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St Alban's College PS F5 PRELIM 2020 P2 Chemistry Memo**Question 1 [20]**

- 1.1 C $c_1v_1=c_2v_2$ (10,0)(15,0) = $c_2(15,0+60,0)$ $c_2=2,00 \text{ mol.dm}^{-3}$
- 1.2 D $E_a = +60 - (-76) = +136 \text{ kJ}$ $\Delta H = +20 - (-76) = +96 \text{ kJ}$
- 1.3 C $E_{k \text{ ave}} \propto T$ $T_1 < T_2 \therefore E_{k \text{ ave } 1} < E_{k \text{ ave } 2}$
- 1.4 D $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at $25^\circ\text{C} \therefore [\text{H}_3\text{O}^+]$ inversely $\propto [\text{OH}^-] \therefore$ if $[\text{H}_3\text{O}^+]$ doubles then $[\text{OH}^-]$ halves. K_w is constant at constant temperature
- 1.5 A Volume of container decreases $\therefore$ pressure (concentration) of all gases increases and ratio of reactant gases : products = 2 : 2 $\therefore$ both rates increase equally
- 1.6 C Both rates decrease but forward rxn less so (it is favoured) $\therefore$ T decreases favouring exothermic forward reaction
- 1.7 B Cd is found between Ni and Zn on SEP table. Stronger reducing agent than Ni but not Zn
- 1.8 B Y-anode (+) $\therefore \text{Cl}^-$ ions oxidised to Cl_2 (Gas B) X-cathode (-) $\therefore$ reduction of OH^- to H_2 Gas (A) Compound C caustic soda (NaOH) product
- 1.9 A C_2H_4 (ethene) is unsaturated $\therefore$ undergoes fast addition reaction of Br_2
- 1.10 B double bond - lowest number possible, alkyl groups in alphabetical order

Question 2 [17]

- 2.1 2.1.1 (a) polar $\checkmark$ covalent bond $\checkmark$ (2)
(b) non-polar $\checkmark$ covalent bond $\checkmark$ (2)
- 2.1.2 weak force of attraction $\checkmark$ between molecules, ions, or atoms of noble gases $\checkmark$ (2)
- 2.1.3 (a) hydrogen bonding $\checkmark$ (1)
(b) London (dispersion) forces $\checkmark$ (1)
- 2.1.4 hydrogen bonding stronger IMF than London $\checkmark$
More energy needed to overcome forces $\checkmark$ (2)
- 2.2 2.2.1 (a) ionic crystal/lattice $\checkmark$ (1)
(b) giant (covalent) lattice $\checkmark$ (1)
- 2.2.2 (a) molten / liquid state $\checkmark$ OR aqueous solution / dissolved $\checkmark$ ionic charges free to flow $\checkmark$ (3)
(b) No $\checkmark$ no charges free to move/only atoms $\checkmark$ (2)

Question 3 [28]

3.1 3.1.1 $(40-0)/(100-0) \checkmark = 0,4 \text{ cm}^3 \cdot \text{s}^{-1} \checkmark$ (2)

3.1.2 $(50-40)/(200-100) \checkmark = 0,1 \text{ cm}^3 \cdot \text{s}^{-1} \checkmark$ (2)

3.2 Decrease $\checkmark$ (1)

3.3 Concentration of the H_2O_2 is decreasing with time $\checkmark \therefore$ less particles per unit volume $\checkmark \therefore$ fewer collisions $\checkmark \therefore$ fewer effective collisions per second $\checkmark \therefore$ slower rate. (4)

3.4 $n = c \times v$ (or implied)

$= 0,1 \times 0,04 \checkmark$ (conversion)

