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Western Cape Government
Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
SEPTEMBER 2025

MARKS	**:**	**150**
TIME	**:**	**3 hours**
DATE	**:**	**25 SEPTEMBER 2025**

This question paper consists of 15 pages and 4 data sheets

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INSTRUCTIONS AND INFORMATION

1. Write your Name and Surname on the first page of your ANSWER BOOK.

2. This question paper consists of **9 QUESTIONS**. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW PAGE of your RULED A4 PAPER. Use BOTH sides of the page to avoid wasting paper.

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 QUESTION 2.2 or 2.1.1 and 2.1.2

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**. In multi-step calculations, intermediate steps, round of to four decimal places.

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

12. Write neatly and legibly.

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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) on your RULED A4 PAPER, for example 1.11 D.

1.1 Consider the condensed structural formula:

$$CH_3COCH_3$$

Identify the name of the functional group in this formula.

A. Formyl group

B. Carboxyl group

C. Ketone

D. Carbonyl group (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. 5,6-dibromo-3,3-dimethylhexane (2)

1.3 Learners investigate the boiling points of the first five straight chain CARBOXYLIC ACIDS. Which of the following factors CANNOT be used explain the increase in boiling points as the number of carbon atoms increases?

A. Increase in chain length

B. Increase in surface area

C. Increase in strength of hydrogen bonds

D. Increase in molecular mass (2)

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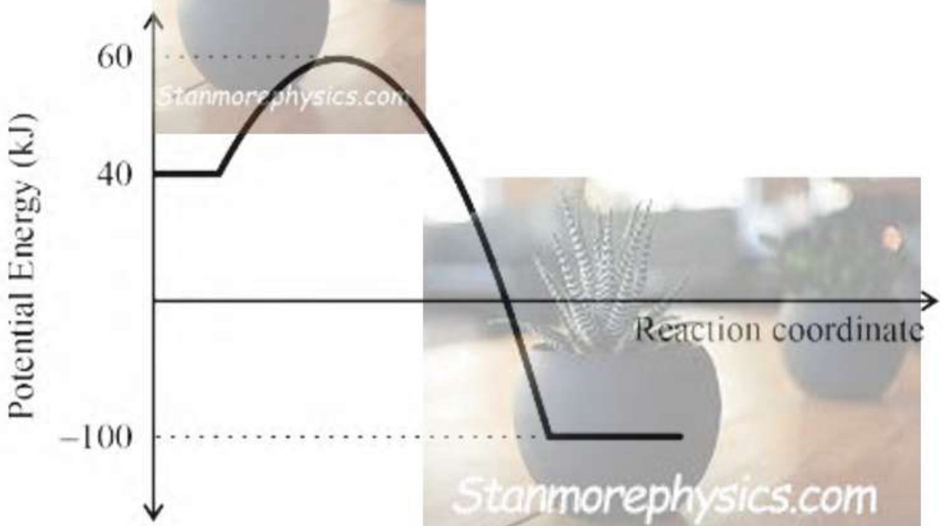
1.4 An alkane reacts with Br_2 in a laboratory. Which of the following shows the correct combination of the REACTION CONDITION, the TYPE OF REACTION and the MAIN PRODUCT of the reaction?

	REACTION CONDITIONS	TYPE OF REACTION	MAIN PRODUCT
A	Conc. NaOH	Elimination	Haloalkane
B	Sunlight	Substitution	Alcohol
C	Conc. H_2SO_4	Elimination	Alkene
D	UV light	Substitution	Haloalkane

(2)

1.5 What is the HEAT OF THE REACTION (ΔH) and ACTIVATION ENERGY for the reverse reaction?



	HEAT OF REACTION (ΔH IN KJ)	ACTIVATION ENERGY (KJ)
A	140	60
B	-140	20
C	-140	-140
D	140	160

(2)

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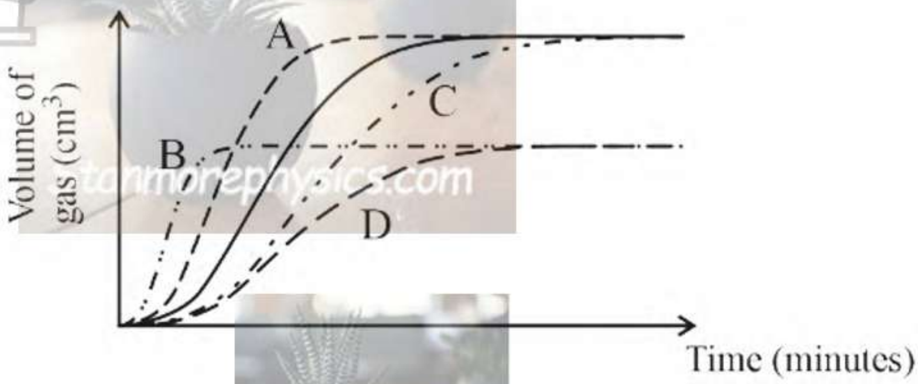
1.6 In an experiment, a 10 g lump of zinc and a 5 g lump of zinc are added to separate flasks containing the same volume of excess sulphuric acid. The solid line in the graph shows the volume of gas given off when the 10 g lump of zinc is used.

Which dotted line is obtained when 5 g lump of zinc is used?



A. Curve A

B. Curve B

C. Curve C

D. Curve D (2)

1.7 A solution of ethanoic acid (acetic acid) is titrated against a standard sodium hydroxide solution. Which of the following indicators would be the most suitable for this titration?

	INDICATOR	pH RANGE OF THE INDICATOR
A	Phenolphthalein	8,3 – 10
B	Methyl orange	3,1 – 4,4
C	Bromothymol blue	6,0 – 7,6
D	Universal indicator	Change colour over a wide range of pH values

(2)

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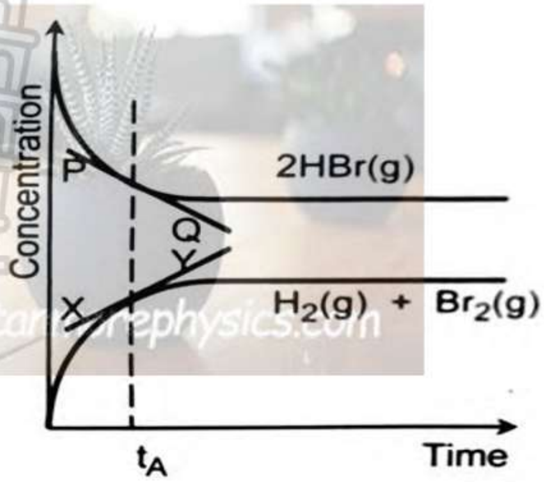
1.8 The graph below refers to the equation: **$2HBr (g) \rightleftharpoons H_2 (g) + Br_2 (g)$**
Which ONE of the following statements is INCORRECT at time t_A?



