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Question 1 – Multiple Choice

1.1 C✓✓

1.2 D

1.3 C

1.4 D

1.5 D

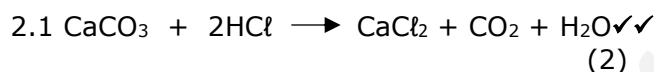
1.6 B

1.7 A

1.8 B

1.9 B

1.10 A [10 x 2 = 20]

Question 2

$$2.2 \quad n = \frac{m}{M} \quad n = c \times v$$

$$= \frac{0,15}{(40+12+3(16))} \checkmark \quad = 0,1 \times 0,05$$

$$= 0,0015 \text{ mol} \checkmark \quad = 0,005 \text{ mol} \checkmark$$

0,0015 mol CaCO_3 would need 0,003 mol HCl
 $\therefore \text{HCl}$ in excess✓

$$0,005 - 0,003 = 0,002 \text{ mol in excess} \checkmark \quad (5)$$

2.3 CO_2 - London
 H_2O - H-Bonds✓
 Like dissolves like $\therefore$ insoluble✓
 (2)

$$2.4 \text{ rate} = \frac{\Delta V}{\Delta t} = \frac{29,3-16,5}{24-10} \checkmark \checkmark = 0,91 \text{ cm}^3 \cdot \text{s}^{-1} \checkmark$$

(3)

2.5 Answer sheet✓ (6)

2.6 Answer sheet✓ (6)✓

2.7 substance that increases the rate of the reaction✓ but remains unchanged at the end of the reaction✓
 (2)

2.8.1 T_2 ✓ (1)

2.8.2 An increase in temperature will increase the average E_k ✓ $\therefore$ more molecules likely to have sufficient $E_k \geq E_A$ ✓ $\therefore$ more chance of successful collisions✓ per unit time✓
 (4)

[31]**Question 3**

3.1.1 the amount of solute per unit volume of solution ✓✓
 (2)

3.1.2	N_2	+	3H_2	$\rightarrow$	2NH_3
Initially:	1		1,5		0
Change:	- 0,4		-1,2		+0,8
Equilibrium:	0,6		0,3		0,8✓✓✓

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

$$= \frac{0,6}{0,2} \checkmark$$

$$= 3 \text{ mol} \cdot \text{dm}^{-3} \checkmark \quad (5)$$

$$3.1.3 \quad K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

$$= \frac{(4)^2}{(3)(1,5)^3} \checkmark$$

$$= 1,58 \checkmark \quad (4)$$

3.1.4 When an external stress (change in pressure, temperature or concentration) is applied to a system in dynamic chemical equilibrium✓, the equilibrium point will change in such a way as to counteract the stress✓
 (2)

3.1.5 increase✓ (1)

3.1.6 According to LCP the reaction will counteract the stress by favouring the reaction that will increase the pressure✓ i.e. towards producing more moles (4:2) ∴ the reverse reaction is favoured✓ ∴ more N₂ will be formed✓ (3)

3.1.7 Stays the same✓ (1)

3.1.8 polar covalent✓✓ (2)

3.1.9 *a weak force of attraction✓ between molecules, ions, or atoms of noble gases✓* (2)

3.1.10 NH₃ – H-bonds✓ > ✓London forces found in H₂ and N₂✓ ∴ more energy needed to overcome NH₃ bonds ∴ greater boiling point✓ (4)

3.2.1 H₂ added✓ (1)

3.2.2 According to LCP the stress will be counteracted by removing H₂✓ ∴ the forward reaction is favoured. Reducing the moles of N₂ and H₂ and increasing the moles of NH₃✓ (2)

3.2.3 Temperature was decreased✓. According to the graph the NH₃ increased and the N₂ and H₂ decreased. ✓This indicates the forward reaction was favoured which must be the exothermic reaction✓ to reduce the stress. The forward reaction would increase the K_c✓ (4)
[33]

