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Physical Science: Trials Paper II Memo

Question 1 Multiple Choice

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

Question 2 Bonding

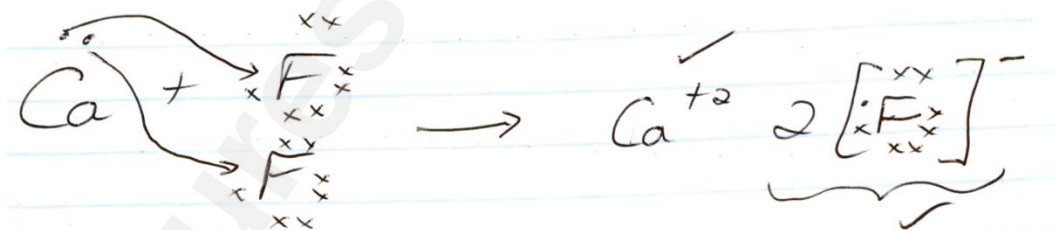
- 2.1.1 Graphite ✓
- 2.1.2 Ne ✓
- 2.1.3 CO ✓
- 2.1.4 CO₂ ✓
- 2.1.5 PH₃ ✓
- 2.1.6 NaCl ✓
- 2.1.7 CO₂ ✓

(7)

- 2.2.1 A transfer of $\bar{e}s$ ✓ and subsequent electrostatic attraction ✓.

(2)

2.2.2



- ✓ Correct atoms
- ✓ arrows

(4)

- 2.3.1 Increasingly larger molecules $\therefore$ more e^-s ✓ $\therefore$ more and stronger dipole – dipole forces ✓ $\therefore$ more E required to overcome them. ✓

(3)

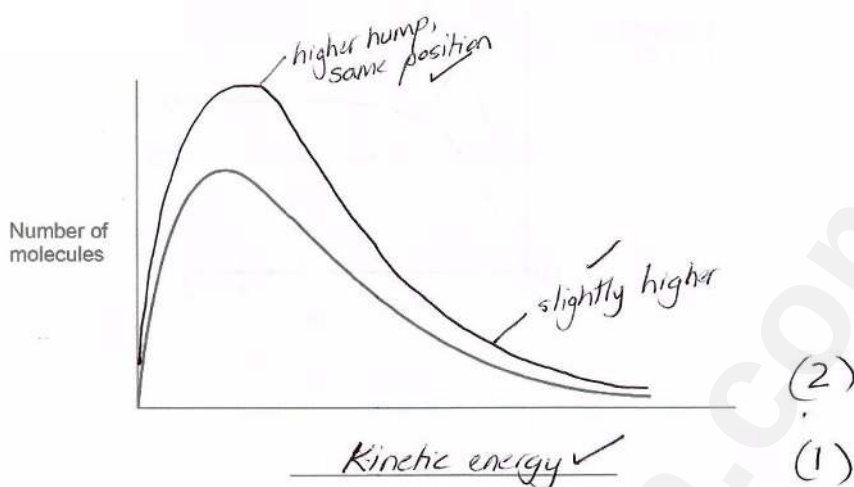
- 2.3.2 Hydrogen bonds ✓ are much stronger ✓ than vd Waals.

(2)

[18]

Question 3 Rates

3.1.1



3.1.2 The amount of solute ✓ per unit volume of solution. ✓

(2)

3.1.3 Answer sheet (see above)

(2)

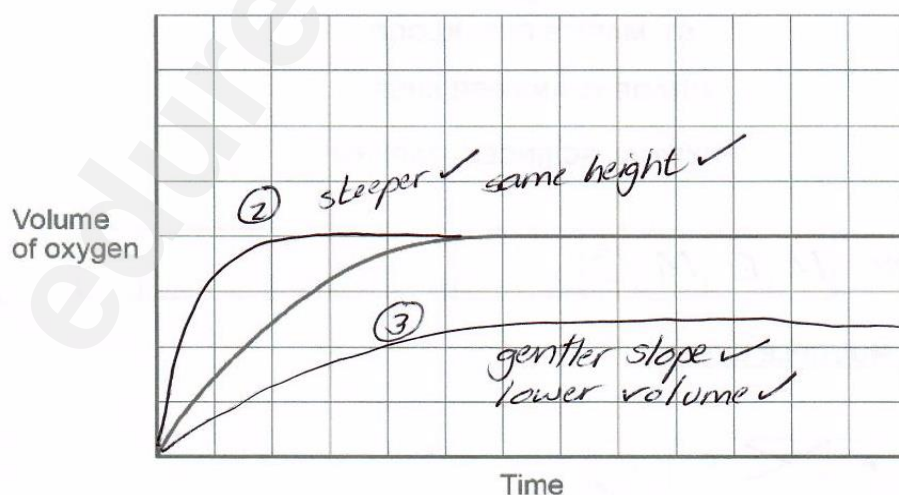
3.1.4 Increase in temperature increases the average kinetic energy ✓ of the particles. They therefore move faster and more collisions per unit time. ✓ There are more effective collisions per unit time ✓ and more molecules with the required activation energy ✓ (or sufficient E_k) ∴ a faster rate.

