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METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P2) – MARKING GUIDELINE
SEPTEMBER 2025

MARKS: 150

TIME: 3 hours



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]



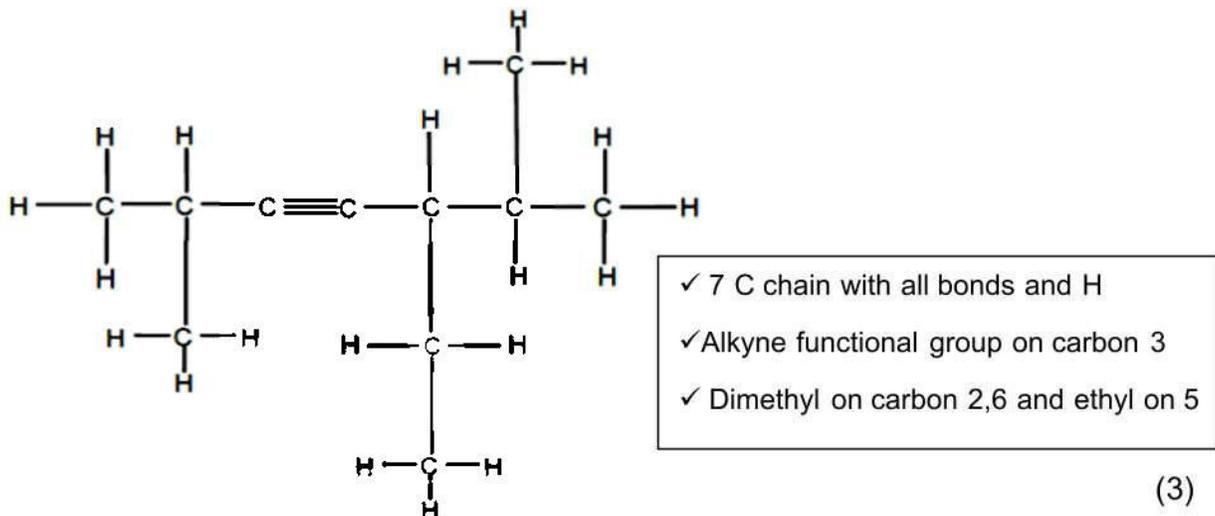
QUESTION 2

2.1.1 A ✓ (1)

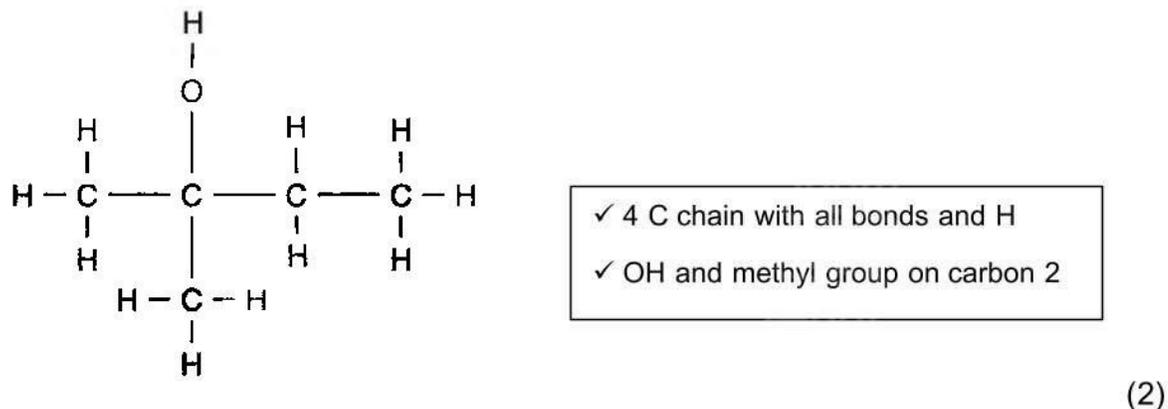
2.1.2 B ✓ (1)

2.2.1 C_nH_{2n-2} ✓ (1)

2.2.2

2.3 Pentanal Pentan ✓ al ✓ (2)2.4.1 Butan-2-ol Butan ✓ 2-ol ✓ ACCEPT: 2-butanol (2)

2.4.2

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]

QUESTION 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓ (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 overcome the increase in intermolecular forces. ✓
(If learners write, "break bonds", only penalise once.)

∴ Boiling 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)



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.