Question 4

4.1 *a base that only dissociates/ionises partially in an aqueous solution ✓✓* (2)

4.2 $\text{Ca(OH)}_{2(s)} \xrightleftharpoons{\text{H}_2\text{O}} \text{Ca}^{2+}_{(aq)} + 2\text{OH}^{-}_{(aq)} \checkmark$ (3)

4.3 Donates one proton✓ (1)

4.4 burette✓ (1)

4.5 $2\text{CH}_3\text{COOH} + \text{Ca(OH)}_2 \rightarrow (\text{CH}_3\text{COO})_2\text{Ca} + 2\text{H}_2\text{O}$

$$n_a = c_a V_a$$

$$= 0,1(0,04)$$

$$= 0,004 \text{ mol} \checkmark$$

$$(2:1) \\ n_b = 0,002 \text{ mol} \checkmark$$

$$c_b = \frac{n}{V}$$

$$= \frac{0,002}{0,05}$$

$$= 0,04 \text{ mol} \cdot \text{dm}^{-3} \text{ of pure base} \checkmark$$

$$c_b = \frac{m}{MV}$$

$$= \frac{2}{(74)(0,25)} \checkmark$$

$$= 0,11 \text{ mol} \cdot \text{dm}^{-3} \text{ of impure base} \checkmark$$

$$\% \text{ purity} = \frac{\text{actual}}{\text{theoretical}} \times 100$$

$$= \frac{0,04}{0,11} \times 100$$

$$= 36,36 \% \checkmark \quad (6)$$

4.6 *a reaction of an ion (from a salt) with water✓✓* (2)

4.7 $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{OH}^- \checkmark$

$\text{Ca}^{2+} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + 2\text{H}_3\text{O}^+ \checkmark$
(don't have to balance) (2)

4.8 equal to 7✓

Both ions react with the H₂O✓ ∴ no change in [H₃O⁺] and [OH⁻]✓ (3)

4.9 HCl is a stronger acid than ethanoic acid✓
∴ it ionizes more completely than ethanoic acid✓
∴ it produces a greater [H₃O⁺]✓
∴ pH lower✓

(3)
[23]

Question 5

- 5.1 a reaction involving the transfer of electrons✓✓ (2)
- 5.2 Cl_2 gas✓ (1)
- 5.3 Cl_2 gas does not conduct electricity✓
Pt is inert and it completes the circuit✓ (2)
- 5.4 salt bridge✓ (1)
- 5.5 anode✓ (1)
- 5.6 NO_3^- ✓ (1)
- 5.7.1 $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$ ✓✓ (2)
- 5.7.2 $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$ ✓✓ (2)
- 5.7.3 $2\text{Fe}^{2+} + \text{Cl}_2 \rightarrow 2\text{Fe}^{3+} + 2\text{Cl}^-$ ✓ (2)
- 5.8
Pt✓/ Fe^{2+} ; Fe^{3+} ✓ (1 mol.dm⁻³) // 2Cl^- (1 mol.dm⁻³)/ Cl_2 (1 atm)/Pt
at 25°C✓ (5)
- 5.9 $E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}}$ ✓
 $= +1,36 - (+0,77)$ ✓
 $= +0,59 \text{ V}$ ✓ (3)
- 5.10 Increase✓ as the forward reaction would be favoured✓ according to LCP to reduce the stress of adding Fe^{2+} by removing it✓ (3)
- 5.11 Increase the surface area of the electrodes✓
Use wider, shorter and more conductive salt bridge✓ (2)
(any 2)

[27]**Question 6**

- 6.1.1 a substance that can conduct electricity by forming free ions when molten or dissolved in solution✓✓ (2)
- 6.1.2 $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$ ✓✓ (2)