(4)

3.2.1 A catalyst lowers the activation energy ✓ required for a reaction ∴ more molecules will have the required activation energy ✓ ∴ more collisions per unit time ∴ more effective collisions ✓ per unit time ∴ higher rate.

(3)

3.2.2



(4)

3.3.1 A measure of the extent of a reaction, ✓ generally measured by comparing the amount of product against the amount of product which is possible. ✓

(2)

3.3.2 Decreases ✓ the yield. (1)

3.3.3 Yield has been sacrificed for rate. ✓ The temperature has been raised to increase the rate but compromises the yield. ✓ Time is money in industry -lots can be made quicker therefore suppliers get goods faster. Time is money in industry ✓ Moderate pressure ensures equipment is safe and not expensive. ✓ (4)

$$3.3.4 \quad \% \text{ yield} = \frac{\text{actual mass}}{\text{theoretical mass}} \times 100$$

$$\frac{40}{100} = \frac{504}{m}$$

$$m = \frac{504 \times 100}{40} = 1260 \text{ g of } \text{HNO}_3 \quad \checkmark$$

$$n_{\text{HNO}_3} = \frac{m}{M} = \frac{1260}{63} = 20 \text{ moles} \quad \checkmark$$

$$\begin{array}{l} \text{mole ratio } \text{HNO}_3 : \text{NO}_2 \\ 4 : 4 \\ 20 : x \end{array}$$

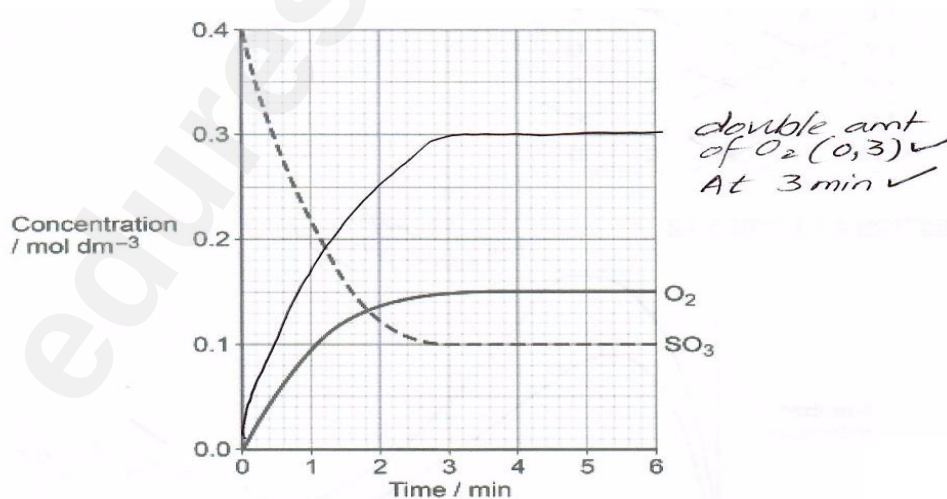
$$x = 20 \text{ moles of } \text{NO}_2 \quad \checkmark$$

$$m_{\text{NO}_2} = nM = 20 \times 46 = 920 \text{ g} \quad \checkmark \quad (4)$$

[27]

Question 4

4.1.1



(2)

4.1.2 When an external stress is applied to a system in dynamic chemical equilibrium, the equilibrium point will change in such a way as to counteract the stress. ✓✓ (2)

