,3	0	0	
Change (mol)	0,8	0,2	0,4	0,4	Using ratio ✓
Quantity at equilibrium (mol)	1 - 0,8	0,1	0 + 0,4 ✓	0,4✓	
Equilibrium concentration (mol·dm^{-3})	0,04	$[O_2]$	0,08	0,08	Divide by 5 ✓

$$K_c = \frac{[H_2O]^2[C\ell_2]^2}{[HC\ell]^4[O_2]} \checkmark$$

$$\therefore 800 = \frac{(0{,}08)^2(0{,}08)^2}{(0{,}04)^4[O_2]} \checkmark$$

$$[O_2] = 0{,}02 \text{ mol·dm}^{-3}$$

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

Wrong K_c expression $\frac{6}{8}$

$n(O_2) = nM$
$= \underline{(0{,}3)\ (32)}$ ✓
$= 9{,}60$ g✓ (range 9,595312 to 9,60)

6.4 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. ✓✓
Note: Underlined phrases must be in correct context (2)

6.5.1 Remains the same. ✓ (1)

6.5.2 Increases. ✓ (1)

6.6 An increase in pressure favours the reaction that produces a fewer number of moles. ✓
The forward reaction is favoured. ✓ (2)

6.7.1 Negative (1)

6.7.2 ***Option 1***

- When the temperature increases the reverse reaction is favoured. ✓
- An increase in temperature favours the endothermic reaction. ✓
- Forward reaction is exothermic. ✓

Option 2

- Kc decreases with an increase in temperature. ✓
- Reverse reaction is favoured/concentration of reactants increases/concentration of products decreases/yield decreases. ✓
- Increase in temperature favours the endothermic reaction. ✓

(3)
[21]

QUESTION 7

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

7.1.2 HSO_4^-/hydrogen sulphate ion✓ (1)

7.2.1 **Marking guidelines:**

- Formula: pH = - log $[H_3O^+]$ ✓
- Substitution: 0,1✓
- Final answer: 1✓

pH = - log $[H_3O^+]$ ✓
= - log 0,1✓
= 1✓

(3)

7.2.2 EQUAL TO 7 ✓ (1)

7.2.3

OPTION 1/*OPSIE 1*	**Marking guidelines*:***
$n(OH^-) = n(H^+)$ ✓ = cV ✓ = (0,1)(0,03) ✓ = 0,003 mol ✓	Mol ratio: $n(OH^-) = n(H^+)$ n = cV (entire eq) Substitution of 0,1 Substitution of 0,03. Final answer: 0,003 mol.
OPTION 2	**Marking guidelines:**
$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ $\frac{0,1 \times 30}{cb \times 20} = \frac{1}{1}$ ✓ $cb = 0,15\ \text{mol} \cdot \text{dm}^{-3}$ ↓ n = cV ✓ = (0,15)(0,02) ✓ = 0,003 mols✓	Mol ratio Formula: n = cV Substitution of (0,15)(0,02) Final answer: 0,03 mol

(4)

7.2.4 **Marking criteria:**

- Calculate number of moles of hydroxide ions in 250 cm^3.✓
- Calculate number of moles of hydroxide ions in $Ba(OH)_2$. ✓
- Calculate number of moles NaOH = 0,02 ✓
- Mol ratio: number of moles of $Ba(OH)_2$: number of moles of OH^-.✓
- Formulae: $n = cV$ ✓
- Substitute in the above formula. ✓
- Final answer: 0,175 $mol.dm^{-3}$. ✓

OPTION 1

$$n(OH^-)\text{in } 250\ cm^3 = \frac{(0,003)(250)}{20}\ \checkmark$$
$$= 0,0375 \text{ mols}$$
$$n(OH^-)\text{in } Ba(OH)_2 = n(OH^-)_{TOTAL} - n(OH^-)NaOH$$
$$= \underline{0,0375 \overset{\checkmark}{-} 0,02}\ \checkmark$$
$$= 0,0175 \text{ mols}$$
$$n(Ba(OH)_2) = ½\ n(OH^-)$$
$$= ½\ (0,0175)\ \checkmark$$
$$= 0,00875 \text{ mols}$$
$$c\ (Ba(OH)_2) = \frac{n}{V}\ \checkmark$$
$$c\ (Ba(OH)_2) = \frac{0,00875}{0,05}\ \checkmark$$
$$= 0,175\ mol.dm^{-3}.\ \checkmark$$