- 6.1.3 Gases produced may react✓
Contamination of products will occur (any one) (1)
- 6.1.4 To prevent the oxidation of H_2O to produce O_2 gas✓✓ (2)
- 6.2 Non toxic✓
Less expensive to run✓ (2)
- 6.3.1 Reduce the melting point of Al_2O_3 ✓ (1)
- 6.3.2 Carbon packs in layers✓ ∴ creating delocalized electrons between the layers that are free to move across a potential difference✓ (2)
- 6.3.3 So that it remains an electrolyte ✓and to siphon off the liquid aluminium✓ (2)
- 6.3.4 $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$
 $n = \frac{m}{M}$
 $= \frac{13,5}{27}$
 $= 0,5 \text{ mol}$ ✓
3 : 1
∴ moles $\text{e}^- = 1,5 \text{ mol}$ ✓
 $q = n F$
 $= (1,5)(96500)$
 $= 144\,750 \text{ C}$ ✓
 $q = I \times t$
 $144\,750 = 10 \text{ t}$ ✓
 $= 14475 \text{ s}$ ✓
 $= 4,02 \text{ hours}$ ✓ (6)

[21]**Question 7**

- 7.1.1 compound in which all of the bonds between carbon atoms are single bonds✓✓ (2)
- 7.1.2 $\text{C}_{12}\text{H}_{26}$ ✓✓ (2)

7.1.3 Fraction X✓

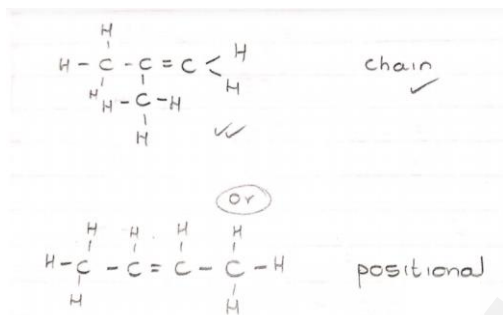
London forces increase with increasing mass✓ due to more electrons and thus a greater induced dipole✓ ∴ more energy needed so it will boil at a higher temperature✓ (4)

7.1.4 penta-1,3-diene✓✓ (2)

7.2.1 an atom or a group of atoms✓ that form the centre of chemical activity in the molecule ✓ (2)

7.2.2 Double ✓carbon-carbon bond✓ (2)

7.2.3

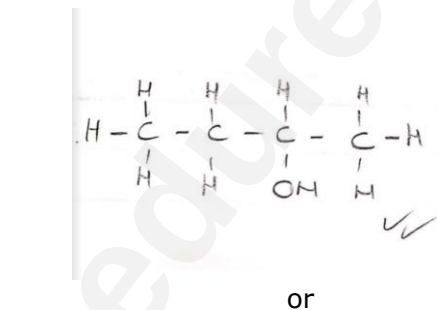


(3)

7.2.4 dehydrohalogenation ✓ (1)

7.2.5 addition✓ (1)

7.2.6

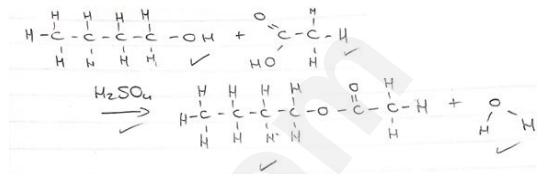


(2)

7.2.7 esterification✓ (1)

7.2.8 butyl ethanoate✓✓ (2)

7.2.9



(5)

7.2.10 hexanoic acid✓

CH₃CH₂CH₂CH₂CH₂COOH✓ (2)

7.2.11 X is more viscous than W✓
X has H-bonds ✓ which are stronger than London forces in W✓ ∴ more energy needed to overcome stronger forces between molecules of X✓ (4)

7.2.12 elimination✓ (1)

7.3.1 halogenation ✓ (1)

7.3.2 Presence of UV light or heat ✓ (1)

7.3.3 hydrolysis ✓ (1)

7.3.4 ethanol✓✓ (2)

7.3.5 sodium chloride ✓ (1)

7.3.6 dehydrohalogenation ✓ (1)

7.3.7 ethene✓✓ (2)

[45]

Answer sheet:

