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Question 1 – Multiple Choice

- 1.1 B
 1.2 A
 1.3 D
 1.4 B
 1.5 D
 1.6 C
 1.7 C
 1.8 D
 1.9 A
 1.10 B

[10 x 2 = 20]

Question 2 – Chemical Bonding

- 2.2.1 (a) polar✓ covalent ✓ (2)
 (b) non polar✓ covalent✓ (2)
- 2.1.2 An **intermolecular force** is a weak force of attraction between molecules or between atoms of noble gases. (2)
- 2.1.3 (a) Hydrogen bonds.✓ (1)
 (b) London forces. ✓ (1)
- 2.1.4 Hydrogen bonds are stronger than London forces.✓ More energy is needed to overcome the stronger intermolecular forces. .✓ (2)
- 2.2.1 Ionic bond.✓ (1)
- 2.2.2 In molten form✓ or when dissolved in water✓ there are free ions present✓ to conduct electricity. (3)
- 2.2.3 MgO forms a crystal lattice✓ not a molecule.✓ (2)
- 2.2.4 A very large amount of energy is needed✓ to overcome the MANY✓ STRONG✓ ionic bonds in the crystal lattice. (3)

2.3 $n = \frac{V}{V_m}$ **Mol ratio** $m = n \times M$
 $= \frac{3,36}{22,4} \checkmark$ NaCl : Cl₂ $= 0,3 \checkmark \times 58,5 \checkmark$
 $= 0,15 \text{ mol Cl}_2 \checkmark$ 10 : 5 $= 17,55 \text{ g } \checkmark$
 2 : 1
 0,3 : 0,15

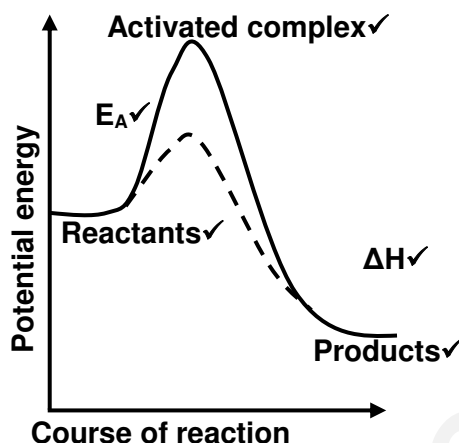
% purity = $\frac{17,55}{20} \times 100 \checkmark = \underline{87,75 \%} \checkmark$

(7)

[26]

Question 3 – Energy changes and rates of reaction

3.1



(6)

3.2 A **catalyst** is a substance that increases the rate of the reaction but remains unchanged at the end of the reaction. (2)

3.3 **catalyst see graph** (1)

3.4 A catalyst lowers the activation energy needed for an effective collision $\therefore$ more of the particles have the required activation energy $\therefore$ more effective collisions per second $\therefore$ faster rate. (3)

[12]**Question 4 – Chemical Equilibrium**

4.1 **Le Chatelier's principle:** When an external stress (change in pressure, temperature or concentration) is applied to a system in chemical equilibrium, the equilibrium point will change in such a way as to counteract the stress. (2)

4.2 Stress: Increase volume of container $\therefore$ decrease pressure. $\checkmark$
Response: Favour forward reaction. $\checkmark$

Reason: Decrease pressure favours production of more mols of gas. $\checkmark$ In order to relieve the stress $\therefore$ increasing yield. (4)

4.3 15 s. $\checkmark$ (1)

4.4 Decrease in temperature. $\checkmark$ (1)

4.5 Decreasing temperature favours the forward reaction which increases the yield of products but it lowers/slows the rate of reaction and time in money in industry. $\checkmark$ (4)

4.6.1 Increase $\checkmark$ (1)

4.6.2 Increase $\checkmark$ (1)

4.6.3 No change $\checkmark$ (1)

$$4.7.1 \quad K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \quad (2)$$

4.7.2

	N_2	+	3H_2	$\rightleftharpoons$	2NH_3
Mol ratio	1		3		2
Mols start	2,8		8,7		0
Mols used/formed	(0,3		0,9)		0,6
Mols eqm	(2,5		7,8)		0,6
Conc. Eqm	(5		15,6)		1,2

x 0,5 dm³ ✓

Ratio mols used/form ✓✓

Subtraction ✓

÷ vol ⇒ conc ✓

Subst ✓

Ans ✓

x 0,5

$$K_c = \frac{1,2^2}{5 \times 15,6^3} \quad (\text{c.o.e from 4.7.1})$$

$$= \underline{7,59 \times 10^{-5}}$$

(7)