OPTION 2

$$V(NaOH) \text{ in } 20\ cm^3 = \frac{4}{5} \times 20$$
$$= 16\ cm^3$$

$$VBa(OH)_2 \text{ in } 20\ cm^3 = 20 - 16$$
$$= 4\ cm^3$$

$$n(OH^-) \text{ from NaOH} = cV$$
$$= (0,1)(16 \times 10^{-3})$$
$$= 1,6 \times 10^{-3} \text{ mols}\ \checkmark$$

$$n(OH^-) \text{ from } Ba(OH)_2 = \underline{3 \times 10^{-3} \overset{\checkmark}{-} 1,6 \times 10^{-3}}\ \checkmark$$
$$= 1,4 \times 10^{-3} \text{ mols}$$

$$n(Ba(OH)_2) = ½\ n(OH^-)$$
$$= ½\ (1,4 \times 10^{-3})\ \checkmark$$
$$= 0,7 \times 10^{-3} \text{ mols}$$
$$c\ (Ba(OH)_2) = \frac{n}{V}\ \checkmark$$
$$c\ (Ba(OH)_2) = \frac{0,0007}{0,004}\ \checkmark$$
$$= 0,175\ mol.dm^{-3}.\ \checkmark$$

(7)
[18]

QUESTION 8

8.1 Voltaic/galvanic cell.✓ (1)

8.2 Temperature: 25 °C/298 K. ✓
Concentration of electrolytes: 1 $mol.dm^{-3}$. ✓ (2)

8.3 spontaneous. ✓ No external energy is required ✓
Accept: cell potential is positive / cell is a galvanic cell. ✓ (2)

8.4.1 $Pt(s)/ Fe^{2+}(aq)(1\ mol.dm^{-3}),\ Fe^{3+}(aq)(1\ mol.dm^{-3})\ //\ X^{+}(aq)(1\ mol.dm^{-3})/X(s)$ (3)

Accept: $Pt/Fe^{2+},\ Fe^{3+}//X^{+}/X$ (MINUS 1 MARK FOR ANY ERROR)

8.4.2 $X^{+}(aq) + e^{-} \rightarrow X(s)$ ✓✓ **Ignore phases**

Notes

- $X \leftarrow X^{+} + e^{-}$ $(\frac{2}{2})$ $X^{+} + e^{-} \rightleftharpoons X$ $(\frac{1}{2})$
  $X \rightleftharpoons X^{+} + e^{-}$ $(\frac{0}{2})$ $X^{+} + e^{-} \leftarrow X$ $(\frac{0}{2})$
- Ignore if charge on electron omitted.
  If a charge of an ion is omitted eg. $X + e^{-} \rightarrow X$ Max: $(\frac{1}{2})$

(2)

8.5

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ $0{,}03$✓ $= E^{\theta}_{reduction} - (0{,}77)$ ✓ $E^{\theta}_{reduction} = 0{,}80V$ X is Ag✓	**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: $\frac{3}{4}$

(4)

[14]

QUESTION 9

9.1 A substance that forms free (positive and negative) ions when melted or dissolved. ✓✓

OR

A solution that conducts electricity. ✓✓

OR

A liquid/solution/dissolved substance that conducts electricity through the movement of ions. ✓✓ (2)

9.2 Electrode P ✓ (1)

9.3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓
Ignore phases

Notes

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

(2)

9.4 Increases. ✓
Reduction takes place at electrode P. ✓ (2)

9.5
9.5.1 Zinc ions(Zn^{2+})✓ and Copper ions(Cu^{2+})✓ (2)

9.5.2 **OPTION 1**

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

OPTION 2 (2)

Zn^{2+} ions are a weaker oxidising agent than Cu^{2+} ions✓ Zn^{2+} will therefore not be reduced to Zn. ✓

[11]

TOTAL: 150