4.1.3 T_2 ✓ higher temperature. Lower yield of SO_3 ∴ forward reaction ✓ favoured to decrease the heat ✓ (∴ forward reaction is endothermic). ✓ (4)

4.2.1 t_2 ✓ (1)

4.2.2 All slopes level out and become horizontal - the number of moles of reactants and products remained constant. ✓ (1)

4.2.3 Rate of forward > rate of reverse. ✓ (1)

4.2.4 Increase in concentration of CO , ✓ which favoured the reverse action ✓ ∴ $[CO]$ and $[H_2]$ started to decrease ✓ and $[CH_2O]$ started to increase. ✓ (4)

4.2.5 No change ✓ (1)

4.3 Increase the volume. ✓ An increase in volume decreases the pressure ✓, leading to forward reaction favoured ✓ leading to more moles of gas. ✓ (4)

4.4.1 $K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓✓ (2)

4.4.2

	N_2	H_2	NH_3
Ratio	1	3	2
Initial	3,4	7,2	0
Consumed	0,6 ✓	1,8 ✓	
E moles	2,8	5,4	1,2 ✓
E conc	5,6 ✓	10,8 ✓	2,4

$$n = cV$$

$$NH_3 = 2,4 \times 0,5$$

$$= 1,2 \text{ moles } \checkmark$$

$$K_c = \frac{(2,4)^2}{(5,6)(10,8)^3}$$

$$= 8 \times 10^{-4} \checkmark \quad (7)$$

4.4.3 Low ✓ (1)

[30]

Question 5 Acids and Bases

5.1 The reaction of a molecular substance ✓ with water to produce ions ✓ (2)

5.2.1 Weak ✓ (1)

5.2.2 $HX + H_2O \rightleftharpoons H_3O^+ + X^{-1}$ ✓ (3)

5.2.3 Strong ✓ acid. Large K_a ✓ value indicating complete ionisation ✓. (3)

$$5.3.1 \quad K_a = \frac{[H_3O^+][A^-]}{[HA]} \quad [H_3O^+] = [A^-] \\ = x$$

$$1,53 \times 10^{-5} \checkmark = \frac{x^2}{0,15 \checkmark}$$

$$x = \sqrt{2,95 \times 10^{-6} \checkmark \text{ mol. dm}^{-3}}$$

$$x = 1,51 \times 10^{-3} \text{ mol. dm}^{-2} \checkmark$$

$$K_w = [H_3O^+][OH^-]$$

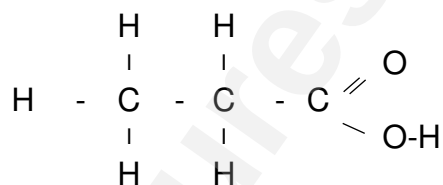
$$1 \times 10^{-14} = [1,51 \times 10^{-3}][OH^-] \checkmark$$

$$[OH^-] = 6,62 \times 10^{-12} \text{ mol. dm}^{-3} \checkmark \quad (5)$$

5.3.2 Decrease pH ✓ ↑ temperature favour forward reaction to decrease temperature ✓ ∴ more $[H_3O^+]$ ✓ (3)

5.4 Colourless to pink ✓. OH^- ions in NaOH would cause the H^+ ions to be removed ✓ therefore forward reaction favoured to replace H^+ ions. ✓ (3)

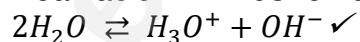
5.5.1



Correct C's + H's ✓
Correct COOH ✓

(2)

5.5.2 $CH_3CH_2COO^-$ combines with H^+ of H_2O to form $CH_3CH_2CO_2H$ which is a weak acid. ✓ Thus removes H^+ so therefore favours forward reaction.



∴ ↑ OH^- ions ✓ which do not combine with K^+ as KOH strong base ✓ (4)

$$5.5.4 \quad V_b = ? \\ C_b = 0,032$$

$$V_a = 25 \text{ cm}^3 \\ C_a = 0,024$$

$$n_a = 0,032V_b \quad n_a = (0,024) \left(\frac{25}{1000} \right) \checkmark$$

$$6 \times 10^{-4} = 0,032V_b$$

$$V_b = 1,88 \times 10^{-2} dm^3 \checkmark \quad = 6 \times 10^{-4} \checkmark$$

