KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2025

MARKS : 150

TIME : 3 Hours

This question paper consists of 15 pages and 4 data sheets.

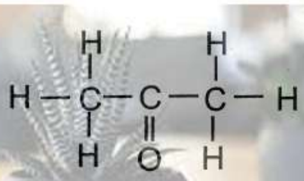
INSTRUCTIONS AND INFORMATION

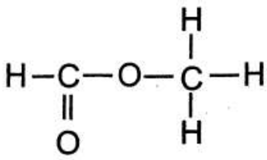
1. Write your name in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question 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.

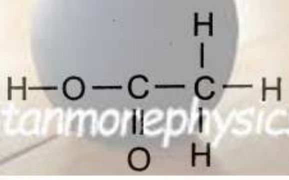
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

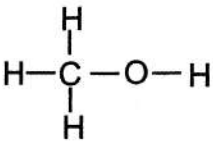
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following compounds represents an ester?

A


B


C


D


(2)

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

A Butanal.

B Pentane.

C Butan – 1 – ol.

D Propanoic acid. (2)

1.3 Consider the reaction represented by the equation below:

$$C_5H_{11}Br + NaOH \rightarrow C_5H_{12}O + NaBr$$

This reaction is an example of . . .

A Hydration.

B Dehydration.

C Substitution.

D Hydrogenation. (2)

1.4 Consider the reaction represented by the balanced equation below:

$$2\ SO_3(g) \rightleftharpoons 2\ SO_2(g) + O_2(g) \qquad \Delta H = 198\ kJ.mol^{-1}$$

Which ONE of the following is TRUE for the reaction?
When 2 moles of $SO_2(g)$ are formed . . .

A 198 kJ of energy is absorbed.

B 198 kJ of energy is released.

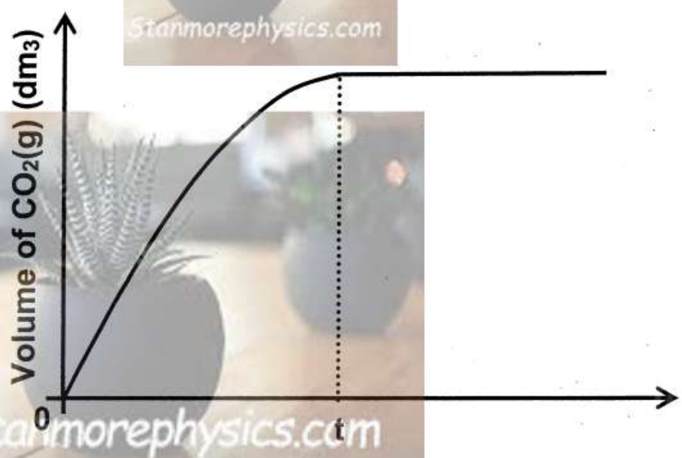
C 396 kJ of energy is absorbed.

D 396 kJ of energy is released. (2)

1.5 Calcium carbonate reacts with excess hydrochloric acid according to the following chemical equation:

$CaCO_3(s) + 2HCℓ(aq) \rightarrow CaCℓ_2(aq) + CO_2(g) + H_2O(ℓ)$

In an investigation, VARYING MASSES of calcium carbonate are added to EQUAL AMOUNTS of HCℓ and the gas released is collected. The following graph is produced from the results of one experiment:



Which ONE of the following conclusions about the reaction is correct at time, **t** indicated in the graph?

A HCℓ is used up in the reaction.

B $CaCO_3$ is in excess.

C $CaCO_3$ is used up in the reaction.

D Both, HCℓ and $CaCO_3$ are in excess. (2)

1.6 Which one of the following statements below regarding a reversible reaction taking place in a closed container is **true**?

A When chemical equilibrium is reached the value of K_c is zero.

B Chemical equilibrium is reached when the forward reaction stops.

C Chemical equilibrium is reached when the concentrations of the product and reactants remain constant.

D Chemical equilibrium is reached when the concentration of the products is equal to the concentrations of the reactants. (2)

1.7 Water is added to a 0,01 mol·dm^{-3} solution of nitric acid. Which one of the following describes the change in concentration of hydronium ions and pH in this solution as water is added?

	[H_3O^+]	**pH**
A	Remains the same	Remains the same
B	Increases	Decreases
C	Increases	Increases
D	Decreases	Increases

(2)

1.8 Bromophenol blue is an acid-base indicator that has a colour change from yellow to blue between pH 3,0 and 4,6. A NaOH solution is titrated with an acetic (ethanoic) acid solution, using bromophenol blue indicator.
Which one of the following statements about this titration is true?

A The end point and the equivalence point occur at the same time.
B The end point occurs after the equivalence point.
C The end point occurs before the equivalence point.
D The indicator will be yellow at the equivalence point of the titration. (2)

1.9 The emf of a galvanic cell is found to be 1,2 V under standard conditions. The following half-reactions and standard electrode potentials are provided:

Half reaction	E^{θ} value (V)
$J^+ + e^- \rightleftharpoons J$	-1,8
$Q^{2+} + 2e^- \rightleftharpoons Q$	0,3
$L^+ + e^- \rightleftharpoons L$	-0.,9
$M^{2+} + 2e^- \rightleftharpoons M$	-0,3

Which of the substances J, K, L and M will act as the anode and cathode respectively?