$= 0,004 \text{ mol} \checkmark$ of H_2O_2

$\text{H}_2\text{O}_2 : \text{O}_2 = 2 : 1 = 0,004 : 0,002 \checkmark$

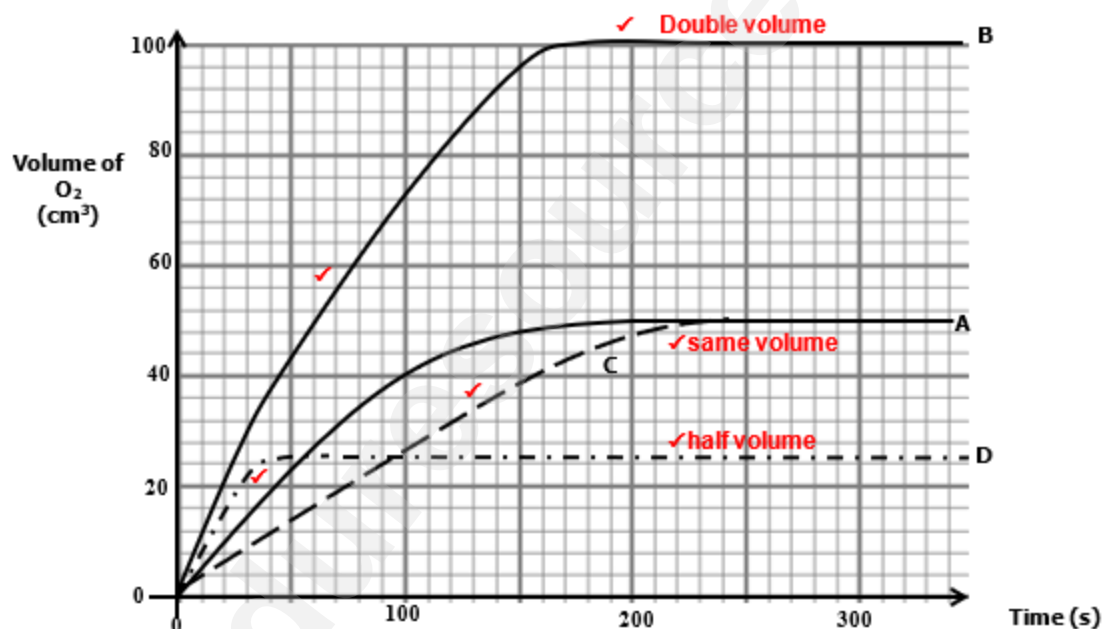
$V = n \times V_m = 0,002 \times 22,4 \checkmark$

$V = 0,0448 \text{ dm}^3 \checkmark$

$= 44,8 \text{ cm}^3 \checkmark$ (6)

3.5 Not conducted at standard conditions $\checkmark$ Temperature higher than standard temperature $\checkmark \therefore$ volume greater than predicted (2)

3.6 3.6.1 - 3.6.3



(6)

3.7 3.7.1 $\text{MnO}_2 \checkmark$ (1)

3.7.2 a substance that increases the rate of the reaction $\checkmark$
but remains unchanged at the end of the reaction $\checkmark$ (2)

3.7.3 (a) increase $\checkmark$

(b) No effect $\checkmark$ (2)

Question 4 [26]

4.1 5 minutes ✓ (1)

$$4.2 \quad K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} \quad \checkmark \text{ for correct powers} \quad (3)$$

$$4.3 \quad [N_2] = 7/10 = 0,7 \text{ mol.dm}^{-3} \quad \checkmark$$

$$[H_2] = 8/10 = 0,8 \text{ mol.dm}^{-3} \quad \checkmark$$

$$[NH_3] = 2/10 = 0,2 \text{ mol.dm}^{-3} \quad \checkmark \quad (3) \text{ -1 for no units}$$

$$4.4 \quad K_c = \frac{[0,2]^2}{[0,7][0,8]^3} \quad \checkmark = 0,112 \quad \checkmark \quad (2)$$

4.5 More hydrogen was added (increase in conc, of H_2) ✓ (1)

4.6 (Increase in amount of H_2 places stress/disturbance in system
According to LCP , system must shift to relieve the stress)
∴ Reaction which used H_2 ✓ (i.e. forward ✓) is favoured (amount of H_2 will decrease)
Amount of N_2 decreases ✓ and amount of NH_3 increases ✓ (4)

4.7 Exothermic ✓ (1)

4.8 Chemical potential energy ✓ → thermal (heat) energy ✓ (2) 0 if reversed

4.9 Decrease ✓ in temperature ✓ (2)

4.10 K_c INCREASES ✓ decrease in T favours exothermic forward reaction ✓ to increase the temperature ✓; [reactants] decreases [products] increases (3)

4.11 High temperature - A lower temp will reduce the rate of reaction ✓
too much so that it will be so slow that process will not be economically viable. ✓
Low pressure - increased cost of high pressure reaction vessels limits the pressure that can be used by industry. ✓
Compromise in yield is offset against economic costs . ✓ (4)

Question 5 [39]

5.1 5.1.1 a substance in which the hydrogen of an acid ✓ has been replaced by a cation ✓ (2)

5.1.2 ammonium chloride ✓ (1)