4.7.3 Low yield. ✓

(1)

[25]

Question 5 – Acids and Bases (1)

5.2.1 Weak acid. ✓ (1)

5.2.2 Na^+ and OH^- ions would remain dissociated as NaOH is a strong base. ✓
 $\text{COO}^- + \text{H}^+$ would form a weak acid so ∴ a decrease in $[\text{H}_3\text{O}^+]$ ∴ salt is slightly basic ✓
 due to an excess OH^- ions. ✓ (4)

5.2.3 Stress: Increase $[\text{COO}^-]$ ✓
 Response: Favour reverse reaction. ✓
 Reason: $[\text{COO}^-]$ decreases (used up) in reverse reaction. ✓
 Observation: pH would increase ✓ as $[\text{H}_3\text{O}^+]$ decrease. ✓ (5)

[15]

Question 6 – Acids and Bases (2) – Calculations

6.1.1 A **standard solution** is a solution of known concentration. (2)

$$\begin{aligned}
 6.1.2 \quad m &= C \times M \times V \checkmark \\
 &= 0,4 \times 56 \checkmark \times 0,25 \checkmark \\
 &= \underline{5,6 \text{ g}} \checkmark
 \end{aligned}
 \quad (4)$$

$$\begin{aligned}
 6.1.3 \quad K_w &= [\text{H}_3\text{O}^+][\text{OH}^-] \\
 \checkmark 1 \times 10^{-14} &= [\text{H}_3\text{O}^+] \times 0,4 \checkmark \\
 [\text{OH}^-] &= 2,5 \times 10^{-14} \text{ mol.dm}^{-3} \checkmark
 \end{aligned}
 \quad (3)$$

6.1.4 A **weak acid** is an acid that only ionises partially $\checkmark$ in an aqueous solution. $\checkmark$ (2)

$$\begin{aligned}
 6.1.5 \quad n &= c \times V \quad \text{formula} \checkmark & \text{CH}_3\text{COOH} : \text{KOH} \\
 &= 0,4 \times 0,03 \checkmark & 1 : 1 \\
 &= 0,012 \text{ mols of KOH} \checkmark & 0,012 \text{ mols} : 0,012 \text{ mols} \\
 c &= \frac{n}{V} = \frac{0,012}{0,02} \checkmark & \\
 &= \underline{0,6 \text{ mol.dm}^{-3}} \checkmark &
 \end{aligned}
 \quad (5)$$

6.1.6 Phenolphthalein. $\checkmark$
 Titration of strong base with weak acid $\checkmark$ produces a basic salt $\checkmark$ $\therefore$ need an indicator which changes colour in a basic pH range. $\checkmark$ (4)

$$\begin{aligned}
 6.2. \quad n &= c \times V \\
 &= 0,5 \times 0,4 \checkmark \\
 &= 0,2 \text{ mol HCl (total)} \checkmark
 \end{aligned}$$

$$n = \frac{m}{M} = \frac{3,2}{40} = 0,08 \text{ mol NaOH} \checkmark$$

NaOH : HCl

1 : 1 (mol ratio)

$\therefore$ 0,08 mol HCl in excess

Mol HCl reacted with shell = $(0,2 - 0,08) = 0,12 \text{ mol HCl} \checkmark$

$$\begin{aligned}
 \text{Mol ratio} \quad \text{CaCO}_3 : \text{HCl} \\
 1 : 2 \\
 0,06 : 0,12
 \end{aligned}$$

$$\begin{aligned}
 m &= n \times M = 0,06 \checkmark \times 100 \checkmark \\
 &= 6 \text{ g of CaCO}_3 \checkmark
 \end{aligned}
 \quad (8)$$

[28]

Question 7 – Galvanic Cell

- 7.1 Palladium nitrate. ✓ (1)
- 7.2 Connect palladium half cell to hydrogen half cell. ✓
 Voltmeter will give E° for palladium. ✓
 Temperature = 25°C ✓, Pressure = 1 atm ✓
 Concentration of electrolytes = 1 mol.dm^{-3} ✓ (5)
- 7.3 $\text{Cr} \rightarrow \text{Cr}^{3+} + 3\text{e}^-$ ✓✓ (2)
- 7.4 $2\text{Cr} + 3\text{Pd}^{2+} \rightarrow 2\text{Cr}^{3+} + 3\text{Pd}$ reactants ✓ products ✓ bal ✓ (3)
- 7.5 Cr ✓ (1)
- 7.6 $\text{Cr} | \text{Cr}^{3+} \parallel \text{Pd}^{2+} | \text{Pd}$ ✓ (3)
- 7.7 $\varepsilon^\circ_{\text{cell}} = \varepsilon^\circ_{\text{cat}} - \varepsilon^\circ_{\text{an}}$
 $= 0,987 - (-0,74)$ ✓ (c.o.e from 7.3)
 $= +1,73\text{ V}$ ✓ (3)
- 7.8.1 Decreases. ✓ (1)
- 7.8.2 $[\text{Pd}^{2+}]$ will decrease ✓ as $\text{Pd}(\text{OH})_2$ forms.
 Reverse reaction is favoured. ✓
 Emf decreases. (2)

[21]**Question 8 – Electrolysis**

- 8.1 Electrical $\rightarrow$ Chemical. ✓✓ (2)
- 8.2 $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ ✓✓ (2)
- 8.3 As you increase the current, the mass of copper coating will increase. ✓✓ (2)
- 8.4 Mass of copper deposited. ✓ (1)
- 8.5 Graph – Heading ✓
 Labels ✓✓
 Scale ✓
 Points ✓✓
 Line ✓ (7)
- 8.6 Line does **not** pass through the origin. ✓ (1)
- 8.7 Read off graph. ✓✓ $\pm 0,34\text{ A}$ (2)

[17]

Question 9 – Organic (1)

9.1.1 Haloalkane ✓ (1)

9.1.2 Alkene ✓ (1)

9.2

```

      H  Br  H  H
      |  |  |  |
H - C - C - C - C - H
      |  |  |  |
      H  H  |  H
              |
            H - C - H
                |
                H
          
```

✓ 4 C's
 ✓ Br on 2
 ✓ Methyl on 3
 ✓ Hydrogen

(4)

9.3.1 Elimination reaction. ✓ (1)

9.3.2 2-methylbut-2-ene (2-methylbut-2-ene) ✓ (3)

9.4.1 Substitution ✓ (1)

9.4.2 $\text{CH}_3\text{CHOHCH}(\text{CH}_3)\text{CH}_3$ Rest correct ✓ (3)9.5 $2\text{C}_5\text{H}_{10} + 15\text{O}_2 \rightarrow 10\text{CO}_2 + 10\text{H}_2\text{O}$ reactants ✓ products ✓ bal ✓ (3)

9.6.1

```

      O  ✓  H  H  H  H ✓
      ||  |  |  |  |
H - C - O - C - C - C - C - H
      |  |  |  |  |
      H  H  H  H  H
          
```

(2)

9.6.2 Butanol ✓✓ (2)

9.6.3 H_2O ✓ (1)

9.6.4 **Isomers** are compounds having the same molecular formula but different structural formulae. (2)

9.6.5 ethyl propanoate methyl butanoate propyl ethanoate ✓✓ only 1 (2)

9.6.6 pentanoic acid ✓✓ (2)

[28]

Question 10 – Organic (2)

10.1 Sample X ✓ (1)

10.2 Both compounds have London forces ✓ between their molecules.
 Pent-2-ene has **stronger** ✓ London forces which require more energy to overcome.
 Reason for stronger London forces in pentene. ✓
 Longer C-chain, greater contact surface area ✓ ∴ larger area temporary dipoles. (4)

10.3 Pent-2-ene will **rapidly** ✓ decolourise ✓ the Br_2 but pentane will have no immediate effect. ✓ (3)

[8]

TOTAL : 200

Question 8.5

Graph to show the relationship between current strength and mass of copper deposited