A J and L

B J and M

C L and M

D L and Q (2)

1.10 When copper is extracted from its ores, the impure copper, which contains small amounts of silver and gold, is purified by electrolysis. During this process, a "sludge" forms beneath the anode which is found to contain silver and traces of gold. Why is silver found in this sludge?

A Silver is a weaker oxidising agent than copper.

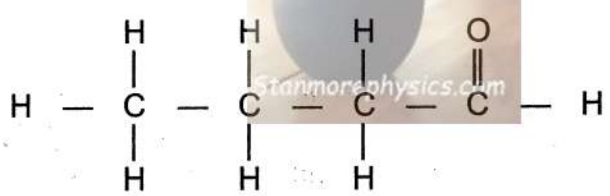
B Silver is an inert metal, so will not dissolve during the electrolysis.

C Silver reacts with the electrolyte to form an insoluble salt.

D Silver is more dense than copper and falls off the cathode. (2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **E** in the table below represent five organic compounds.

A					
B	$CH_3CH(CH_3)CHCH_2$	**C**	$CH_3CH_2COCH_3$	**D**	$CH_3COO(CH_2)_2CH_3$
E					

2.1 Write down the IUPAC name of the compound:

2.1.1 **A** (3)

2.1.2 **B** (2)

2.2 Write down general formula for compound **D**. (1)

2.3 Write down the letter that represents the compound that:

2.3.1 Belongs to the same homologous series as ethanal. (1)

2.3.2 Has a carbonyl carbon atom bonded to two carbon atoms. (1)

2.4 Compound **D** has functional isomers.

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

2.4.2 Write down the empirical formula of the functional isomer of compound **D**. (2)

2.4.3 Write down the IUPAC name of the functional isomer of compound **D**. (2)

[14]

QUESTION 3 (Start on a new page.)

Organic compounds X, Y and Z are used to investigate one of the factors that influences a *physical property* of organic compounds. The table below shows the results obtained.

Organic Compound	BOILING POINT (°C)
W	138
X	129
Y	114

Compounds W, X and Y are *CHAIN ISOMERS* with a molecular formula of $C_5H_{12}O$. The FUNCTIONAL GROUP FOR EACH COMPOUND IS POSITIONED on the first carbon atom for the purposes of this investigation.

3.1 Define *boiling point*. (2)

3.2 Write down the:

3.2.1 Reason why the functional group for each compound is positioned on the first carbon atom for the purposes of this investigation. (1)

3.2.2 Name of the weakest intermolecular force between molecules of W. (1)

3.2.3 Name of the strongest intermolecular force between molecules of Y. (1)

3.4 Which compound W, X or Y will have the highest vapour pressure? Give a reason for the answer. (2)

3.5 Although compounds W and X have the same molecular, they have different boiling points. Fully explain the difference in boiling points. (4)

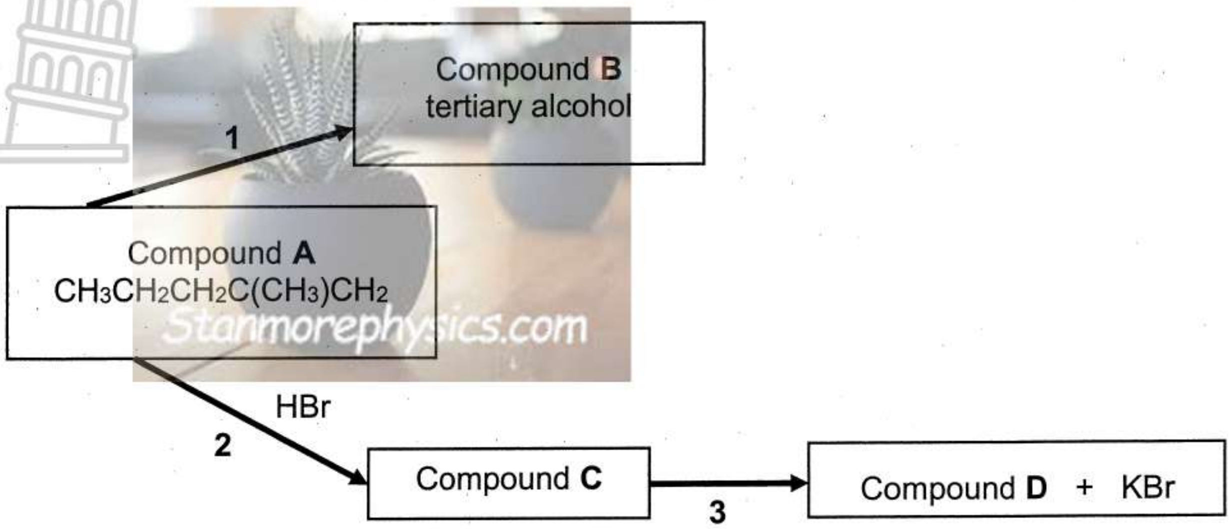
3.6 Draw the structural formula for compound Y. (3)

3.7 Will the boiling point of 2,2 – dimethylpropane be HIGHER THAN, EQUAL TO or LOWER THAN the boiling point of compound Y? Fully explain the answer. (4)

[18]

QUESTION 4 (Start on a new page.)

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



Compound **A** produces compounds **B** and **C** during reactions **1** and **2** respectively. **ONLY, ONE OF THE COMPOUNDS, EITHER B OR C IS A MAJOR PRODUCT**.

4.1 Write down a SINGLE term for the type of reaction represented by **1** and **2**. (1)

4.2 Define the term *tertiary alcohol*. (2)

4.3 Write down the name or formula of the:

4.3.1 Inorganic reagent/reactant needed for reaction **1**. (1)

4.3.2 Catalyst used in reaction **1**. (1)

4.4 Write down the:

4.4.1 Structural formula for compound **B**. (3)

4.4.2 IUPAC name for compound **C**. (3)

4.5 Compound **D** belongs to the same homologous series as compound **B**.

4.5.1 Write down the name of the functional group of the homologous series to which both compounds **B** and **D** belong. (1)

4.5.2 Write down the type of reaction represented by reaction **3**. Choose from SUBSTITUTION, ADDITION or ELIMINATION. (1)

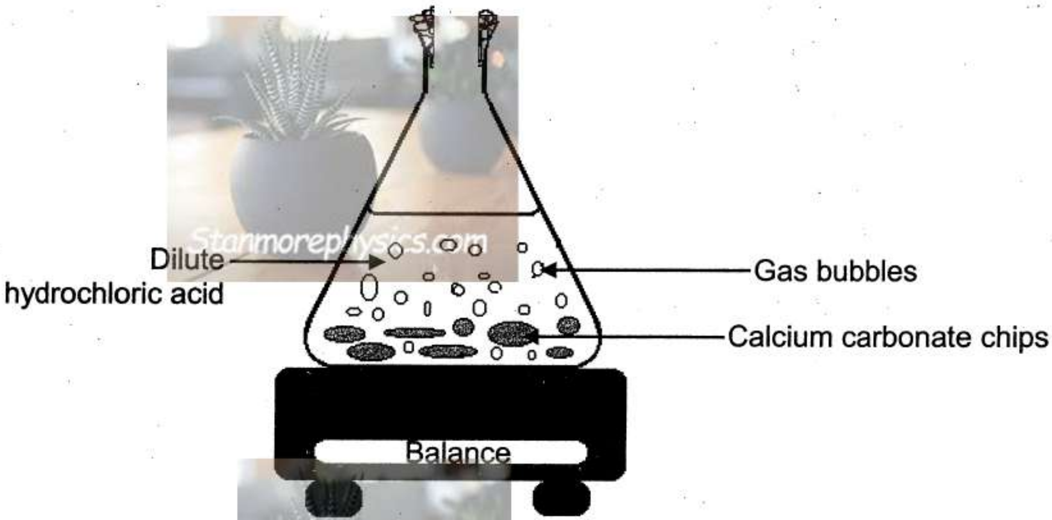
4.5.3 Besides heat write down ONE reaction condition for reaction **3** that will ensure the formation of the indicated products. (1)

4.5.4 Balanced equation for reaction **3**, using molecular formulae. (3)
[17]

QUESTION 5 (Start on a new page.)

62,25 g of calcium carbonate chips are added to an EXCESS dilute hydrochloric acid solution in a flask placed on a balance as illustrated below. The balanced equation for the reaction that takes place is:

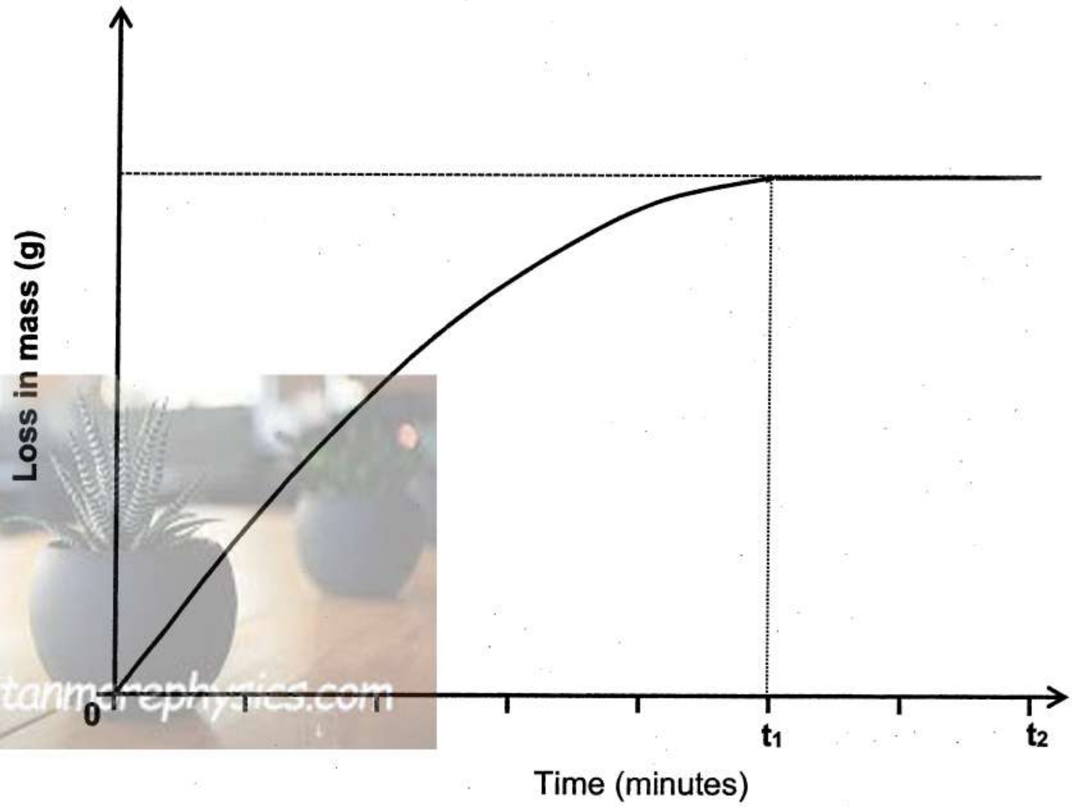
$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$