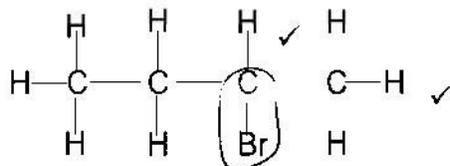
Or

Compound F has the stronger intermolecular forces (Hydrogen bonding) of the two. (while ✓

(2)
[14]

QUESTION 4

4.1



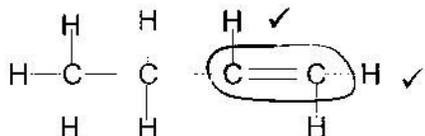
✓ 4-C chain with all H
✓ Br on second C

(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 $\text{CH}_3\text{CH}_2\text{CHBrCH}_3 + \text{NaOH} \checkmark \longrightarrow \text{CH}_3\text{CH}_2\text{CHOHCH}_3 \checkmark + \text{NaBr} \checkmark$ (3)

[If molecular formula used \rightarrow 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 Ni/Pd/Pt ✓

(1)

4.6.2 $\text{C}_n\text{H}_{2n+2}$ ✓

(1)

[13]

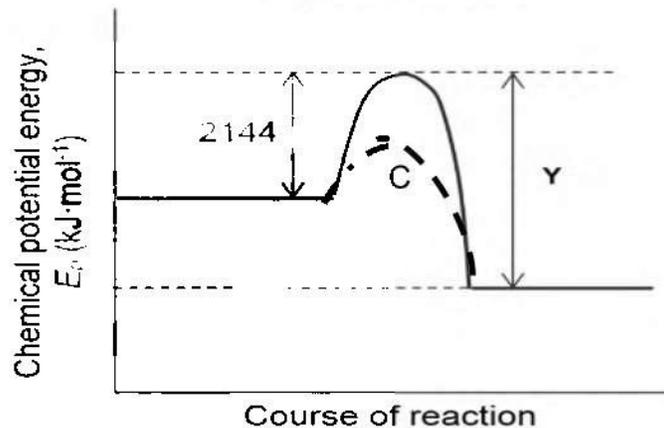


QUESTION 5

5.1.1 The unstable transition state ✓ from reactants to products ✓ (2)

5.1.2 $\Delta H = E_{\text{absorbed}} - E_{\text{released}}$
 $-203 = 2144 - Y$
 $Y = 2347 \text{ (kJ}\cdot\text{mol}^{-1})$ ✓✓ (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 more particles with sufficient kinetic energy or $E_k > E_a$. ✓
- More collisions per unit time.
- More effective collisions per unit time. ✓
- 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 $\text{Rate} = - \frac{\Delta C}{\Delta t}$ ✓

$$1,73 \times 10^{-5} \checkmark = - \frac{(C-0,01)}{(200-0)} \checkmark$$

$$C = 6,54 \times 10^{-3} \checkmark \text{ (mol}\cdot\text{dm}^{-3}) \rightarrow \text{unit not necessary}$$

Or $C = 0,00654 \approx 0,007$ accept (4)



5.3.2 (a) $n(\text{H}_2\text{O}_2) = cV$

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

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

(b) $n(\text{H}_2\text{O}_2) : n(\text{O}_2)$

$$2 : 1 \quad \checkmark \text{ ratio}$$

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

(c) $n(\text{O}_2) = \frac{V}{V_m} \checkmark$

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

$$V = 1,510 \times 10^{-3} \text{ dm}^3 \checkmark \quad 0,00151 \text{ dm}^3$$

(6)

[23]

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 Q₂ (x) and RS₃ (x) produced.
- Equilibrium moles
- Equilibrium concentration
- K_c equation
- Substitution of K_c
- 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·dm ³	$\frac{0,6 + x}{0,5}$	$\frac{0,6 + x}{0,5}$	$\frac{0,4 - 2x}{0,5}$	

✓

✓

✓

Divide by
0,5 dm³ ✓

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

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

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

$$x = 0,127 \text{ moles} = \text{change in moles of } Q_2 \quad \checkmark$$

(7)



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	
Equilibrium mol	0,6 - x	0,6 - x	0,4 + 2x	
Equilibrium [] mol·dm ³	$\frac{0,6 - x}{0,5}$	$\frac{0,6 - x}{0,5}$	$\frac{0,4 + 2x}{0,5}$	

No mark

✓

✓

Divide by
0,5 dm³ ✓

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

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

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

$$x = -0,127 \text{ moles}$$

$$\therefore \text{change in moles of } Q_2 = -(-0,127) = 0,127 \text{ mole} \quad \checkmark$$



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 dm³ ✓

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

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

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

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

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

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

$$x = 0,25455 \text{ mol·dm}^{-3}$$

∴ change in moles of Q = cV

$$= (0,25455)(0,5)$$

$$= 0,127 \text{ moles} \quad \checkmark$$

(7)



6.3 POSITIVE ✓

Mark Explanation independently

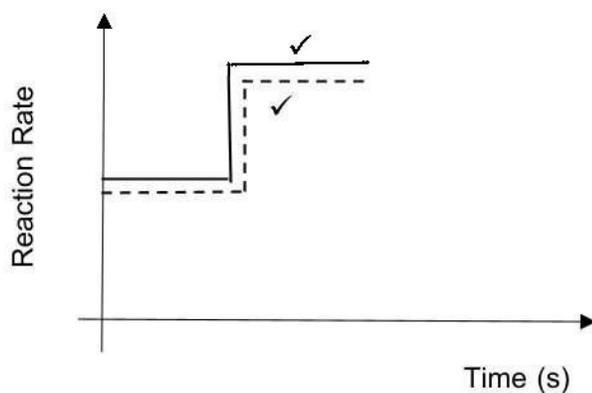
- An increase in temperature favours an endothermic reaction, ✓ the reactants are being decreased indicating the forward reaction is favoured
- Therefore the forward reaction is endothermic. ✓ (3)