5.1.3 Less than 7 ✓ The H^+ ions from water and the Cl^- ions will form the strong acid HCl which remains fully ionised. ✓
The OH^- ions from water and the NH_4^+ ions form the weak base NH_4OH which is only partially dissociated. ✓
Therefore OH^- are removed from the solution leading to an excess of H^+ (H_3O^+) ions. ✓
OR $NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$ ✓✓ Therefore excess H_3O^+ ions ✓ (4)

5.1.4 $n = c \times v \checkmark = (0,1)(2) \checkmark = 0,2 \text{ mol} \checkmark$ **(3)**

5.1.5 $n(\text{NaOH}) = (0,6)(0,04) \checkmark = 0,024 \text{ mol} \checkmark = n(\text{HCl}) (1:1) \checkmark$ **(3)**

5.1.6 $n(\text{HCl}) = 0,2 - 0,024 = 0,176 \text{ mol} \checkmark$ **(1)**

5.1.7 $n((\text{NH}_4)_2\text{O}): n(\text{HCl}) = 1:2 \therefore n((\text{NH}_4)_2\text{O}) = 0,176/2 = 0,088 \text{ mol} \checkmark$

$m((\text{NH}_4)_2\text{O}) = n \times M = (0,088)(52) = 4,576 \text{ g} \checkmark$

$\% \text{purity} = \frac{\text{mass of pure compound}}{\text{mass of impure sample}} \times 100 \checkmark = \frac{4,576}{5} \times 100 \checkmark = 91,52\% \checkmark$ **(5)**

5.1.8 Number of moles of acid / base did not change $\checkmark$ **(1)**

5.1.9 (a) Neutralisation is the point where an acid and base have reacted $\checkmark$ so neither is in excess. $\checkmark$ **(2)**

(b) Indicator B $\checkmark$ Strong acid + strong base $\checkmark \rightarrow$ neutral end point $\checkmark \rightarrow$ choose indicator which changes colour around pH 7 $\checkmark$

OR Salt formed does not undergo hydrolysis $\checkmark \rightarrow$ neutral end point $\checkmark$ **(4)**

5.2 5.2.1 Sulphurous acid is stronger. $\checkmark$

The stronger the acid the greater the ionisation $\checkmark$ in aqueous solution.

Sulphurous acid has a higher $K_a \checkmark$

meaning concentration of ions greater (or it ionises more) $\checkmark$ making it a stronger acid. **(4)**

5.2.2 (a) proton donor $\checkmark$ **(1)**

(b) can donate 2 H^+ ions/protons $\checkmark$ **(1)**

5.2.3 (a) amphiprotic/amphoteric/ampholyte $\checkmark$ **(1)**

(b) $\text{SO}_3^{2-} \checkmark$ **(1)**

5.2.4 $K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]} \checkmark \checkmark$ -1 if not [] ; -1 if ionic charges not shown **(2)**

5.2.5 At $\equiv m$ let $[\text{CH}_3\text{COO}^-] = [\text{H}_3\text{O}^+] = x$

$1,8 \times 10^{-5} \checkmark = (x)(x)/0,2 \checkmark$

$x = 1,897 \times 10^{-3} \quad [\text{CH}_3\text{COO}^-] = 1,9 \times 10^{-3} \text{ mol.dm}^{-3} \checkmark$ **(3)**

Question 6 [13]

6.1 Even distribution of the plating on the handlebar $\checkmark$ **(1)**

6.2 $\text{Cr}(\text{NO}_3)_3$ (any soluble CrIII salt) $\checkmark$ **(1) FORMULA**

6.3 Chromium $\checkmark$ **(1)**

6.4 $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr} \checkmark \checkmark$ **(2)** -1 double arrow

6.5 $n(\text{Cr}^{3+}): n(\text{e}^-) = 3:1 \checkmark \quad n(\text{e}^-) = 3(0,01) = 0,03 \text{ mol} \checkmark$ **(2)**

6.6 $q = nF \checkmark = (0,03)(96500) \checkmark = 2895 \text{ C}$

$t = q/I = 2895/0,8 \checkmark = 3618,75 \text{ s} \checkmark$ **(4)**

6.7 1 mol chromium ions needs 3 mol electrons $\checkmark$ so large amount of charge needed $\checkmark$ **(2)**

Question 7 [17]

- 7.1 Chemical energy $\rightarrow$ electrical energy $\checkmark\checkmark$ (2)
- 7.2 Salt bridge $\checkmark$ (1)
- 7.3 $[\text{Pb}^{2+}] = 1 \text{ mol.dm}^{-3} \checkmark$ Temperature = $25^\circ\text{C} \checkmark$ (2)
- 7.4 Pb^{2+} or lead(II) ions NOT lead/Pb $\checkmark$ (1)
- 7.5 $E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} \checkmark$ $1,53 = (-0,13) - E^\theta_{\text{X}} \checkmark$ $E^\theta_{\text{X}} = -1,66 \text{ V} \checkmark$ X is aluminium $\checkmark$ (4)
- 7.6 $2\text{Al} + 3\text{Pb}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Pb} \checkmark$ **Reactants** $\checkmark$ **Products** $\checkmark$ **Balancing** (3)
- 7.7 Decreases $\checkmark$ reverse reaction favoured $\checkmark$ to reduce $[\text{Al}^{3+}] \checkmark$ (3)
- 7.8 Zero or 0 V $\checkmark\checkmark$ (1)

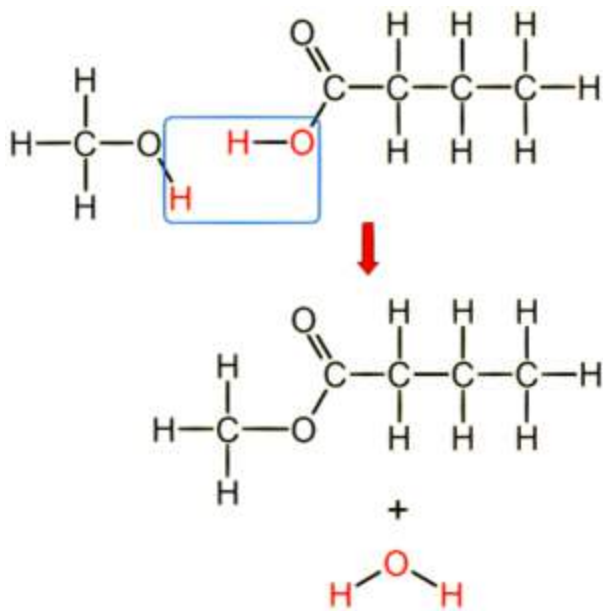
Question 8 [17]

- 8.1 $\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O} \checkmark$ **reactants** $\checkmark$ **products** $\checkmark$ **balancing** (3)
- 8.2 Butane $\checkmark\checkmark$ (2) **NAME**
- 8.3 8.3.1 compounds having the same molecular formula $\checkmark$ but different structural formulae $\checkmark$ (2)
- 8.3.2 chain isomers $\checkmark$ (1)
- 8.3.3 Both have London IMFs/Compound B has larger contact surface area than compound C $\checkmark$ larger temporary dipoles (OR more London IMFs can form) $\therefore$ IMFs are stronger $\checkmark \therefore$ more energy required to overcome the IMFs between pentane molecules.(4)
- 8.4 8.4.1 No $\checkmark$ Different molecular formula $\checkmark$ (2)
- 8.4.2 Both D and E have hydrogen bonding $\checkmark$ E has more hydrogen bonds and thus stronger IMFs. $\checkmark$ more energy required to overcome $\checkmark$ (3)

Question 9 [23]

- 9.1 Methane $\checkmark$ (1) **NAME**
- 9.2 $\text{CH}_4 \checkmark + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} \checkmark + \text{HCl} \checkmark$ (3) **CONDENSED STRUCTURAL FORMULA**
- 9.3 Halogenation/chlorination $\checkmark$ (1)
- 9.4 Alkane X is saturated $\checkmark$ rate is Slow $\checkmark$ Requires more energy to break strong C-H bonds $\checkmark$ (3)
- 9.5 series of similar compounds which have the same functional group $\checkmark$ and have the same general formula, $\checkmark$ in which each member differs from the previous one by a single CH_2 unit $\checkmark$ (3)
- 9.6 Alcohols $\checkmark\checkmark$ (2)
- 9.7 Methanol $\checkmark$ (1) **NAME**
- 9.8 9.8.1 Esterification $\checkmark$ (1)
- 9.8.2 carboxyl $\checkmark$ (1) **NAME**
- 9.8.3 butanoic acid $\checkmark$ (1) **NAME**

9.8.4



(4) STRUCTURAL FORMULA

9.9 Water bath ✓ alcohol is (or reactants are) flammable ✓ (2)