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Beaulieu College Marking Guidelines Chemistry Prelim Exam 2020

Question 1 (20)

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

Question 2**(21)**

2.1 Electronegativity is the measure of the tendency of an atom to attract a bonding pair of electrons. ✓✓ (2)

2.2 SiCl_2 END = $3.0 - 1.8 = 1.2$ ✓ or $\neq 0$

CS_2 END = $2.5 - 2.5 = 0$ ✓

SiCl_2 has polar covalent bonds ✓ and CS_2 has non-polar or pure covalent bonds ✓ (4)

2.3.1 metallic bonds ✓ (1)

2.3.2 There is electrostatic attraction ✓ between the delocalised electrons and the positively charged atomic kernels. ✓ (2)

2.3.3 A reaction that transforms chemical potential energy ✓ into thermal energy. ✓ (2)

2.3.4 Exothermic ✓. More energy is released than is absorbed ✓ since ΔH is negative. ✓ (3)

2.4.1 $M_r(\text{MoS}_2) = 96 + 2(32) = 160 \text{ g/mol}$ ✓

$n = \frac{m}{M} \text{ ✓} = 4/160 = 0.025 \text{ mol}$ ✓

(3)

2.4.2 $n = \frac{V}{V_m} = 28/22.4 \text{ ✓} = 1.25 \text{ mol}$ ✓

$\text{MoS}_2 : \text{O}_2$

$2 : 7 \text{ ✓}$

Required $0.025 : 0.0875$

$m(\text{O}_2) = 1.16 \times 32$

Have $n(\text{O}_2) = 1.25 \text{ mol}$

$= 37.2 \text{ g}$ ✓

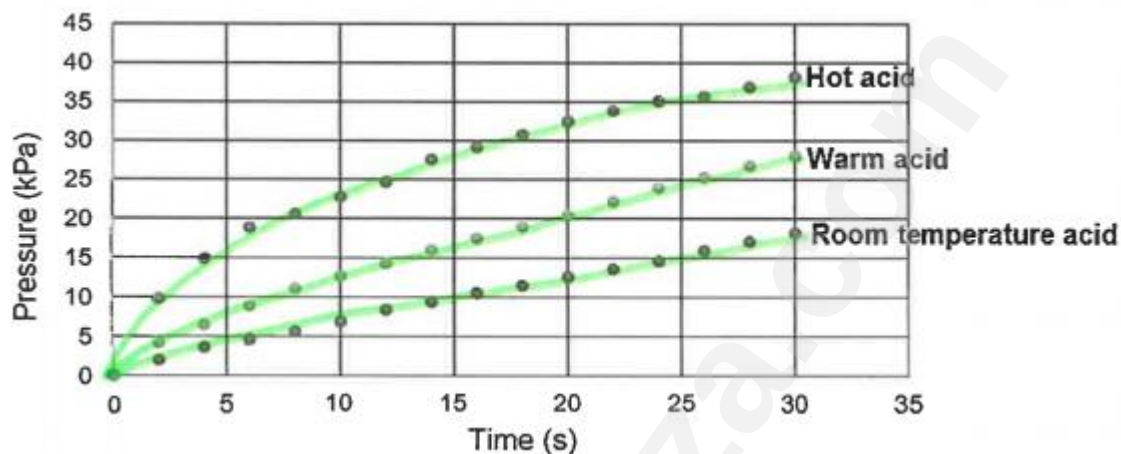
O_2 is in excess by: $1.25 - 0.0875 = 1.16 \text{ mol}$ ✓

(4)

Question 3**[22]**

3.1.1 The change in concentration per unit time ✓ of either a reactant or product. ✓ (2)

3.1.2 ON ANSWER SHEET. Curve ✓ trend ✓ (2)



3.1.3 Average rate of reaction. ✓✓ (1)

3.1.4 As the temperature of the acid increases ✓ the reaction rate also increases. ✓ (2)

3.1.5 The average kinetic energy of the particles increase ✓

Particles move faster and there are more collisions per unit time

More particles have kinetic energy greater than activation energy ✓

More effective/successful collisions per unit time ✓

Therefore reaction rate increases. (3)

3.2 $n(\text{Mg}) = \frac{m}{M} = \frac{0,05}{24,3} = \underline{2,06 \times 10^{-3} \text{ mol}}$ ✓ (5)

$$n(\text{HCl}) = cv = 5 \times 10^{-3} \times 1 = \underline{5 \times 10^{-3} \text{ mol}} \checkmark$$

Mg : HCl

1 : 2 ✓

$$2,06 \times 10^{-3} : 4,2 \times 10^{-3}$$

therefore Mg is the limiting reagent ✓

Must use the limiting reagent to calculate the hydrogen formed.

