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REPUBLIC OF

**PHYSICAL SCIENCES P2  
(CHEMISTRY)**

**DEEDADATODV**

**NATIONAL**

**MARKS : 150**

**TIME : 3 hours**

This memorandum consists of 10 pages.

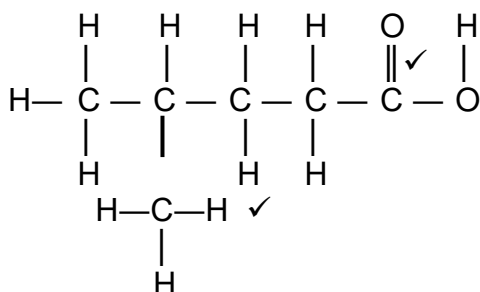
The marking guidelines as per 2014 Examination Guidelines, pages 34-37 must be applied when marking this Paper.

**QUESTION 1**

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

**QUESTION 2**

- 2.1. H ✓✓ (2)
- 2.2 A ✓ (1)
- 2.3 B ✓✓ (2)
- 2.2.1 chloroethene accept 1-chloroethene ✓✓ (2)
- 2.2.2 2-methylpentan-2-ol accept 2-methyl- 2-pentanol ✓✓ (2)
- 2.3



Functional group correct ✓

rest of structure correct ✓

(2)  
**[10]**

**QUESTION 3**

- 3.1.1 Boiling does not involve breaking the chemical (intra molecular) bonds between atoms. ✓  
OR Boiling involves breaking the intermolecular forces between molecules. ✓ (1)

- 3.1.2 Pentane has a longer chain of carbons than methane, therefore a greater surface area ✓. Hence more sites for London force attraction ✓ and stronger intermolecular forces. More energy is needed to break the stronger intermolecular forces. ✓ (3)

3.1.3

|                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>OPTION 1:</b><br/>2-methylbutane ✓ (or methylbutane)</p> <pre>       H   H   H   H                     H - C - C - C - C - H   ✓✓                           H       H   H        H - C - H                   H           </pre> | <p><b>OPTION 2:</b><br/>2,2-dimethylpropane ✓ (or dimethylpropane)</p> <pre>           H                     H - C - H                     H       H                         H - C - C - C - H   ✓✓                           H       H          H - C - H                       H           </pre> <p>(3)</p> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- 3.2 The pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓ (2)

- 3.3.1 D ✓✓ (2)

- 3.3.2 A ✓✓ (2)

- 3.4 The carboxylic acid has the strongest intermolecular forces, ✓ because there are two sites for hydrogen bonding in each carboxylic acid molecule. ✓ The stronger the intermolecular forces the lower the vapour pressure (at a given temperature). ✓ The graph indicates that D has the lowest vapour pressure. (3)

**[16]**

**QUESTION 4**

4.1.1 methyl ethanoate ✓

(2)

4.1.2

$$M(C_3H_6O_2) = 74$$

$$n = \frac{m}{M} \quad \checkmark$$

$$= \frac{68,88}{74} \quad \checkmark$$

$$= 0,93 \text{ mol}$$

$$M(CH_4O) = 32$$

1 : 1 (alcohol : acid)

$$m = 0,93 \times 32 \quad \checkmark$$

$$= 29,78 \text{ g}$$

$$\% \text{ purity} : \frac{29,78}{50} \times 100 = 59,57 \% \quad \checkmark$$

(5)

4.2.1 A - hydration (or addition) ✓

C - substitution ✓

D - dehydration (or elimination) ✓

E - combustion ✓

(4)

4.2.2 (i) Dissolve  $C_2H_5Cl$  in ethanol. ✓

(ii) Add concentrated NaOH solution. ✓

(iii) Heat the mixture. ✓

(3)

4.2.3  $H_2SO_4$  OR sulphuric acid ✓

(1)

4.2.4 Polythene OR Polyethene ✓

(1)

4.2.5 The chemical process in which longer chain hydrocarbon molecules are broken down to shorter molecules ✓ at high temperatures (and pressures) ✓.