A. The slope of PQ represents the rate at which the concentration of 2HBr(g) decreases.

B. The slope of XY represents the rate at which the concentration of H_2 (g) and Br_2 (g) increase.

C The rate at which the concentration of 2HBr(g) decreases is not equal to the rate at which the concentration of H_2(g) and Br_2(g) increases.

D The slopes of PQ and XY are not affected by temperature changes. (2)

1.9 According to the Table of Standard Reduction Potentials, Sn is a stronger reducing agent than:

A. Ag

B. Zn

C. Ni

D. Mn (2)

1.10 During the electrolysis of concentrated sodium chloride solution:

A. Sodium hydroxide forms at the anode.

B. Hydrogen forms at the positive electrode.

C. Sodium forms at the cathode.

D. Chlorine gas forms at the positive electrode. (2)

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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			
F	C_4H_9OH		

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Use the information in the table (where applicable) to answer the questions that follow.

2.1 Write down the letter(s) representing:

2.1.1 An unsaturated hydrocarbon (1)

2.1.2 A compound that it used as a fuel (1)

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

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

2.2.2 Structural formula (3)

2.3 Compound **C** is a functional isomer of compound **E**.
Write down the IUPAC name of compound **C** (2)

2.4 Compound **D** is a tertiary alcohol whereas compound **F** is a secondary alcohol.
Write down the:

2.4.1 IUPAC name of compound **F** (2)

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

2.5 Write down the balanced equation using MOLECULAR FORMULAE for the complete combustion of compound **B**. (3)

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QUESTION 3 (Start on a NEW page)

The table below shows the boiling points of some organic compounds.

ORGANIC COMPOUND		BOILING POINT (°C)
A	Ethanol	79
B	Propan-1-ol	97
C	Butan-1-ol	117
D	Pentan-1-ol	138
E	Pentane	X
F	Pentanoic acid	Y

3.1 Define the term *boiling point* (2)

3.2 Refer to compounds **A** to **D**. When comparing their boiling points, write down:

3.2.1 The independent variable. (1)

3.2.2 One control variable. (1)

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3.3 Fully explain the increase in boiling point from compound **A** to **D** by referring to the TYPE, STRENGTH and ENERGY of the intermolecular forces. (3)

3.4 Refer to compounds **D** and **E**. Is it fair to compare their boiling point? Write down YES or NO. Explain the answer. (2)

3.5 Which compound, **D** or **E**, has a higher boiling point? Explain the answer by referring to the TYPE, STRENGTH and ENERGY of the intermolecular forces. (3)

3.6 Compound **B** reacts with another compound to form the product compound **Z**, the *functional isomer* of compound **F**. Which compound **F** or **Z** will have the higher vapour pressure. Give a reason for the answer. (2)

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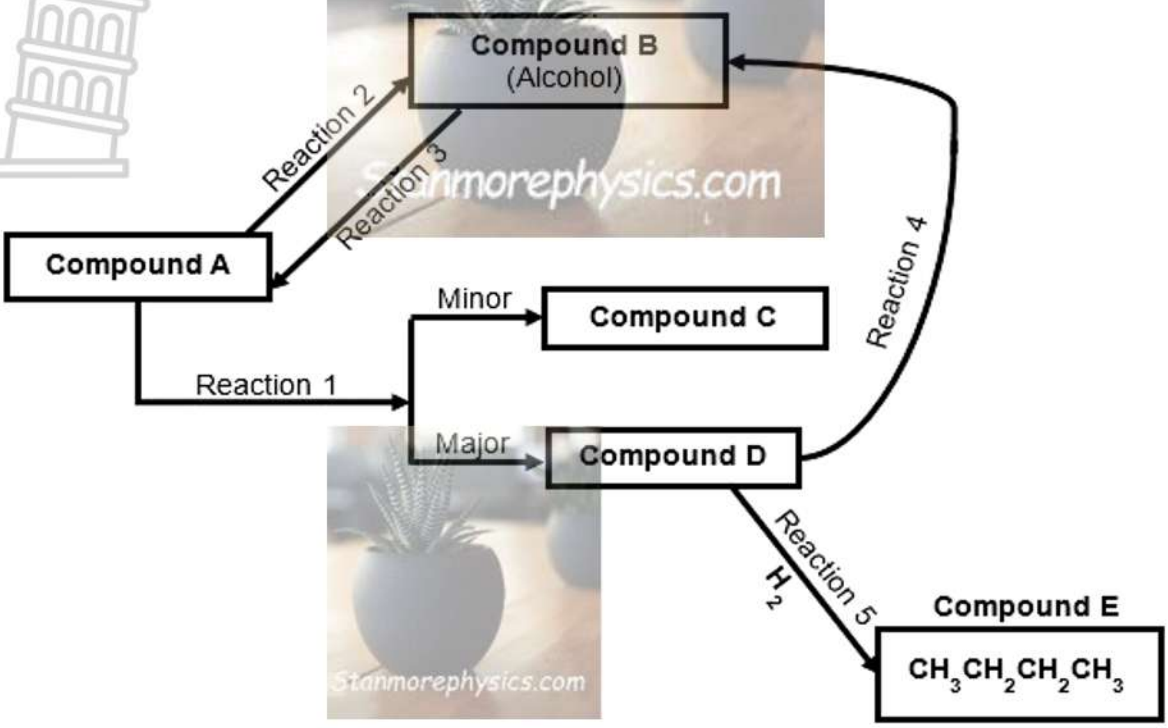
QUESTION 4 (Start on a NEW page)

In the flow diagram below, **a *secondary* bromoalkane**, compound **A,** is used as a starting reactant to form different organic compounds under different reaction conditions. Use the diagram below to answer the questions that follow.