$$V_b = 18,75 cm^3 \checkmark \quad (4)$$

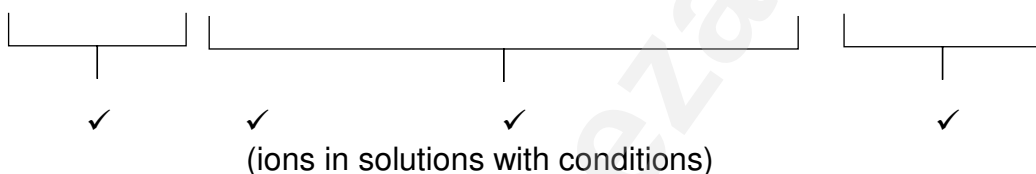
[32]

Question 6 Galvanic cells

6.1 The electrode $\checkmark$ where reduction $\checkmark$ takes place. (2)

6.2 $2H^+ + 2e^- \rightarrow H_2 \checkmark \checkmark$ (2)

6.3 $Pt/H_2(1 atm)/H^+(aq, 1mol. dm^{-3})//Mg^{2+}(aq, 1mol. dm^{-3})/Mg(s) at 25^\circ C$



(4)

6.4 $E^\circ = E^\circ cathode - E^\circ anode$
 $= 2,37 - 0,00 \checkmark \quad \checkmark$ for correct values from table
 $= 2,37V \checkmark$ (3)

6.5 Voltmeter reading would increase $\checkmark$. The OH^- ions would react with Mg^{2+} ions to form a precipitate $\checkmark$ thus removing Mg^{2+} ions $\checkmark$. Anode would therefore oxidise more $\checkmark$ to replace those ions. (4)

6.6 As the forward reaction proceeds, the H^+ ions (reactant ions) decreases and product ions (Mg^{2+}) increases $\checkmark$. Reverse reaction starts to be favoured $\checkmark$, therefore reading on voltmeter decreases, until equilibrium $\checkmark$ is reached, and difference between two cell potentials = 0,00. (3)

6.7 Shorter, wider salt bridge $\checkmark$
 OR
 Increase surface area of electrodes. (1)

[19]

Question 7 Electrolytic cells

7.1.1 Advantage: lowers MP of alumina therefore less power used. ✓
 Disadvantage: contains fluoride which can cause toxic emissions ✓ (2)

7.1.2 Carbon anodes react with the oxygen gas provided at the anode, which is a corrosive process therefore needs to be replaced. ✓



7.1.3 Must be > mp of aluminium ✓ (660°C) so that the aluminium can be siphoned off as a liquid. ✓ (2)

7.1.4 Water is a stronger oxidising agent than Al^{3+} ✓ $\therefore$ will be selectively reduced ✓ at the cathode to form hydrogen gas, (and no Al metal will form)

**7.1.5 Method 1**

$$n_{Al} = \frac{13,5}{27} = 0,5 \text{ mol} \quad \checkmark$$

Mol ratio Al : e^-

$$1 : 3$$

$$0,5 : 1,5 \checkmark \text{ mol } e^-s$$

$$\text{No. of } e^-s = 1,5 \times 6,02 \times 10^{23} = 9,03 \times 10^{23} e^-s \quad \checkmark$$

$$\text{No. of } C = 9,03 \times 10^{23} \times 1,6 \times 10^{-19} = 144480 \text{ C} \quad \checkmark$$

$$t = \frac{Q}{I} = \frac{144480}{10} \checkmark = \frac{14448s}{3600} = 4,01 \checkmark \text{ hours} \quad (6)$$

Method 2

$$n_{Al} = \frac{13,5}{27} = 0,5 \text{ mol} \quad \checkmark$$

Mol ratio Al : e^-s

$$1 : 3 \quad \checkmark$$

$$0,5 : 1,5 \text{ mol } e^-s$$

$$q = nF$$

$$= 1,5 \times 96\,500 \quad \checkmark \text{ (multiplying by Faraday's constant)}$$

$$= 144\,750 \text{ C}$$

$$t = \frac{Q}{I} = \frac{144\,750}{10} \quad \checkmark$$

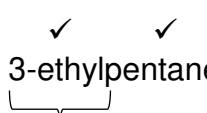
$$= 14\,475 / 3600 \quad \checkmark \text{ (dividing by 3600)}$$