(2)

4.2.6  $C_4H_{10}$  ✓✓

(2)

**[20]**

**QUESTION 5**

- 5.1 The amount of product formed/reactant used up✓ per unit time✓ (per second). (2)
- 5.2 concentration of HCl✓ (1)
- 5.3 Product  $\text{CO}_2$  is an insoluble gas✓ and escapes from the beaker. ✓ (2)
- 5.4 Calcium carbonate is used up✓ and the reaction stops, no more  $\text{CO}_2$  formed. ✓ (2)
- 5.5.1 graph B✓ (1)
- 5.5.2 graph D ✓ (1)
- 5.5.3 graph C✓ (1)
- 5.6 graph C✓.  
Catalyst speeds up the rate of reaction✓, therefore gradient ✓ of graph will be steepest for same initial mass. ✓ (4)
- 5.7 Remains the same. ✓ (1)
- [15]**

**QUESTION 6**

6.1.1 Increases ✓ (1)

6.1.2 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)

6.1.3 Increase in temperature increases  $K_c$  ✓  
Increase in  $K_c$  indicates that the forward reaction has been favoured ✓,  
Increase in temperature favours the endothermic reaction ✓,  
Therefore the forward reaction is endothermic ✓. (4)6.1.4 Add a catalyst ✓  
Increase pressure OR decrease volume of container ✓ (2)

6.2

|                   | $A_2$     | + | $2B$ | → | $2AB$                                 |
|-------------------|-----------|---|------|---|---------------------------------------|
| Initial (mol)     | x         |   | 2    |   | 0 ✓                                   |
| Used / formed     | -0,2      |   | -0,4 |   | 0,4 ✓ (✓) ← <b>RATIO</b>              |
| Equilibrium (mol) | $x - 0,2$ |   | 1,6  |   | 0,4 ✓ ← <b>Addition for all three</b> |
| [equilibrium]     | $x - 0,2$ |   | 1,6  |   | 0,4 ✓                                 |

For conc. only ✓

|                                       | $A_2$     | + | $2B$ | → | $2AB$                                 |
|---------------------------------------|-----------|---|------|---|---------------------------------------|
| Initial conc. (mol.dm <sup>-3</sup> ) | x         |   | 2    |   | 0 ✓                                   |
| Used / formed                         | -0,2      |   | -0,4 |   | 0,4 ✓ (✓) ← <b>RATIO</b>              |
| [equilibrium]                         | $x - 0,2$ |   | 1,6  |   | 0,4 ✓ ← <b>Addition for all three</b> |

$$K_c = \frac{[AB]^2}{[A_2][B]^2} \checkmark$$

$$= \frac{(0,4)^2}{(x - 0,2)(1,6)^2} \checkmark$$

$$= 0,5$$

$$\therefore 0,5 [(x - 0,2)(1,6)^2] = (0,4)^2$$

$$\therefore 1,28x - 0,256 = 0,16$$

$$\therefore X = 0,325 \text{ mol } \checkmark$$

**Marking criteria:**

- Initial mol/conc correctly indicated. ✓
- Mol/conc of AB produced = 0,4. ✓
- Ratio applied correctly. ✓
- Equilibrium mol: ✓  $\left. \begin{array}{l} \text{initial} - \text{used} \\ \text{Initial} + \text{produced} \end{array} \right\}$
- OR
- Equilibrium conc: ✓✓  $\left. \begin{array}{l} \text{initial} - \text{used} \\ \text{Initial} + \text{produced} \end{array} \right\}$
- Equilibrium mol  $\div 1 = \text{eq conc.}$  ✓
- Correct  $K_c$  expression. ✓
- Substitution of eq conc to  $K_c$  expression. ✓
- Final answer. ✓

Wrong  $K_c$  expression – (Max.: 4/8)  
Wrong values on the table but used in the calculation (positive marking) – (Max.: 3/8) no mark for answer.