It is given that Reaction **1** and Reaction **2** both use sodium hydroxide (NaOH) as a reagent.

4.1 Write down the structural formula of compound **A** (2)

4.2 In **Reaction 1** concentrated NaOH is used. Write down:

4.2.1 The type of reaction. (1)

4.2.2 The STRUCTURAL FORMULA of compound **C**. (2)

4.3 In **Reaction 2** dilute NaOH is used. Write down the balanced chemical equation using CONDENSED STRUCTURAL FORMULAE.
No reaction condition is required. (3)

4.4 State TWO reaction conditions for **Reaction 3**. (2)

4.5 Write down the TYPE of addition reaction represented by **Reaction 4**. (1)

4.6 Consider **Reaction 5**. Write down:

4.6.1 ONE reaction condition. (1)

4.6.2 The *general formula* of the homologous series to which the PRODUCT belongs. (1)

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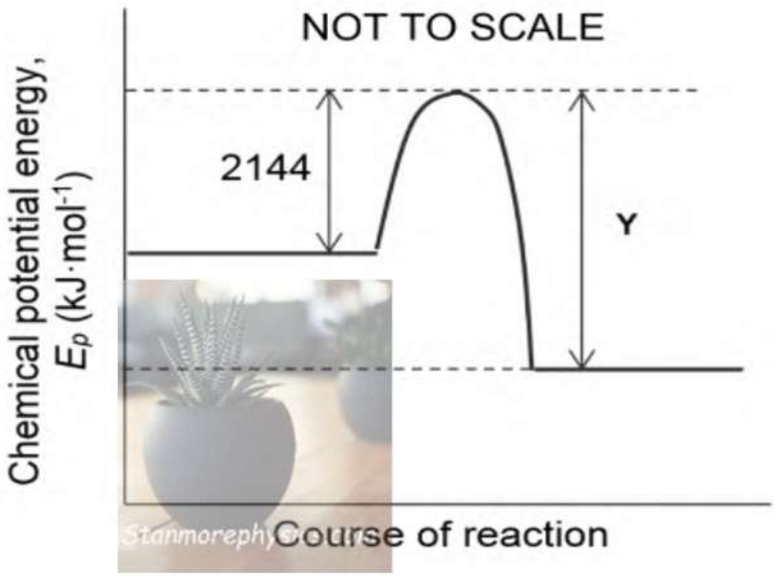
QUESTION 5 (Start on a NEW page)

5.1 The decomposition of hydrogen peroxide is given below:

$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$ ………… $\Delta H = -203\ kJ \cdot mol^{-1}$

The energy-profile graph for the decomposition of H_2O_2 is shown below:



5.1.1 Define the term *activated complex*. (2)

5.1.2 Calculate the energy released, **Y.** (2)

5.1.3 Manganese dioxide (MnO_2) can be used as a catalyst in the decomposition of hydrogen peroxide.
Redraw the above graph and on the same system of axes draw the curve that will be obtained for the catalysed reaction and label the catalysed activated complex as **C.** (2)

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5.2 Four experiments, **P**, **Q**, **R** and **S**, are carried out to investigate factors that affect the rate of decomposition of hydrogen peroxide, $H_2O_2(\ell)$.

Identical samples of hydrogen peroxide are used in each experiment.

The conditions used in each experiment are summarised in the table below.

EXPERIMENT	TEMPERATURE (^0C)	CONDITIONS
P	20	Without catalyst
Q	20	With MnO_2 catalyst
R	40	Without catalyst
S	40	With MnO_2 catalyst

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

5.2.2 Compare EXPERIMENTS **P** and **R**.

Which experiment **P** or **R**, will have the higher reaction rate?
Use the collision theory to explain the answer. (3)

5.3 The decomposition of hydrogen peroxide is given below:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g) \quad \ldots\ldots\ldots\ldots \quad \Delta H = -203\ kJ\cdot mol^{-1}$$

During EXPERIMENT **S**, the following results for the decomposition of hydrogen peroxide are obtained:

TIME (s)	H_2O_2 CONCENTRATION ($mol\cdot dm^{-3}$)
0	0,0100
100	0,008
200	**X**
300	0,0053
400	0,0043

5.3.1 The rate of reaction during the first 200 s is $1,73 \times 10^{-5}\ mol\cdot dm^{-3}\cdot s^{-1}$.

Calculate the concentration, **X**, of H_2O_2. (4)

5.3.2 Calculate the volume of oxygen produced within the first 300 s if 25 cm^3 of hydrogen peroxide decomposes in this time interval.

Take the molar gas volume as 25,7 $dm^3\cdot mol^{-1}$ (6)

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QUESTION 6 (Start on a NEW page)

The hypothetical reaction represented by the balanced equation below reaches *chemical equilibrium* in a closed container at temperature T °C.

$$Q_2(g) + RS_3(g) \rightleftharpoons 2QS(g) + RS(s)$$

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

6.2 Initially 0,6 moles of $Q_2(g)$, 0,6 moles of $RS_3(g)$, 0,4 moles of QS(g) and 0,4 moles of RS(s) were mixed and sealed in a 500 cm^3 flask.

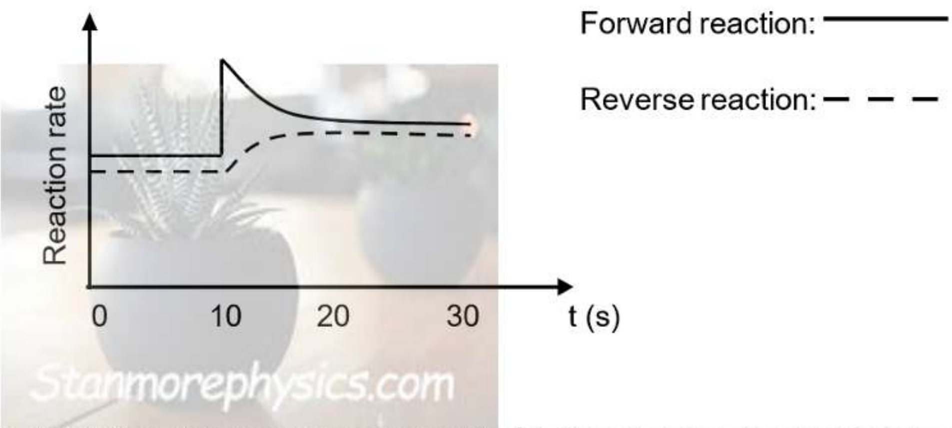
If the equilibrium constant (K_c) for this reaction at temperature T °C is 0,04, Calculate to THREE decimal places, the CHANGE IN THE NUMBER OF MOLES of Q_2. (7)

The temperature is now increased causing the amount of Q_2 in the container to decrease.

6.3 What is the sign of ΔH for the forward reaction?
Write down POSITIVE or NEGATIVE. Fully explain the answer. (3)

Further changes are made to the above equilibrium mixture.

The graph below shows how reaction rate changes with time.



6.4 Write down the disturbance responsible for the change observed at t = 10 s. (1)

6.5 Fully explain the change in reaction rate of both the forward and the reverse reactions from t = 10 s to t = 20 s. (3)

6.6 A suitable catalyst is now added to the reaction mixture at t = 30 s.
Redraw the above graph from 20 s to 30 s. On the same system of axes draw the change(s) in the graph, if any, from 30 s onwards. (2)

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

7.1 Consider the following acid-base reactions, **X** and **Y**.

X: $H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+$

Y: $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$

7.1.1 Define the term *acid* according to the Arrhenius theory. (2)

7.1.2 Write down the NAME or FORMULAE of the substance that acts as an ampholyte. (1)

7.1.3 Write down the FORMULAE of the conjugate acid in reaction **X**. (1)

7.1.4 Calculate the pH of a 0,3 mol·dm^{-3} sulphuric acid solution. (3)

7.2 A solution is made by dissolving Na_2CO_3(s) in water.

7.2.1 Will the solution of Na_2CO_3 have a pH EQUAL to 7, LESS THAN 7 or GREATER THAN 7? (1)

7.2.2 Write down a balanced chemical equation to explain the answer to QUESTION 7.2.1 (2)

7.3 An IMPURE sample of sodium carbonate (Na_2CO_3(s)) with a mass of 5 g is added to a 100 cm^3 volume of sulphuric acid of a pH of 0,2. After the reaction is complete, the EXCESS H_2SO_4 is titrated with 0,1 mol·dm^{-3} NaOH of volume 50 cm^3.

The following reactions take place during the above process:

Reaction 1: $H_2SO_4(aq) + Na_2CO_3(s) \rightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(\ell)$

Reaction 2: $H_2SO_4(aq) + 2NaOH(s) \rightarrow Na_2SO_4(aq) + H_2O(\ell)$

7.3.1 Calculate the initial concentration of the sulphuric acid solution. (3)

7.3.2 Calculate the percentage purity of the Na_2CO_3 sample (7)

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QUESTION 8 **(Start on a NEW page.)**

The following reaction takes place in a galvanic cell under standard conditions.

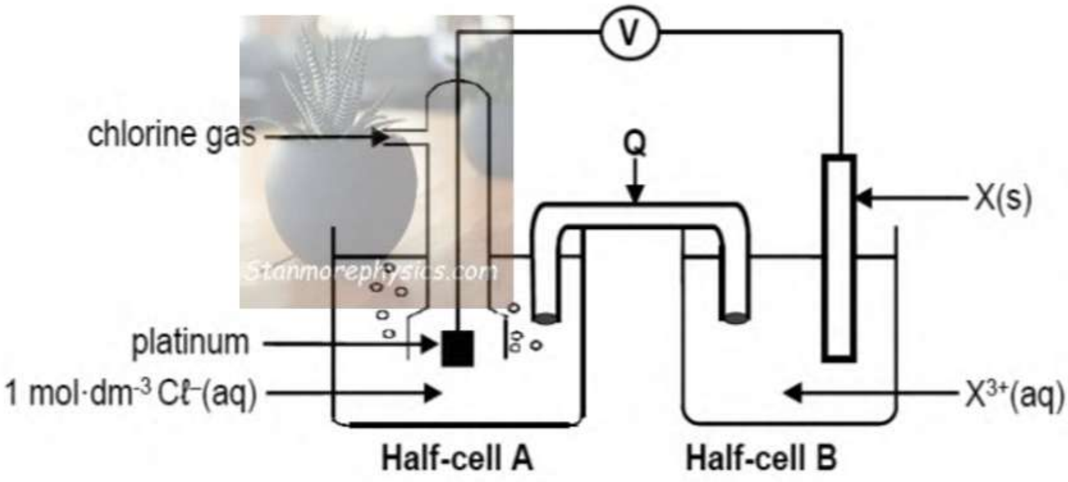
$$Mg(s) + X^{3+}(aq) \rightarrow Mg^{2+}(aq) + X(s)$$

8.1 Write down the energy conversion that takes place in this cell. (1)

8.2 Write down the half reaction taking place at the ANODE. (2)

8.3 Explain in terms of CHANGES IN OXIDATION NUMBERS, why $X^{3+}(aq)$ is the oxidising agent. (1)

The Mg half-cell is replaced with a chlorine half-cell as shown in the diagram below. The electrochemical cell below also functions under standard conditions.



8.4 Give a reason why platinum is used as the electrode in half-cell **A**. (1)

8.5 Besides concentration, state TWO other standard conditions for the above electrochemical cell. (2)

8.6 Write down the cell notation for the above electrochemical cell. (3)

8.7 The initial emf of this cell is 2,10 V. Using a suitable calculation, determine the NAME or FORMULA of metal **X**. (5)

8.8 What will be the effect on the cell potential when a small amount of silver nitrate solution, $AgNO_3$ (aq), is added to half-cell **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (HINT: Silver chloride is an insoluble salt.) (3)