Mg : H₂

$$1 : 1 \quad n = \underline{2,06 \times 10^{-3} \text{ mol}} \checkmark$$

3.2.2 All the magnesium will be used up. ✓✓ OR (2)

No more bubbles form ✓✓ OR

The reading on the pressure sensor will be constant. ✓✓

3.3 Ratio Mg : H₂ (5)

1:1 ✓

therefore $n(\text{Mg}) = 0,04 \text{ mol}$

Pure mass of Mg $n = m/M$ $m = 0,04 \times 24,3 \checkmark = \underline{0,972 \text{ g}} \checkmark$

% purity = $\frac{\text{pure mass}}{\text{impure mass}} \times 100$

$0,895 = \frac{0,972}{x} \checkmark$ impure mass = $\underline{1,09 \text{ g}} \checkmark$

Question 4 (25)

4.1 $K_c = \frac{[\text{NH}_3]^2 \checkmark}{[\text{N}_2][\text{H}_2]^3 \checkmark}$ (2)

4.2 $[\text{N}_2] = \frac{n}{V} \checkmark = \frac{7}{5} = \underline{1,4 \text{ mol.dm}^{-3}} \checkmark$ (4)

$[\text{H}_2] = \frac{8}{5} = \underline{1,6 \text{ mol.dm}^{-3}} \checkmark$

$[\text{NH}_3] = \frac{2}{5} = \underline{0,4 \text{ mol.dm}^{-3}} \checkmark$

4.3 $K_c = (0,4)^2 \checkmark / (1,6)^3 \checkmark (1,4) = \underline{0,028} \checkmark \text{ c.o.e}$ (3)

4.4 Since K_c is much less than 1 ✓ it means that the yield of the product is very low. ✓ (2)

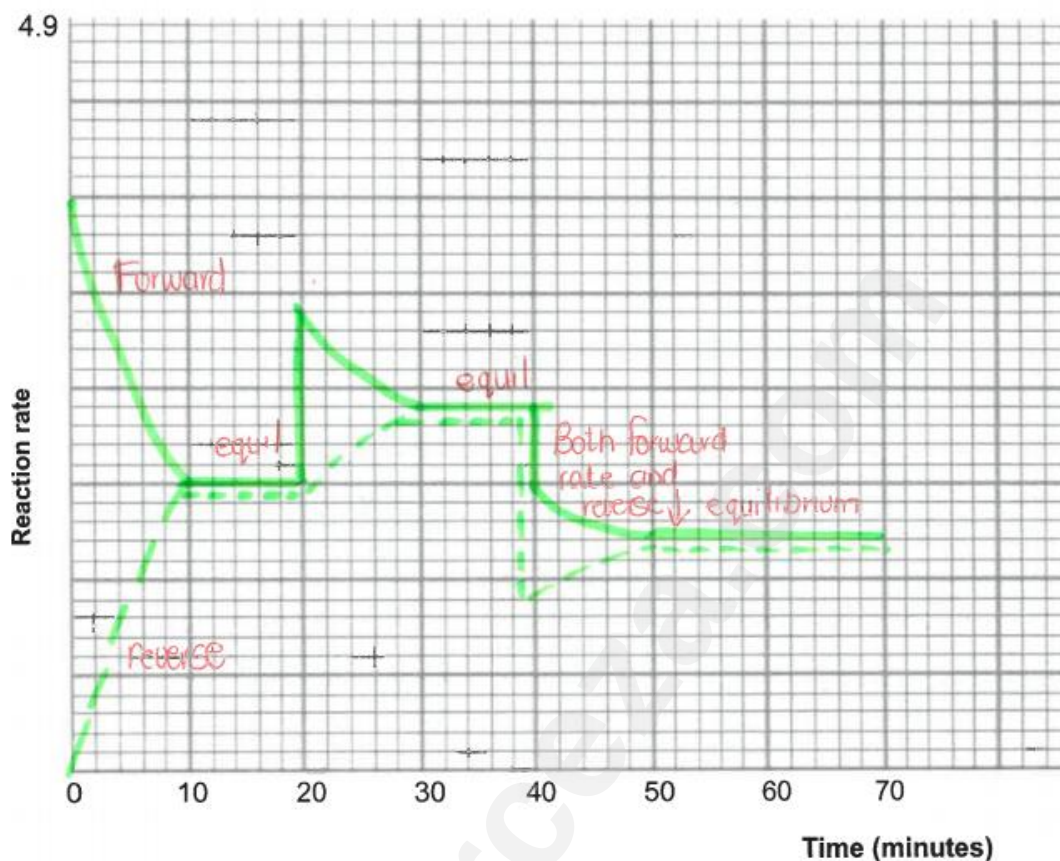
4.5 H₂ was added or the concentration of H₂ increased ✓✓ (2)