5.1 It is observed that the initial mass of the flask and its contents decreases as the reaction progresses. Write down the reason why the initial mass decreases. (1)

The loss in mass of the flask and its contents is recorded. The results obtained are shown in the graph below.

Graph of loss in mass versus time



The average gradient of the above graph for the time interval **0** to **t_1** minutes is 1,37 $g.min^{-1}$.

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

5.3 Explain the shape of the graph for the time interval **t_1** to **t_2** minutes. (2)

5.4 Apart from concentration and temperature changes, write down TWO other changes that can be made to increase the rate of this reaction. (2)

5.5 Calculate the value of **t_1** in minutes. (8)

5.6 The experiment is now repeated using hydrochloric acid of a higher concentration.
How would a higher concentration of hydrochloric acid affect the following:
(Write down only INCREASES, DECREASES or REMAINS THE SAME.)

5.6.1 Loss in mass per unit time. (1)

5.6.2 Total loss in mass.
Give a reason for the answer. (2)

5.7 Use the collision theory to explain the answer to question 5.6.1 (3)
[21]

QUESTION 6 (Start on a new page.)

Gas A_2Q is introduced into a flask, which is then sealed, and allowed to reach dynamic chemical equilibrium at a certain temperature. The gas A_2Q decomposes as shown in the balanced chemical equation below:

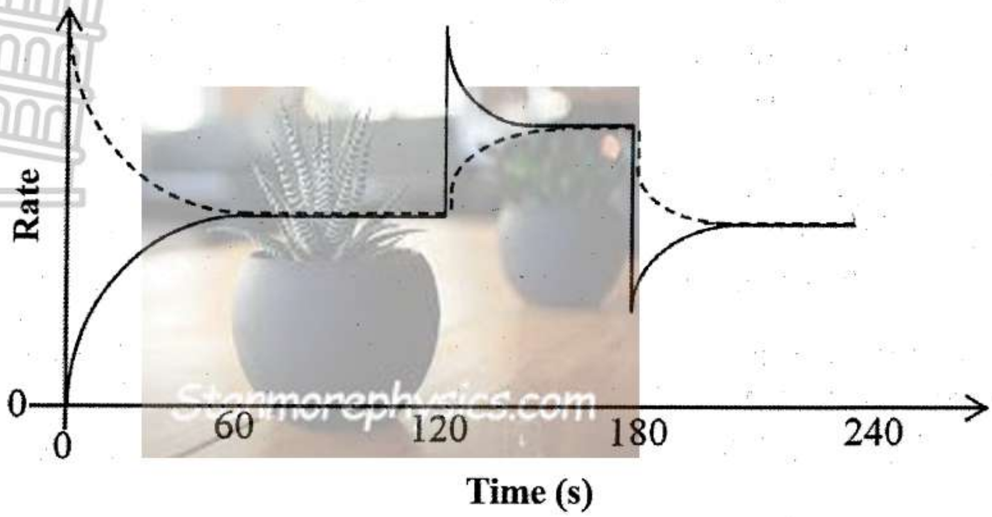
$$2A_2Q(g) \rightleftharpoons 2A_2(g) + Q_2(g)$$

6.1 Describe ONE method to FAVOUR **ONLY** the FORWARD reaction. (1)

6.2 Initially 5 moles of the gas A_2Q are introduced into the reaction flask. The flask is then sealed and kept at a constant temperature. When dynamic chemical equilibrium is established, 70.59 % of the gas A_2Q has decomposed and the concentration of gas Q_2 in the flask is 0,8825 $mol.dm^{-3}$.

Calculate the value of the equilibrium constant (Kc) for this reaction at this constant temperature. (9)

The graph below shows the changes in the rates of the forward and reverse reactions with time for the reaction above.



6.3 A change was made to the reaction at 120 s. Refer to the graph and write down a reason for why this change is NOT the addition of a catalyst. (1)

6.4 State Le Chatelier's Principle. (2)

6.5 The temperature was changed at 180 s. Refer to the graph and Le Chatelier's Principle to write down how this change in temperature will affect the Kc value. Choose from GREATER THAN, EQUAL TO or LESS THAN the value calculated in question 6.2. (1)

6.6 Refer to the graph and Le Chatelier's Principle to explain the answer to question 6.5. (3)
[17]

QUESTION 7 (Start on a new page.)