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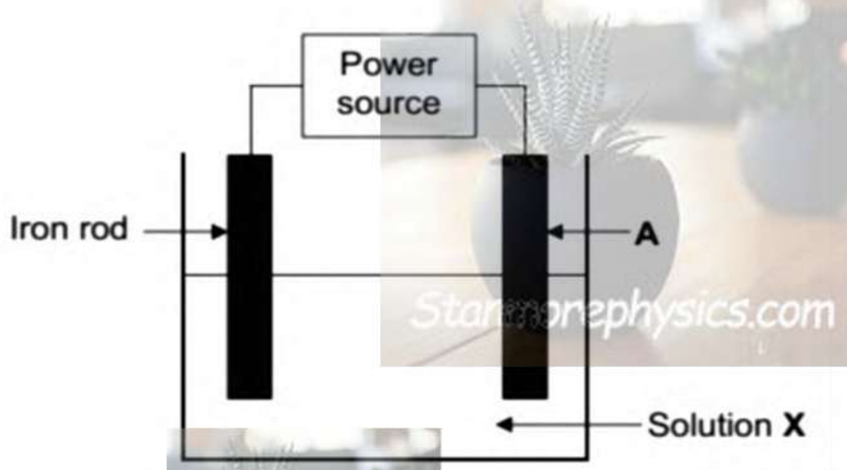
QUESTION 9 (Start on a NEW page.)

The diagram below shows an electrolytic cell that is used to electroplate an iron rod with **copper.** Solution **X** is made up of an UNKNOWN **nitrate.**



Solution X is an electrolyte.

9.1 Explain the term *electrolyte*. (2)

9.2 Write down the **FORMULA** of solution **X.** (1)

9.3 Which electrode (**A** or **iron rod**) is the cathode?
Give a reason for the answer. (2)

9.4 Write down the half reaction that takes place at electrode **A.** (2)

Electrode **A** is now replaced by a silver rod without making any other changes to the cell. After a while, TWO metallic ions are found to be present in the solution.

9.5 Name the TWO metallic ions present in the solution. (2)

9.6 Refer to the relative strength of oxidising agents to explain which ONE of the two ions will preferably be involved in the plating process. (2)

[11]

TOTAL 150 MARKS

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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 Molêregasvolume 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* $E^{\theta}_{cell} = E^{\theta}_{oxidising\,agent} - E^{\theta}_{reducing\,agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{q_e}$ where n is the number of electrons/ *waar n die aantal elektrone is*

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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

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TABLE 4A: STANDARD REDUCTION POTENTIALS

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
$\mathbf{2H^+ + 2e^-}$	⇌	$\mathbf{H_2(g)}$	**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*

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TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*

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Western Cape Government

Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P2) – MARKING GUIDELINE

SEPTEMBER 2025

MARKS: 150

TIME: 3 hours

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QUESTION 1

1.1	**D**	✓✓	(2)
1.2	B	✓✓	(2)
1.3	C	✓✓	(2)
1.4	D	✓✓	(2)
1.5	D	✓✓	(2)
1.6	**D**	✓✓	(2)
1.7	A	✓✓	(2)
1.8	**D**	✓✓	(2)
1.9	A	✓✓	(2)
1.10	D	✓✓	(2)
			[20]

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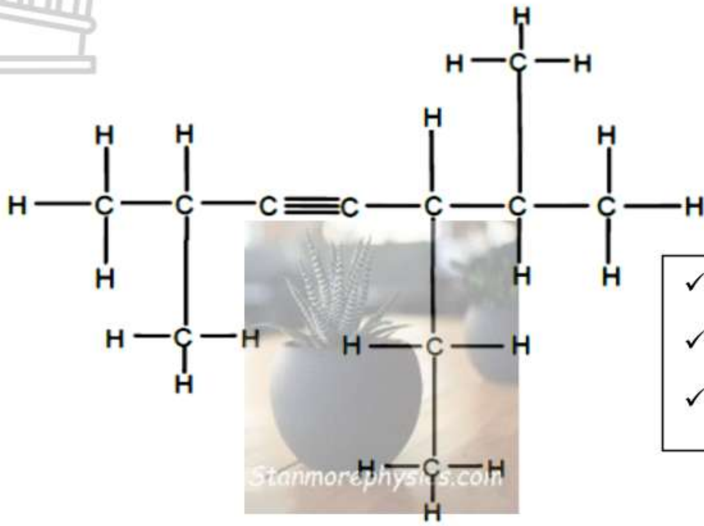
QUESTION 2

2.1.1 A ✓ (1)

2.1.2 B ✓ (1)

2.2.1 C_nH_{2n-2} ✓ (1)

2.2.2



✓ 7 C chain with all bonds and H
✓Alkyne functional group on carbon 3
✓ Dimethyl on carbon 2,6 and ethyl on 5

(3)

2.3 Pentanal

Pentan ✓ al ✓

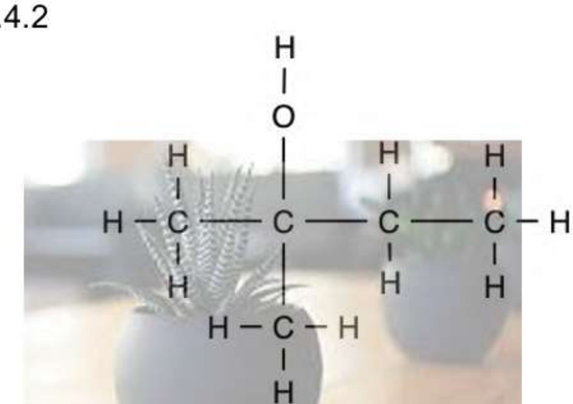
(2)

2.4.1 Butan-2-ol

Butan ✓ 2-ol ✓

ACCEPT: 2-butanol (2)

2.4.2



✓ 4 C chain with all bonds and H
✓ OH and methyl group on carbon 2

(2)

2.5 $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ ✓ Reactant, ✓ product, ✓ Balanced eq. (3)

Note: No balancing mark, if reactants and products are incorrect.

[15]

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QUESTION 3

3.1 The <u>temperature</u> at which the <u>vapour pressure</u> of a substance <u>equals atmospheric pressure</u>. ✓✓ (2)

3.2 3.2.1 Carbon chain length/Molecular mass/Number of carbon atoms/ number of London forces.(sites) ✓ (1)

3.2.2 Primary Alcohols/ Straight chains alcohol
ACCEPT: Functional group/ Homologous series/ type of IMF/ atmospheric pressure✓ (1)

3.3 FROM **A** to **D**

- Chain length increases / larger surface area / higher molecular mass. ✓
- The number of London forces increases
  OR
  Increasing strength of the Intermolecular forces. ✓
- More energy needed to <u>overcome</u> the increase in intermolecular forces. ✓
  (If learners write, "break bonds", only penalise once.)