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

4.7 $n(\text{H}_2)$ decreased $n(\text{N}_2)$ decreased. ✓ $n(\text{NH}_3)$ increased ✓ (4)
According to LCP the system will counteract the stress. ✓
The forward reaction is favoured. ✓

4.8 The temperature is decreased ✓✓ (2)

4.9 Graph ON ANSWER SHEET (4)
Initial rate of forward and reverse reactions ✓
Equilibrium at 10, 30 and 60 minutes ✓
At 20 minutes forward reaction favoured ✓
At 40 min both reaction rates decrease but the forward reaction ends at a higher rate ✓

**Question 5****(30)**

- 5.1 A standard solution is a solution of known concentration. ✓✓ (2)
- 5.2 $c = \frac{n}{v}$ ✓ $n = 0,22 \times 0,5$ ✓ = 0,11 mol ✓ (3)
- 5.3 $X(OH)_2(s)$ ✓ $\rightarrow X^{2+}(aq) + 2OH^{-}(aq)$ ✓ ✓ state symbols (3)
- 5.4 $[H_3O^+][H_2O] = K_w$ ✓ $[OH^-] = 2 \times 0,22 = 0,44 \text{ mol.dm}^{-3}$ ✓ (3)
 $[H_3O^+][0,44] = 1,219 \times 10^{-14}$
 $[H_3O^+] = \underline{2,77 \times 10^{-14} \text{ mol.dm}^{-3}}$ ✓
- 5.5 HCl ✓ - K_a value is much higher ✓ or it is a strong acid thus it would dissociate completely to form more ions ✓ that can conduct electricity (3)
- 5.6 Point where an acid and a base have reacted where neither is in excess. ✓✓ (2)

- 5.7 HCl ✓ (1)
- 5.8 The graph shows a very low pH at the start ✓ which means a strong acid was used. ✓ (2)
- 5.9 A ✓ (1)
- 5.10 The conjugate acid of a strong acid does not undergo hydrolysis ✓ but the conjugate base of a weak acid does ✓ and form OH⁻ ions. ✓ (3)
- 5.11 bromothymol blue ✓ (1)
- 5.12 a) C F A B D G E ✓✓ -1 for each error (2)
- 5.13 b) $CbVb/CaVa = 1/2$ ✓ (4)

$$25 \times Cb / 0,22 \times 24,9 = 1/2$$

$$50Cb = 0,22 \times 24,9$$

$$Cb = 0,11 \text{ mol.dm}^{-3} \checkmark$$

$$n = cv$$

$$= 0,11 \times 25 \times 10^{-3}$$

$$= 2,74 \times 10^{-3} \text{ mol} \checkmark$$

In original solution (250 ml)

$$n = 2,74 \times 10^{-2} \text{ mol} \checkmark$$

$$n = cv$$

$$= 0,22 \times 24,9 \times 10^{-3}$$

$$= 5,478 \times 10^{-3} \text{ mol} \checkmark$$

Ratio acid : base

$$2 : 1 \checkmark$$

$$5,478 \times 10^{-3} : x$$

$$n (\text{base}) = 2,74 \times 10^{-3} \text{ mol} \checkmark$$

$$\text{In original solution } n = 2,74 \times 10^{-2} \text{ mol} \checkmark$$

Question 6

(23)

- 6.1 chemical energy ✓ → electrical energy ✓ (2)
- 6.2 Sn ✓ reduction occurs at this electrode ✓ OR this electrode gains electrons to form metal / gains mass ✓ (3)
- 6.3 electrode at which oxidation occurs. ✓✓ (2)
- 6.4 X to Sn ✓
- 6.5 $E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}} \checkmark$ (3)
- 0,6 = (- 0,14) - $E^{\circ}_{\text{anode}} \checkmark$
- $E^{\circ}_{\text{anode}} = - 0,74 \text{ V} \checkmark$
- 6.6 chromium (Cr) ✓ (1)

6.7 $\text{Cr}_{(s)} / \text{Cr}^{3+}_{(aq)} \checkmark // \checkmark \text{Sn}^{2+}_{(aq)} / \text{Sn}_{(s)} \checkmark$ anode, cathode, saltbridge, conditions
 $1\text{mol}\cdot\text{dm}^{-3}$ $1\text{mol}\cdot\text{dm}^{-3} \checkmark$ @ 25 °C

6.8 $3\text{Sn}^{2+} + 2\text{Cr} \checkmark \rightarrow 3\text{Sn} + 2\text{Cr}^{3+} \checkmark$ (2)

6.9 At the cathode the positive ions are removed from the solution and the concentration of the positive ions decreases. $\checkmark$ The solution becomes more negative. The salt bridge provides the positive ions $\checkmark$ to the cathode to maintain the neutrality. $\checkmark$ (3)

6.10.1 Remains the same $\checkmark$ (1)

6.10.2 Increases $\checkmark$ (1)

6.10.3 Decreases $\checkmark$ (1)

Question 7 (14)

7.1 $2\text{Cl}^- \rightarrow \text{Cl}_{2(g)} + 2\text{e}^- \checkmark \checkmark$ (2)

7.2 Both are highly explosive and react spontaneously when in contact $\checkmark \checkmark$ (2)

7.3 Water is a stronger oxidising agent than sodium ions $\checkmark \checkmark$. Water will therefore rather be reduced $\checkmark$ and not the sodium ions. (3)

7.4 $Q = It \checkmark = 4150 \times 3,5 \times 60 \checkmark$ (7)

$$= \underline{\underline{871\,500\text{ C or }8,71 \times 10^5\text{ C}}}$$

$$Q = nF \checkmark$$

$$n = 871500 / 2 \times 96500 \checkmark$$

$$= \underline{\underline{4,52\text{ mol}}} \checkmark$$

$$V = nV_m$$

$$= 4,52 \times 22,4 \checkmark$$

$$= \underline{\underline{101,02\text{ dm}^3}} \checkmark \text{ OR}$$

$$Q = nF \checkmark$$

$$871500 = n \times 96500$$

$$n = \underline{\underline{9,02\text{ mol}\cdot\text{e}^-}} \checkmark$$

$$n\text{e}^- : n\text{Cl}_2$$

$$2 : 1 \checkmark$$

$$9,02 : 4,51$$

$$V = nV_m$$

$$= 4,51 \times 22,4 \checkmark$$

$$= \underline{101 \text{ dm}^3} \checkmark$$

Question 8

(22)

- 8.1 Atom or group of atoms that form the centre of chemical activity in the molecule. $\checkmark \checkmark$ (2)
- 8.2 carboxyl group $\checkmark$ (1)
- 8.3 methyl propanoate $\checkmark \checkmark$ (2)
- 8.4 $\text{CH}_3\text{COOCH}_2\text{CH}_3$ $\checkmark \checkmark$ (2)
- 8.5 Compounds with the same molecular formula but a different structural formula. $\checkmark \checkmark$ (2)
- 8.6 They do not have the same molecular formula. $\checkmark \checkmark$ (2)
- 8.7 butanoic acid $\checkmark \checkmark$ (2)
- 8.8 A weak force of attraction between molecules or atoms of a noble gas. $\checkmark \checkmark$ (2)
- 8.9 D has **dipole-dipole forces** $\checkmark$ while C has **hydrogen bonding**. $\checkmark$ (4)
 Hydrogen bonding is a stronger intermolecular force than dipole-dipole forces.
 $\checkmark \therefore$ More energy is needed to overcome the stronger hydrogen bonds in C. $\checkmark$
 C has a higher boiling point than D.
- 8.10 3-ethyl $\checkmark$ -2,4-dimethyl $\checkmark$ hexane $\checkmark$ (3)

Question 9

(22)

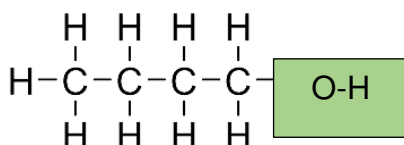
9.1 Series of compounds which have the same functional group and have the same general formula, in which each member differs from the previous by a single CH_2 unit. ✓✓ (2)

9.2 haloalkane ✓ (1)

9.3.1 hydrolysis ✓ (1)

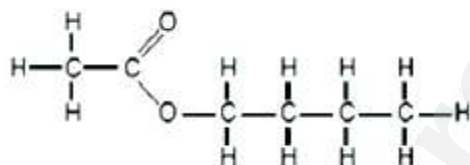
9.3.2 dehydrohalogenation ✓ (1)

9.4



(2)

9.5.1



(4)

Butyl ethanoate ✓✓

9.5.2 H_2O ✓✓ (2)

9.5.3 Dehydrating agent or acts as a catalyst ✓ (1)

9.6.1 $\text{C}_4\text{H}_8 + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 4\text{H}_2\text{O}$ R ✓ L ✓ B ✓ (3)

9.6.2 $n(\text{butane}) = \frac{m}{M} = \frac{12,32}{56} = \underline{0,22 \text{ mol}}$ ✓ (5)

$\text{C}_4\text{H}_8 : \text{CO}_2$

$1 : 4$ ✓

$0,22 : 0,88 \text{ mol CO}_2$

$m(\text{CO}_2) = nM = 0,88 \times 44 = \underline{38,72 \text{ g}}$ ✓

% yield = actual yield / theoretical yield $\times 100$

$= \underline{30,03/38,72}$ ✓

$= \underline{77,56 \%}$ ✓