(8)  
[17]

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**QUESTION 7**

7.1.1

**Option 1:**

$$\text{pH} = -\log [\text{H}_3\text{O}^+] \quad \checkmark$$

$$= 1$$

$$\therefore [\text{H}_3\text{O}^+] = 10^{-1} = 0,1 \quad \checkmark$$

$$\therefore [\text{HCl}] = 0,1 \text{ mol}\cdot\text{dm}^{-3} \quad \checkmark$$

**Option 2:**

$$\text{pH} = -\log [\text{H}_3\text{O}^+] \quad \checkmark$$

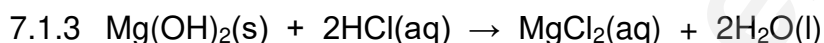
$$= 1$$

$$\therefore [\text{HCl}] = 0,1 \text{ mol}\cdot\text{dm}^{-3} \quad \checkmark\checkmark$$

(3)

7.1.2 increase  $\checkmark$ 

(1)



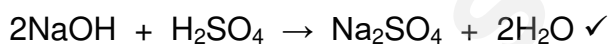
(3)

Reactants  $\checkmark$ Products  $\checkmark$ Balancing  $\checkmark$ 

7.2 When an acid reacts with a base  $\checkmark$  to produce a salt and water.  $\checkmark$  OR  
Chemically equivalent quantities of acid and base are reacted.  $\checkmark\checkmark$

(2)

7.3

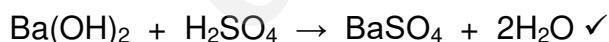
**Option 1:**

$$n(\text{NaOH}) = c \times V \quad \checkmark = 0,1 \times 0,012 \quad \checkmark = 0,0012 \text{ mol}$$

$$n(\text{H}_2\text{SO}_4) = \frac{1}{2} \times n(\text{NaOH}) \quad \checkmark = 0,0006 \text{ mol}$$

$$V(\text{H}_2\text{SO}_4) = n/C = 0,0006 / 0,05 = 0,012 \text{ dm}^3$$

$$V(\text{H}_2\text{SO}_4) \text{ that reacts with } \text{Ba}(\text{OH})_2 = 54 - 12 \quad \checkmark = 42 \text{ cm}^3 \quad (\text{OR } 0,054 - 0,012 = 0,042 \text{ dm}^3)$$

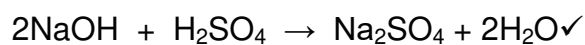


$$n(\text{H}_2\text{SO}_4) \text{ that reacts with } \text{Ba}(\text{OH})_2 = c \times V = 0,05 \times (42 \times 10^{-3} \text{ mol}) = 0,0021 \text{ mol}$$

$$n(\text{Ba}(\text{OH})_2) = 1 \times 0,0021 = 0,0021 \text{ mol}$$

$$[\text{Ba}(\text{OH})_2] = n/v = 0,0021 \times 0,048 \quad \checkmark = 0,04375 \text{ mol}\cdot\text{dm}^{-3} \quad \checkmark$$

7.3

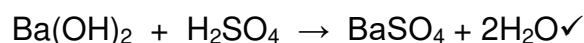
**Option 2:**

$$n(\text{NaOH}) = c \times V \checkmark = 0,1 \times 0,012 \checkmark \\ = 0,0012 \text{ mol}$$

$$n(\text{H}_2\text{SO}_4) = \frac{1}{2} \times n(\text{NaOH}) \checkmark \\ = 0,0006 \text{ mol}$$

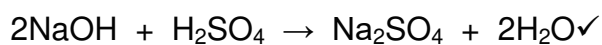
$$n(\text{H}_2\text{SO}_4)_{\text{tot}} = c \times V \\ = 0,05 \times (54 \times 10^{-3}) \\ = 0,0027 \text{ mol}$$

$$n(\text{H}_2\text{SO}_4)_{\text{with Ba(OH)}_2} \\ = 0,0027 - 0,0006 \checkmark = 0,0021 \text{ mol}$$



$$n(\text{Ba(OH)}_2) = 1 \times 0,0021 \\ = 0,0021 \text{ mol}$$

$$[\text{Ba(OH)}_2] = n / v = 0,0021 \times 0,048 \checkmark = \\ 0,04375 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