∴ Boling point increases (3)

3.4 NO ✓ Two independent variables
ACCEPT: molar mass/type of IMF/ different functional groups). ✓ (2)

3.5 **OPTION 1**

- Compound D / Pentan-1-ol has hydrogen bonding (and London forces) between its molecules, whereas Compound E / Pentane has London forces between its molecules. ✓
- Hydrogen bonding forces are stronger than London forces OR Intermolecular forces in Compound D / Pentan-1-ol are stronger than the intermolecular forces in Compound E / Pentane. ✓
- More energy is needed to overcome the intermolecular forces in Compound D / Pentan-1-ol than in Compound E / Pentane..

∴ Boiling point of Compound D / Pentan-1-ol is higher than compound E /Pentane. ✓

OPTION 2

- Compound E / Pentane has London forces between its molecules whereas Compound D / Pentan-1-ol has hydrogen bonding (and London forces) between its molecules. ✓
- London forces are weaker than hydrogen bonding OR Intermolecular forces in Compound E / Pentane are weaker than the intermolecular forces in Compound D / Pentan-1-ol. ✓
- Less energy is needed to overcome the intermolecular forces in Compound E / Pentane than in Compound D / Pentan-1-ol.

∴ Boiling point of Compound D / Pentan-1-ol is higher than Compound E / Pentane ✓ (3)

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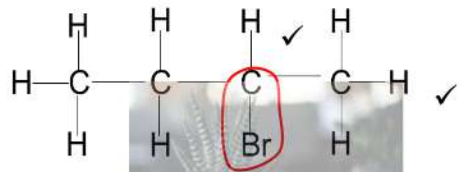
3.6 Compound Z (Ester) ✓
Compound Z has the weakest intermolecular forces (dipole-dipole) of the two. ✓
(while compound F has stronger hydrogen bonds between the molecule.
Or
Compound F has the stronger intermolecular forces (Hydrogen bonding) of the two. (while ✓ (2)

[14]

QUESTION 4

4.1

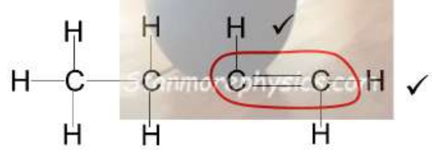


✓ 4-C chain with all H
✓ Br on second C

(2)

4.2 4.2.1 Elimination / dehydrohalogenation / dehydrobromination ✓ (1)

4.2.2



✓ 4-C chain with all H
✓ double bond on first C

(2)

4.3 <u>$CH_3CH_2CHBrCH_3$ + NaOH</u> ✓ $\longrightarrow$ $CH_3CH_2CHOHCH_3$✓ + NaBr✓ (3)

[If molecular formula used → 1 mark for NaBr]

4.4

- Add HBr or NaBr or KBr ✓
- Absence of water or heat ✓ (2)

4.5 Hydration ✓ (1)

4.6.1 Heat or Catalyst <u>Ni/Pd/Pt</u> ✓ (1)

4.6.2 C_nH_{2n+2} ✓ (1)

[13]

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QUESTION 5

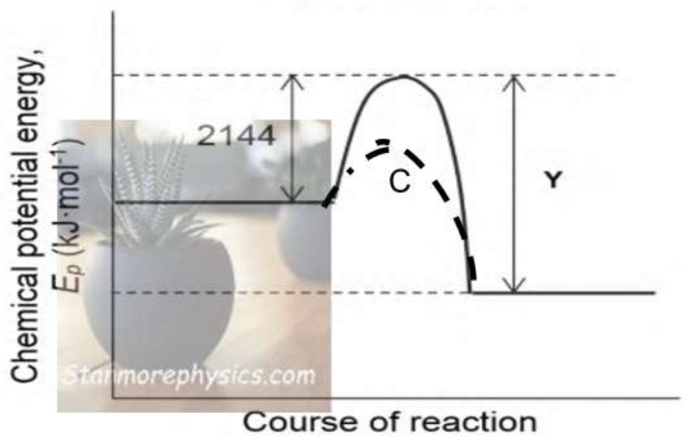
5.1.1 The unstable transition state✓ from <u>reactants to products</u> ✓ (2)

5.1.2 $\Delta H = E_{absorbed} - E_{released}$

$-203 = 2\ 144 - Y$

$Y = 2\ 347$ (kJ·mol^{-1}) ✓✓ (2)

5.1.3



✓ correct energy of reactants and product AND lower activated complex
✓ label C (2)

5.2.1 The change in concentration of reactants or products per unit time✓✓.[2 or 0] (2)

5.2.2 **R** ✓

- R is at a higher temperature and therefore there are <u>more particles with sufficient kinetic energy</u> or Ek > Ea. ✓
- More collisions per unit time.
- <u>More effective collisions per unit time</u>. ✓
- Higher/greater/faster rate of reaction.

NB. If **P** selected and the following explanation given [maz 2 marks]:

- Fewer particles with sufficient kinetic energy above E_a ✓
- Fewer effective collisions per unit time ✓ (3)

5.3.1 Rate = $-\frac{\Delta C}{\Delta t}$ ✓

$1{,}73\times 10^{-5}$✓ $= -\frac{(C-0.01)}{(200-0)}$✓

$C = 6{,}54 \times 10^{-3}$ ✓ (mol·dm^{-3}) → unit not necessary

Or C = 0,00654 ≈ 0,007 accept (4)

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5.3.2 (a) $n(H_2O_2) = cV$

$= (0{,}01 - 0{,}0053)$ ✓ $\left(\frac{25}{1000}\right)$ ✓

$= 1{,}175 \times 10^{-4}$ moles

(b) $n(H_2O_2) : n(O_2)$

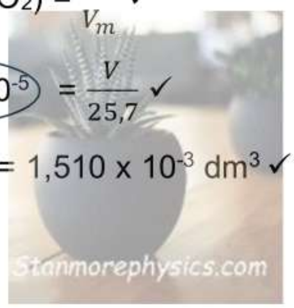
2 : 1 ✓ ratio

$1{,}175 \times 10^{-4} : 5{,}875 \times 10^{-5}$

(c) $n(O_2) = \frac{V}{V_m}$ ✓

$5{,}875 \times 10^{-5} = \frac{V}{25{,}7}$ ✓

$V = 1{,}510 \times 10^{-3}$ dm^3 ✓ 0,00151 dm^3 (6)



[23]

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QUESTION 6

6.1 It is that stage of a chemical reaction when the rate of the forward reaction equals the rate of the reverse reaction ✓✓ [2 or 0] (2)

6.2 **Marking criteria**

- Assume QS (2x) reacts and Q_2 (x) and RS_3 (x) produced.
- Equilibrium moles
- Equilibrium concentration
- Kc equation
- Substitution of Kc
- Substitution of conc of reactants and products
- Answer for x (= 0,127 moles).

OPTION 1

Reaction	Q_2	RS_3	2QS	RS(s)	
Initial moles	0,6	0,6	0,4	0,4	
Change in moles	+ x	+ x	- 2x		✓
Equilibrium mol	0,6 + x	0,6 + x	0,4 – 2x		✓
Equilibrium [ ] mol·dm³	$\frac{0,6+x}{0,5}$	$\frac{0,6+x}{0,5}$	$\frac{0,4-2x}{0,5}$		✓ ← Divide by 0,5 dm³✓

$$Kc = \frac{[QS]^2}{[Q_2][RS_3]} ✓$$

$$0,04 ✓ = \frac{\left(\frac{0,4-2x}{0,5}\right)^2}{\left(\frac{0,6+x}{0,5}\right)\left(\frac{0,6+x}{0,5}\right)} ✓$$

$$0,2 = \frac{0,4-2x}{0,6+x}$$

x = 0,127 moles = change in moles of Q_2 ✓ (7)

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ACCEPT **[max 5 marks**

if correct conclusion made → then 6 marks]

Reaction	Q_2	RS_3	2QS	RS(s)	
Initial moles	0,6	0,6	0,4	0,4	
Change in moles	- x	- x	+ 2x		**No mark**
Equilibrium mol	0,6 - x	0,6 - x	0,4 + 2x		✓
Equilibrium [ ] mol·dm³	$\frac{0,6-x}{0,5}$	$\frac{0,6-x}{0,5}$	$\frac{0,4+2x}{0,5}$		✓ ← Divide by 0,5 dm³✓

$$Kc = \frac{[QS]^2}{[Q_2][RS_3]} \checkmark$$

$$0,04 \checkmark = \frac{\left(\frac{0,4+2x}{0,5}\right)^2}{\left(\frac{0,6-x}{0,5}\right)\left(\frac{0,6-x}{0,5}\right)} \checkmark$$

$$0,2 = \frac{0,4+2x}{0,6-x}$$

x = - 0,127 moles

∴ change in moles of Q_2 = <u>- (-0,127) = 0,127 mole</u> ✓

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OPTION Concentration route

Reaction	Q_2	RS_3	2QS	RS	
Initial moles mol	0,6	0,6	0,4	0,4	
Initial conc	1,2	1,2	0,8		✓
Change in conc	+x	+x	- 2x		✓
Equilibrium mol·dm^3	1,2+x	1,2+x	0,8-2x		✓

Divide by 0,5 dm^3✓

$$Kc = \frac{[QS]^2}{[Q_2][RS_3]} \checkmark$$

$$0{,}04 \checkmark = \frac{(0{,}8-2x)^2}{(1{,}2+x)(1{,}2+x)} \checkmark$$

$$0{,}2 = \frac{0{,}8-2x}{1{,}2+x}$$

$$0{,}2(1{,}2+x) = 0{,}8-2x$$

$$0{,}24 + 0{,}2x = 0{,}8 - 2x$$

$$2{,}2x = 0{,}8 - 0{,}24$$

$$X = 0{,}25455 \text{ mol·dm}^{-3}$$

∴ change in moles of Q = cV

= (0,25455)(0,5)

= 0,127 moles ✓ (7)

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6.3 POSITIVE ✓

Mark Explanation independently

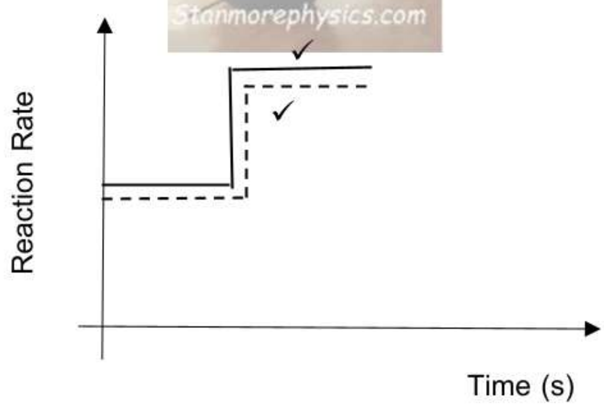
- An increase in temperature favours an endothermic reaction, ✓ the reactants are being decreased indicating the forward reaction is favoured
- Therefore the forward reaction is endothermic. ✓ (3)

6.4 Concentration of Reactants increases / Q_2 and/or RS_3 added ✓ (1)

6.5

- Increase in concentration of reactants results in an increase in the rate of the forward reaction. ✓
- As reactants are used, the rate of forward reaction decreases. ✓
- As products are formed, the rate of the reverse reaction increases. ✓
- Equilibrium is obtained after 20 s when the rates of the forward and reverse reactions are equal. (3)

6.6



Criteria
✓ both vertical line
✓ both horizontal lines

(2)

[18]

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QUESTION 7

7.1.1 An acid is a substance when ionized in water produces (H^+) /(H_3O^+) hydronium ions OR
Acids produces hydrogen ions (H^+) /(H_3O^+) hydronium ions ✓ in an aqueous solution. ✓✓ [2 or 0] (2)

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

7.1.3 H_3O^+ ✓ (1)

7.1.4

$$\boxed{\begin{aligned} pH &= -\log[H_3O^+] \checkmark \\ &= -\log(0{,}6) \checkmark \\ &= 0{,}22 \checkmark \end{aligned}}$$

(3)

7.2.1 pH > 7 ✓ (1)

7.2.2 OPT 1: $CO_3^{2-}(aq) + H_2O(\ell)$ ✓ $\rightarrow HCO_3^-(aq) + OH^-(aq)$ ✓
OR
OPT 2: $CO_3^{2-}(aq) + 2H_2O(\ell)$ ✓ $\rightarrow H_2CO_3(aq) + 2OH^-(aq)$ ✓
(OH^- was formed $\therefore$ pH > 7)

ACCEPT: $Na_2CO_3 + 2H_2O$ ✓ $\rightarrow 2NaOH + H_2CO_3$ ✓ [(2)

7.3.1 <u>**Initial mol of H_2SO_4**</u>

(a) $pH = -\log[H_3O^+]$ ✓

$0{,}2$ ✓ $= -\log[H_3O^+]$

$[H_3O^+] = 0{,}63096\ mol.dm^{-3}$

(b) $[H_3O^+] : [H_2SO_4]$

2 : 1

$0{,}63096 : 0{,}31548\ mol.dm^{-3}\ [H_2SO_4]$ [ACCEPT: $0{,}32\ mol{\cdot}dm^{-3}$] ✓ (3)

7.3.2 **POSITIVE MARKING FROM 7.3.1**

Marking criteria

- $n_{initial} = C.V$ formula ✓
- Substitution into formula ✓
- Initial mol of NaOH substitution ✓
- Mol of H_2SO_4 reacted with Na_2CO_3 subtraction ✓
- $m = n.M$ formula ✓
- Substitution into formula ✓
- Percentage purity answer ✓

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(a) $n_{initial} = C.V$ ✓

= (0,31548)(0,1) ✓

= 0,031548 mol

Initial mol of NaOH

(b) $n_{initial} = C.V$

= (0,1)(0,05) ✓

= 0,005 mol

Mol of H_2SO_4 reacted with NaOH

(c) n(NaOH) : n(H_2SO_4)

1 : 2

0,005 : 0,0025 mol of H_2SO_4

Mol of H_2SO_4 reacted with Na_2CO_3

(d) $n_{initial} - n_{reacted(NaOH)}$

0,031548 - 0,0025 ✓

= 0,029048 mol

Mass of pure Na_2CO_3

(e) n(H_2SO_4) : n(Na_2CO_3)

1 : 1

0,029048 : 0,029048 mol of Na_2CO_3

(f) n(Na_2CO_3) = $\frac{m}{M}$ ✓

0,029048 = $\frac{m}{106}$ ✓

m = 3,079 g

Percentage purity of Na_2CO_3

(g) Percentage purity = $\frac{3,079}{5} \times \frac{100}{1}$

= 61,58 % ✓ [Range: 61,48% – 61,59%] (7)

[20]

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QUESTION 8

8.1 Chemical energy to electrical energy ✓ (1)

8.2 $Mg (s) \rightarrow Mg^{2+} (aq) + 2e^-$ ✓✓ (2)
Double arrow = 1 mark

Accept: $Mg^{2+} (aq) + 2e^- \leftarrow Mg (s)$ ✓✓
Double arrow = no marks

8.3 X^{3+} is the oxidising agent because it gains electrons and its <u>oxidation number decreases from +3 to 0</u>. ✓ (1)

8.4
- Pt is inert or Unreactive. OR
- Very good conductor of electricity ANY ONE ✓ (1)

8.5
- Temperature: <u>25 ºC or 298K</u> ✓
- Pressure: <u>1atm or 101,3 kPa</u> ✓

[Must give values for temperature and pressure] (2)

8.6

<u>Marking Criteria</u>
• anode (reducing agent I oxidised species) ✓
• salt bridge ǀǀ ✓
• cathode (oxidising agent I reduced species) ✓

$$X(s) \,|\, \overset{\checkmark}{X^{3+}(aq)} \;||\; \overset{\checkmark}{C\ell_2(g)} \,|\, \overset{\checkmark}{C\ell^-(aq)} \,|\, Pt(s)$$
$\qquad (1\ mol.dm^{-3}) \qquad\qquad (1\ mol.dm^{-3})$

[NOTE: NO deductions if 1 $mol.dm^{-3}$ or state of matter omitted] (3)

8.7 $E^{\ominus}_{cell} = E^{\ominus}_{reduction} - E^{\ominus}_{oxidation}$ ✓
2,10 ✓ = + 1,36 - (X) ✓
X = - 0,74 (V) ✓

X is Cr / Chromium ✓ (5)

8.8 Increases ✓

Nett Cell Reaction: $2Cr + 3C\ell_2 \rightarrow 2Cr^{3+} + 3C\ell^-$
Adding $AgNO_3$ will precipitate $AgC\ell$ ✓ leading to a decrease in chloride ion ($C\ell^-$) concentration. ✓ Therefore forward reaction is favoured. (3)

[18]

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QUESTION 9

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

9.2 $Cu(NO_3)_2$ / $CuNO_3$✓ (1)

9.3 Iron rod ✓
Mark reason below independently
Reduction takes place (on the iron rod) OR
Cu^{2+} (or Cu^+) ions gain electrons to form Cu ✓ (2)

9.4 $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ ✓✓

ACCEPT: $Cu(s) \rightarrow Cu^+(aq) + e^-$ ✓✓ (2)

9.5 Copper ions ✓/copper(II) ions / copper(I) ions [ACCEPT: Cu^{2+} /Cu^+]
Silver ions ✓ [ACCEPT: Ag^+] (2)

9.6 **Mark independently from 9.5**
Since Ag is connected to the anode it will undergo oxidation to produce Ag^+ ions.
In the solution there will now be Ag^+ ions and Cu^{2+} ions.
Ag^+/silver (I) ions is a stronger oxidising agent ✓ than Cu^{2+}/copper (II) ions ✓
and will be reduced more readily to form silver/Ag on the iron rod.
OR
Cu^{2+}/copper (II) ions is a weaker oxidising agent ✓ than Ag^+/silver ions ✓
and will not be reduced readily to form copper/Cu on the iron rod.

ACCEPT: $Ag^+ + e^- \rightarrow Ag$ (one mark) (2)

[11]

TOTAL 150 MARKS