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]

QUESTION 7

7.1.1 An acid is a substance when ionized in water produces (H⁺) / (H₃O⁺) hydronium ions OR

Acids produces hydrogen ions (H⁺) / (H₃O⁺) hydronium ions ✓ in an aqueous solution. ✓✓ [2 or 0] (2)

7.1.2 HSO₄⁻ / hydrogen sulphate ion ✓ (1)

7.1.3 H₃O⁺ ✓ (1)

7.1.4

$$\begin{aligned} \text{pH} &= -\log [\text{H}_3\text{O}^+] \quad \checkmark \\ &= -\log (0,6) \quad \checkmark \\ &= 0,22 \quad \checkmark \end{aligned}$$

(3)

7.2.1 pH > 7 ✓ (1)

7.2.2 OPT 1: CO₃²⁻ (aq) + H₂O (ℓ) ✓ → HCO₃⁻ (aq) + OH⁻ (aq) ✓

OR

OPT 2: CO₃²⁻ (aq) + 2H₂O (ℓ) ✓ → H₂CO₃ (aq) + 2OH⁻ (aq) ✓
(OH⁻ was formed ∴ pH > 7)

ACCEPT: Na₂CO₃ + 2H₂O ✓ → 2NaOH + H₂CO₃ ✓ [(2)

7.3.1 Initial mol of H₂SO₄

(a) pH = -log [H₃O⁺] ✓

$$0,2 \checkmark = -\log [\text{H}_3\text{O}^+]$$

$$[\text{H}_3\text{O}^+] = 0,63096 \text{ mol}\cdot\text{dm}^{-3}$$

(b) [H₃O⁺] : [H₂SO₄]

2 : 1

$$0,63096 : 0,31548 \text{ mol}\cdot\text{dm}^{-3} [\text{H}_2\text{SO}_4] \quad [\text{ACCEPT: } 0,32 \text{ mol}\cdot\text{dm}^{-3}] \checkmark \quad (3)$$

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 H₂SO₄ reacted with Na₂CO₃ subtraction ✓
- m = n.M formula ✓
- Substitution into formula ✓
- Percentage purity answer ✓

$$\begin{aligned}
 \text{(a)} \quad n_{\text{initial}} &= C \cdot V \quad \checkmark \\
 &= (0,31548)(0,1) \quad \checkmark \\
 &= 0,031548 \text{ mol}
 \end{aligned}$$

Initial mol of NaOH

$$\begin{aligned}
 \text{(b)} \quad n_{\text{initial}} &= C \cdot V \\
 &= (0,1)(0,05) \quad \checkmark \\
 &= 0,005 \text{ mol}
 \end{aligned}$$

Mol of H₂SO₄ reacted with NaOH

$$\begin{aligned}
 \text{(c)} \quad n(\text{NaOH}) : n(\text{H}_2\text{SO}_4) \\
 1 : 2 \\
 0,005 : 0,0025 \text{ mol of H}_2\text{SO}_4
 \end{aligned}$$

Mol of H₂SO₄ reacted with Na₂CO₃

$$\begin{aligned}
 \text{(d)} \quad n_{\text{initial}} - n_{\text{reacted}}(\text{NaOH}) \\
 0,031548 - 0,0025 \quad \checkmark \\
 = 0,029048 \text{ mol}
 \end{aligned}$$

Mass of pure Na₂CO₃

$$\begin{aligned}
 \text{(e)} \quad n(\text{H}_2\text{SO}_4) : n(\text{Na}_2\text{CO}_3) \\
 1 : 1 \\
 0,029048 : 0,029048 \text{ mol of Na}_2\text{CO}_3
 \end{aligned}$$

$$\begin{aligned}
 \text{(f)} \quad n(\text{Na}_2\text{CO}_3) &= \frac{m}{M} \quad \checkmark \\
 0,029048 &= \frac{m}{106} \quad \checkmark \\
 m &= 3,079 \text{ g}
 \end{aligned}$$

Percentage purity of Na₂CO₃

$$\begin{aligned}
 \text{(g)} \quad \text{Percentage purity} &= \frac{3,079}{5} \times \frac{100}{1} \\
 &= 61,58 \% \quad \checkmark
 \end{aligned}$$

[Range: 61,48% – 61,59%]

(7)

[20]

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 $\text{Cu}(\text{NO}_3)_2 / \text{CuNO}_3$ ✓ (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 $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$ ✓✓

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

9.5 Copper ions ✓ / copper(II) ions / copper(I) ions [ACCEPT: $\text{Cu}^{2+} / \text{Cu}^+$]
 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: $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ (one mark) (2)

[11]

TOTAL 150 MARKS