$$= 4,02 \text{ hours} \quad \checkmark \quad (6)$$

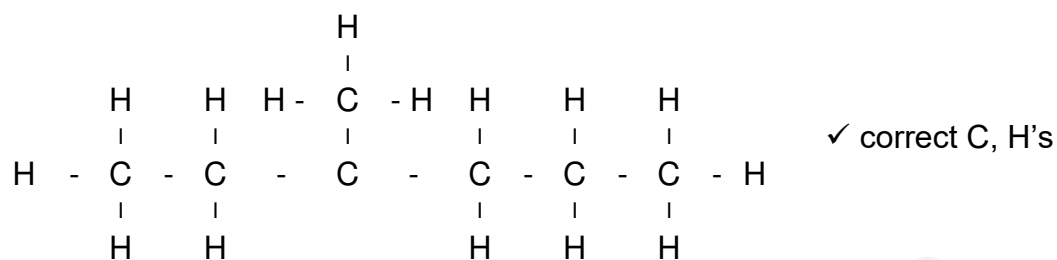
- 7.2.1 Cl_2 gas and H_2 gas are not separated ✓, and would explode when they came into contact ✓ OR Chlorine would combine with NaOH ✓ (to produce NaOCl .) and reduce purity of NaOH . ✓ (2)
- 7.2.2 If not kept concentrated, oxygen gas ✓ will be produced at the anode instead of chlorine, as H_2O is a stronger reducing agent than Cl^- ✓ (2)
- 7.2.3 i) No environmental hazards of asbestos or mercury poisoning ✓
- ii) Uses less energy therefore cheaper to run ✓ (2)

[22]

Question 8 Organic chemistry

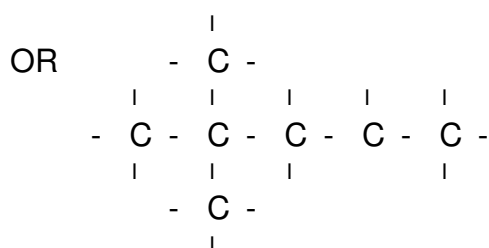
- 8.1.1 Breaking up ✓ of large hydrocarbon molecules into smaller and more useful molecules. ✓ (2)
- 8.1.2 Compounds having the same molecular formula ✓ but different structural formula. ✓ (2)
- 8.1.3 $\text{C}_7\text{H}_{16} \rightarrow \text{C}_3\text{H}_6 + \text{C}_4\text{H}_{10}$ ✓ (2)
- 8.2.1 Chain isomers ✓ (1)
- 8.2.2 3-ethylpentane ✓ ✓ (2)
- 

8.2.3

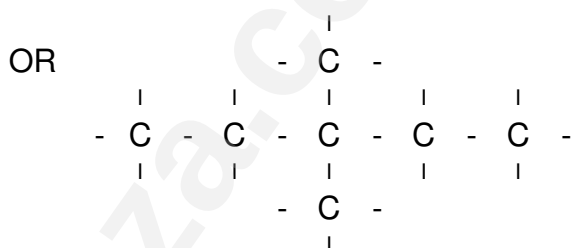


3-methylhexane

✓ ✓



2,2-dimethyl pentane



3, 3-dimethyl pentane (3)

8.2.4 $\text{CH}_3\text{CH}(\text{CH}_3)\checkmark\text{C}(\text{CH}_3\checkmark)_2\text{CH}_3$ (2)

8.2.5 2,2,3-trimethylbutane ✓. All have weak London forces ✓ and same molecular mass ✓ but 2,2,3-trimethylbutane has smallest surface area ✓ therefore fewer points of contact for temporary dipoles ✓ to form therefore weaker IMF's therefore less E required to overcome therefore lower b.pt. (5)

9.1 B ✓, E ✓ (2)

9.2 butane-1,4-diol ✓ ✓

✓ ✓

(2)

9.3 hydroxyl ✓ (1)

9.4 Heating ✓ with excess concentrated H_2SO_4 OR H_3PO_4 ✓ (2)

9.5 Substitution. ✓ (1)

9.6.1 Dissolved in organic solvent with Pt,/Pd/Ni catalyst ✓ in H_2 atm. (1)

9.6.2 Hydrogenation ✓ (1)

9.7.1 butylethanoate ✓ ✓

(2)

9.7.2 Ester ✓ (1)

[13]