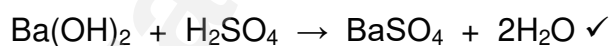
**Option 3:**

$$\frac{n_a}{n_b} = \frac{V_a \times c_a}{V_b \times c_b} \checkmark$$

$$\frac{1}{2} \checkmark = \frac{V_a \times 0,05}{0,1 \times 12} \checkmark$$

$$V_a = 12 \text{ cm}^3$$

$$V(\text{H}_2\text{SO}_4)_{\text{with Ba(OH)}_2} \rightarrow 54 - 12 \checkmark \\ = 42 \text{ cm}^3$$



$$\frac{n_a}{n_b} = \frac{V_a \times c_a}{V_b \times c_b}$$

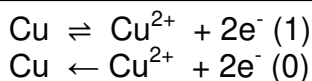
$$\frac{1}{1} = \frac{0,05 \times 42}{48 \times c_b} \checkmark$$

$$[\text{Ba(OH)}_2] = 0,04375 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

(8)

**[17]****QUESTION 8**

8.1.1 Pt or the electrode where oxygen reacts or where peroxide is formed ✓ (1)



(2)



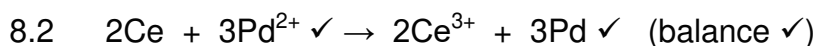
(2)

8.1.4  $E^\ominus_{\text{cell}} = E^\ominus_{\text{cathode}} - E^\ominus_{\text{anode}} \checkmark$

$$= 0,68 \checkmark - 0,34 \checkmark$$

$$= 0,34 \text{ V} \checkmark$$

(4)



(3)

**[12]**

**QUESTION 9**

- 9.1 Electrical energy to chemical energy. ✓ (1)
- 9.2 Decrease in mass/ decrease in size/ gets used up/ erosion ✓✓ (2)
- 9.3 Oxidation ✓ (1)
- 9.4
- 9.4.1  $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$  ✓✓ (2)
- 9.4.2 Silver nitrate OR  $\text{AgNO}_3$  ✓
- OR**
- Silver ethanoate/silver acetate ✓
- $\text{CH}_3\text{COOAg}$ /  $\text{AgC}_2\text{H}_3\text{O}_2$ /  $\text{AgCH}_3\text{CO}_2$  (1)
- OR**
- $\text{Ag}^+$  ions
- 9.5 Rate of oxidation is equal to the rate of reduction. ✓✓
- ACCEPT:** Reduction and oxidation take place simultaneously ✓✓

(2)

**[9]****QUESTION 10**

- 10.1.1  $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$  ✓✓ (ACCEPT:  $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$  ✓✓) (2)
- 10.1.2 Step 2 ✓ (1)
- 10.1.3 Vanadium pentoxide ✓ (1)
- 10.2.1 Fertilisers must replenish nutrients used by growing of crops. ✓ (1)
- 10.2.2 **Any ONE:**
- Excessive fertiliser seeps/washes into groundwater and contaminates Drinking Water **OR**
- Excessive fertiliser run-off can lead to eutrophication which depletes aquatic life which serves as a food source **OR**
- Excessive fertilisation can damage a crop which leads to a smaller harvest. ✓ (1)
- 10.2.3 Eutrophication ✓ (1)
- 10.2.4  $(\text{NH}_4)_2\text{SO}_4$  ✓✓ (2)

10.3.1 Total percentage of active fertiliser. OR Combined percentage of N, P and K. ✓  
(1)

10.3.2 **OPTION 1**

$$13 = \frac{5}{x} \times 26 \quad \checkmark$$

$$x = 10 \quad \checkmark$$

$$\text{thus } N = 3 \quad \checkmark$$

$$N:P:K = 3:2:5 \quad (4)$$

**OPTION 2**

$$(N + P + K) \text{ in the bag} = 26/100 \times 20 = 5,2 \text{ kg}$$

$$K \text{ in the bag} = 13/100 \times 5,2 = 2,6 \text{ kg}$$

$$2,6/5,2 \times 100 \quad \checkmark = 50\% = 5 \text{ parts} \quad \checkmark$$

$$P = 2 \text{ parts} = 20\% \quad \checkmark$$

$$\text{Therefore, } N = 30\% = 3 \text{ parts}$$

$$\text{Unknown component} = 3. \quad \checkmark$$

(4)  
[14]