7.1 The salt sodium ethanoate (CH_3COONa) is produced when ethanoic acid (CH_3COOH) reacts with sodium hydroxide ($NaOH$).

7.1.1 Write down the formula of the conjugate base of the acid CH_3COOH. (1)

7.1.2 Will the pH of a solution of sodium ethanoate be GREATER THAN 7, EQUAL TO 7 or LESS THAN 7. (1)

7.1.3 Write a balanced equation to support the answer to question 7.1.2 (3)

7.2 An aqueous solution $HC\ell$ reacts with an aqueous solution of Na_2CO_3 according to the following balanced equation:

$$2HC\ell(aq) + Na_2CO_3(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

7.2.1 Define the term *strong acid*. (2)

50 cm^3 of a solution of dilute hydrochloric acid, $HC\ell(aq)$ is added to 25 cm^3 of a 0,075 $mol.dm^{-3}$ solution of sodium carbonate, $Na_2CO_3(aq)$ at 25 °C. The $HC\ell$ is in EXCESS.

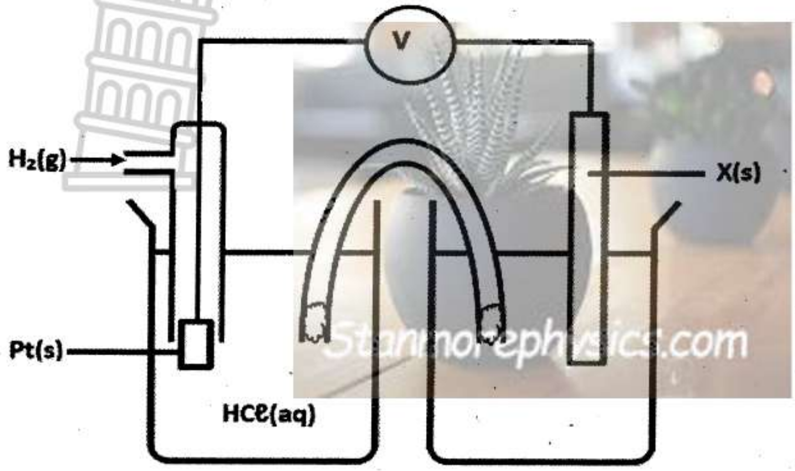
The concentration of the EXCESS $HC\ell$ in the resulting solution is 0,013 $mol.dm^{-3}$.

7.2.2 Calculate the pH of the 50 cm^3 of $HC\ell$ solution that was initially added to the Na_2CO_3 solution. Assume the temperature remains at 25 °C. (10)

[17]

QUESTION 8 (Start on a new page.)

A electrochemical cell is set up, under STANDARD CONDITIONS as shown below. A standard hydrogen electrode is connected to metal **X** in a solution of its ions.



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

(I) The pH of the HCℓ(aq) decreases.

(II) The initial emf of the cell is 0,34 V.

8.1 Which electrode, X or Pt is the anode of the above cell. (1)

8.2 Does the mass of the platinum (Pt) INCREASE, DECREASE or REMAIN the same while the above cell is in operation? (1)

8.3 Write down the:

8.3.1 Half-reaction to support the answer to question 8.1 (2)

8.3.2 Initial temperature at which the above electrochemical cell operates. (1)

8.3.3 Initial concentration of the HCℓ(aq) solution. (1)

8.4 Refer to the table of standard reduction potential table to write down the formula of the cations in the cathode compartment of the above cell. (1)

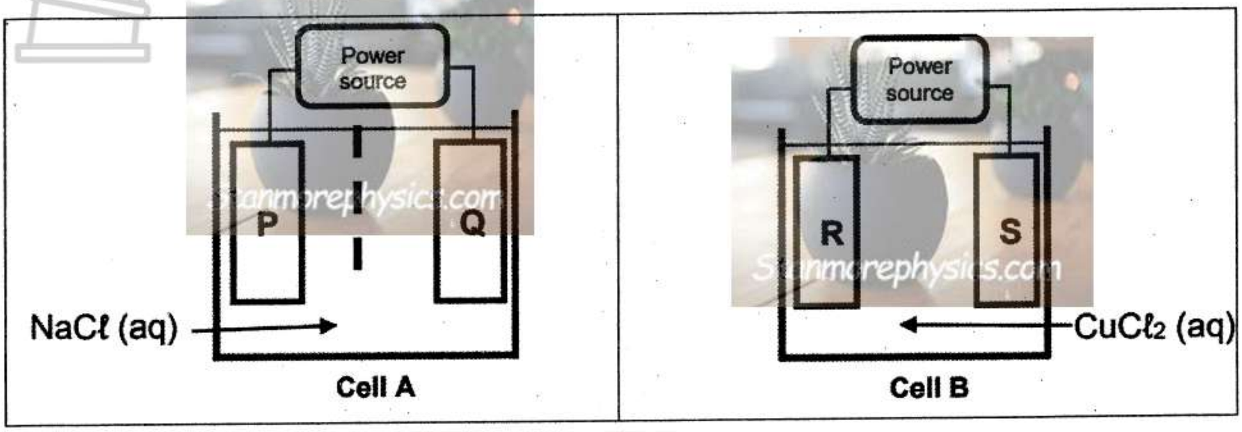
8.5 Hence write down the cell notation for this cell. (3)

8.6 The hydrogen half-cell is replaced with another half-cell that undergoes oxidation. The initial emf of the cell under STANDARD CONDITIONS changes to 0,75 V. Fully explain if the platinum electrode is still required. (Choose from YES or NO) Support the answer with a relevant calculation. (6)

[16]

QUESTION 9 (Start on a new page.)

Two different cells, A and B are shown in the diagrams below. Cell A contains a concentrated solution of sodium chloride ($NaC\ell$) and cell B contains a concentrated solution of copper(II) chloride ($CuC\ell_2$). P, Q, R and S are identical carbon electrodes. Chlorine gas is formed at electrode P and S.



9.1 Are the above cells ELECTROLYTIC or GALVANIC?
Give a reason for your answer. (2)

9.2 Define an *electrolyte*. (2)

9.3 Write down the equation for the half reaction taking place at electrode Q. (2)

9.4 Write down the NAME or SYMBOL of the product formed at electrode R. (1)

9.5 What happens to the concentration of the electrolyte in cell B when the cell is in operation?
Write down INCREASES, DECREASES or REMAINS THE SAME.
Give a reason for the answer. (3)

[10]

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

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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
$Cl_2(g) + 2e^-$	⇌	$2Cl^-$	+ 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
$Al^{3+} + 3e^-$	⇌	Al	– 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

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* (↑)

FINAL

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2025

MARKING GUIDELINES

MARKS: 150

This marking guideline consists of 11 pages.

QUESTION 1

1.1 B ✓✓ (2)

1.2 D ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 C ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 C ✓✓ (2)

1.9 D ✓✓ **DO NOT MARK** (2)

1.10 B ✓✓ (2)
[20]

QUESTION 2

2.1.1 4 – bromo – 5 – ethyl – 2 - methylheptane✓✓✓

Marking criteria*:*
- correct stem i.e. heptane ✓
- substituents correctly identified i.e. bromo, ethyl, methyl✓
- IUPAC name completely correct including numbering, sequence and hyphen ✓

(3)

2.1.2 3 – methylbut – 1 - ene✓✓

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

(2)

2.2 $C_nH_{2n}O_2$✓ (1)

2.3.1 E✓ (1)

2.3.2 C✓ (1)

2.4.1 Compounds with the same molecular formula, ✓ but different functional groups/homologous series.✓

Marking criteria:
If any one of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark.

(2)

2.4.2 $C_5H_{10}O_2$✓✓ (2)

2.4.3 Pentanoic acid or methylbutanoic acid✓✓

Marking criteria:
• correct homologous series: carboxylic acid. ✓ • IUPAC name completely correct. ✓

(2)
[14]

QUESTION 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓

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

(2)

3.2.1 Ensure a fair test/comparison. ✓ (1)

3.2.2 London forces/Dispersion forces. ✓ (1)

3.2.3 Hydrogen bonding ✓ (1)

3.4 Y. ✓
Y has the lowest boiling point. ✓
Or Y has the lowest intermolecular forces compared to W and X. (2)

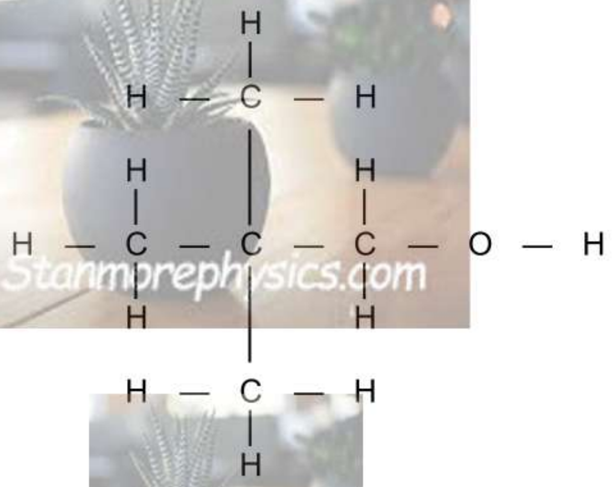
3.5

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. ✓

X has the lowest boiling point ✓ and therefore has the shorter carbon chain/is branched/more compact/more spherical/smaller surface area over which the intermolecular forces act than W.✓
Weaker intermolecular forces/Van der Waals forces/London forces than W.✓
Less energy needed to overcome the intermolecular forces✓ OR (4)

W has the higher boiling point ✓ and therefore has the longer carbon chain/no branches/less compact/less spherical/largest surface area over which the intermolecular forces act than X.✓
Stronger/more intermolecular forces/Van der Waals forces/London forces than X✓
More energy needed to overcome the intermolecular forces✓

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

Marking criteria*:*

- LOWER THAN ✓
- Correctly identify intermolecular forces in both compounds. ✓
- Compare the strength of the intermolecular forces. ✓
- Compare the energy required to overcome the intermolecular forces. ✓

LOWER THAN✓
2,2 – dimethylpropane has only London/Dispersion forces between molecules and Compound Y has hydrogen bonds✓ and dipole-dipole forces in addition to London/Dispersion forces
Intermolecular forces between molecules of 2,2 – dimethylpropane are weaker✓
Require less energy to overcome. ✓

(4)
[18]

QUESTION 4

4.1 addition✓ (1)

4.2 The C-atom bonded to the hydroxyl/-OH✓ is bonded to three other carbon atoms.✓

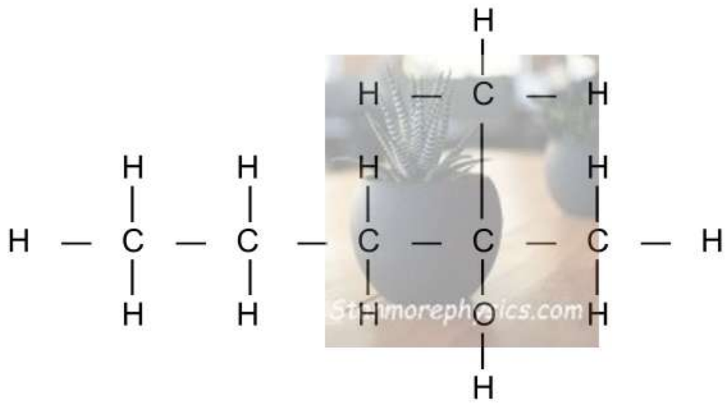
> **Marking criteria:**
> If any one of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark.
> The underlined phrases must be in the correct context.

(2)

4.3.1 Water/H_2O✓ (1)

4.3.2 Sulphuric acid/H_2SO_4 or Phosphoric acid/H_3PO_4✓ (1)

4.4.1



> **Marking criteria:**
> - Correct functional group✓
> - substituent correctly identified i.e. methyl✓
> - IUPAC name completely correct including numbering, sequence and hyphen ✓

(3)

4.4.2 2 – methyl – 1 - bromopentane✓✓✓

> **Marking criteria:**
> - correct stem i.e. pentane ✓
> - substituents correctly identified i.e. bromo, methyl✓
> - IUPAC name completely correct including numbering, sequence and hyphen ✓

(3)

4.5.1 hydroxyl✓ (1)

4.5.2 substitution✓ (1)

4.5.3 Dilute KOH/potassium hydroxide✓ (1)

4.5.4 $C_6H_{13}Br$ + KOH → $C_6H_{14}O$ + KBr

> **Marking criteria:**
> - Both reactants correct. ✓
> - Both products correct✓
> - Balancing ✓

(3)
[17]

QUESTION 5

5.1 The CO_2 produced escapes from the container. ✓ (1)

5.2
- 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. ✓✓

> **Marking criteria:**
>
> If any one of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark.
> The underlined phrases must be in the correct context.

- Rate of change in concentration/amount/number of moles/volume/ mass. ✓✓ (**2 or 0**) (2)

5.3
- Reaction is complete/no more CO_2 is produced/$CaCO_3$ is used up✓✓ (2)

5.4
- Crush the calcium carbonate chips to a powder. ✓
- Add a catalyst. ✓ (2)

5.5 **Marking criteria:**

- Correct substitution ($\frac{62,25}{100}$) in the formula $n = \frac{m}{M}$ to calculate $n(CaCO_3)$ ✓
- Ratio: $n(CaCO_3)$ used equals $n(CO_2)$ produced ✓
- Use $n = \frac{m}{M}$ to calculate $m(CO_2)$ ✓
- Substitute for both n and M correctly i.e.: n = 0,6225 and M = 44✓
- Rate formula: rate $= \frac{\Delta m}{\Delta t}$ ✓
- Correct substitution of 1,37 for rate✓
- Correct substitution for Δm in the formula: rate $= \frac{\Delta m}{\Delta t}$✓
- Final answer Δt = 19,99 minutes✓

$n(CO_2)$ lost = $n(CaCO_3)$ reacted ✓

$= \frac{m}{M}$ ✓

$= \frac{62,25}{100}$ ✓

$= 0,6225$ mols

$m(CO_2)$ lost = nM

$= (0,6225)(44)$ ✓

$= 27,39$ g

rate $= \frac{\Delta m}{\Delta t}$ ✓

1,37✓ $= \frac{27,39}{\Delta t}$ ✓

Δt = 19,99 minutes✓

(8)

5.6.1 INCREASES.✓ (1)

5.6.2 REMAINS THE SAME✓
$CaCO_3$ is the limiting reagent✓ (2)

5.7
- More reacting molecules per unit volume. ✓
- More molecules correctly orientated. ✓
- More effective collisions per unit time/second. ✓
  OR
- Frequency of effective collisions increases. (3)

[21]

QUESTION 6

6.1 Add more reactants/increase the amount/mols/concentration of the reactants. ✓
OR
Remove some of the products/ decrease the amount/mols/concentration of the products.
OR
Decrease in pressure (1)

6.2

Marking criteria:

- Correctly calculate 70,59% of 5 = 3,53✓
- Using the correct mol ratio✓
- Calculating the quantity(mol) at equilibrium of all three substances ✓
- Using the concentration of Q_2 at equilibrium and the number of mols of A_2 at equilibrium in the equation c = n/Vto calculate the volume of the container. ✓✓
- Calculating the equilibrium concentrations of the reactants✓
- K_c expression✓
- Correct substitution of equilibrium concentrations into K_c expression ✓
- Kc = 5,09 ✓

	A_2Q	A_2	Q_2	
Initial quantity (mol)	5	0	0	
Change (mol)	3,53✓	3,53	1,765	✓
Quantity at equilibrium (mol)	1,47	3,53	1,765	✓
Equilibrium concentration ($mol.dm^{-3}$)	0,735	1,765	0,8825	✓

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

$$0,8825 = \frac{1,765}{V} \checkmark$$

$$V = 2\ dm^3$$

$$Kc = \frac{[A_2]^2[Q_2]}{[A_2Q]^2} \checkmark$$

$$= \frac{(1,765)^2(0,8825)}{(0,735)^2} \checkmark$$

$$= 5,09 \checkmark$$

(9)

6.3 The rates of the forward and reverse reaction do not increase equally. ✓ (1)

6.4

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 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)

6.5 GREATER THAN ✓ (1)

6.6 The rate of the forward reaction decreases less than the rate of the reverse reaction. ✓
The forward reaction is favoured. ✓
Concentration of the products increases while the concentration of the reactants decreases. ✓ (3)
[17]

QUESTION 7

7.1.1 CH_3COO^-✓ (1)

7.1.2 GREATER THAN 7✓ (1)

7.1.3 $CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$
LHS✓
RHS✓
Balancing✓ (3)

7.2.1 It is a substance <u>that ionises completely</u> ✓ in water to produce a <u>high concentration of hydronium ions</u>. ✓ (2)

7.2.2

<u>Marking criteria:</u>

- Calculate $n(HC\ell)_{excess}$ ✓
- Substitute for c and V in n = cV ✓
- Ratio $HC\ell : Na_2CO_3 = 2:1$✓
- Substitute for c and V ✓
- Calculate $n(HC\ell)_{total}$ by adding above 2 values✓
- Ratio of $c(HC\ell) = c(H_3O^+)$✓
- Substitute into c = n/V to calculate concentration of H_3O^+✓
- Equation: $pH = -\log[H_3O^+]$✓
- Substitute into $pH = -\log[H_3O^+]$ ✓
- Final answer✓

$n(HC\ell)_{excess} = cV$ ✓
$= (0,013)(0,075)$ ✓
$= 0,000975$ mols

$n(HC\ell)$ reacted with $Na_2CO_3 = 2cV$ ✓
$= (2)(0,075)(0,025)$ ✓
$= 0,00375$ mols

$n(HC\ell)_{total} = 0,000975 + 0,00375$ ✓
$= 0,004725$ mols

$c(H_3O^+) = c(HC\ell)$ ✓
$= \frac{n}{V}$
$= \frac{0,004725}{0,05}$ ✓
$= 0,0945$ mol.dm^{-3}

$pH = -\log[H_3O^+]$ ✓
$= -\log 0,0945$ ✓
$= 1,02$ ✓

(10)

[17]

QUESTION 8

8.1 Pt✓ (1)

8.2 Remain the same. ✓ (1)

8.3.1 $H_2 \rightarrow 2H^+ + 2e^-$ ✓✓

> **Notes**
> - **Ignore phases**
> - $H_2 \leftarrow 2H^+ + 2e^-$ $(\frac{0}{2})$ $2H^+ + 2e^- \rightleftharpoons H_2$ $(\frac{0}{2})$
>
> $H_2 \rightleftharpoons 2H^+ + 2e^-$ $(\frac{1}{2})$
>
> Ignore if charge on electron omitted.

(2)

(1)

8.3.2 25°C/298 K ✓

8.3.3 1 mol.dm^{-3} ✓ (1)

8.4 Cu^{2+} ✓ (1)

8.5 Pt(s) /H_2(g)/H^+(aq)(1 mol.dm^{-3}) ✓ // ✓ Cu^{2+}(aq)(1 mol.dm^{-3})/Cu(s) ✓ (3)
Ignore the phases and concentrations

8.6

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: $\frac{3}{4}$

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
$0,75$ ✓ $= 0,34$ ✓ $- E^\theta_{oxidation}$
$E^\theta_{oxidation} = -0,41$ V ✓
Yes✓, Cr^{2+} is not a solid. ✓

(6)

[16]

QUESTION 9

9.1 Electrolytic✓
They both have a power supply✓
Both cells converts electrical energy to chemical energy. (2)

9.2 An electrolyte is a substance of which the aqueous solution contains ions.✓✓
OR
A substance that dissolves in water to give a solution that conducts electricity. (2)

9.3 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$✓✓
Ignore phases

Notes
- $2H_2O + 2e^- \leftrightharpoons H_2 + 2OH^-$ (1/2)
- $H_2 + 2OH^- \leftarrow 2H_2O + 2e^-$ (2/2)
- $H_2 + 2OH^- \leftrightharpoons 2H_2O + 2e^-$ (0/2)
- $2H_2O + 2e^- \leftarrow H_2 + 2OH^-$ (0/2)

(2)

9.4 Cu or Copper✓ (1)

9.5 Decreases✓

Cu^{2+} (or Copper(II) ions) are reduced✓ to Cu ✓ (or Copper). (3)

[10]

TOTAL: 150

NB: MARK SCRIPT OUT OF 148 AND THEREAFTER CONVERT TO TOTAL MARKS : 150