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WOODRIDGE COLLEGE

14 SEPTEMBER 2020

3 HOURS

PHYSICAL SCIENCES: PAPER II

EXAMINER: Dr C Logie

TOTAL = 200 marks

MODERATOR: Mr P Maartens

GRADE 12

MEMO

QUESTION 1 – Multiple Choice

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

[10×2=20]

QUESTION 2 – Chemical Bonding

(Adapted from St Anne's Trial 2019)

2.1 $3\text{Cl}_2 + 6\text{NaOH} \rightarrow \text{NaClO}_3 + 5\text{NaCl} + 3\text{H}_2\text{O}$ formulae ✓✓✓, balanced ✓ (4)

2.2

2.2.1 Ionic bond: A transfer of electrons✓ and subsequent electrostatic attraction✓ (2)

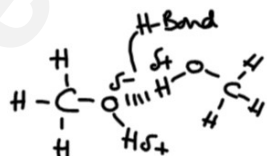
2.2.2 When molten✓ or dissolved in water✓; ions are free to move✓ (3)

2.3

2.3.1 Electronegativity: A measure of the tendency of an atom to attract a bonding pair of electrons. ✓✓ (2)

2.3.2 O and H ✓ (1)

2.3.3



(✓✓ molecules draw correctly; ✓ hydrogen bond labelled) (3)

2.3.4 Hydrogen bonded to a small atom✓ of high electronegativity✓ with at least one lone pair of electrons✓ (3)

2.4

2.4.1 Dipole-dipole intermolecular forces ✓✓ (2)

- 2.4.2 Increase in mass ✓ from HCl to HBr to HI and increase in number of electrons ✓ so an increase in strength of Van der Waals forces ✓ and boiling temperature. (3)

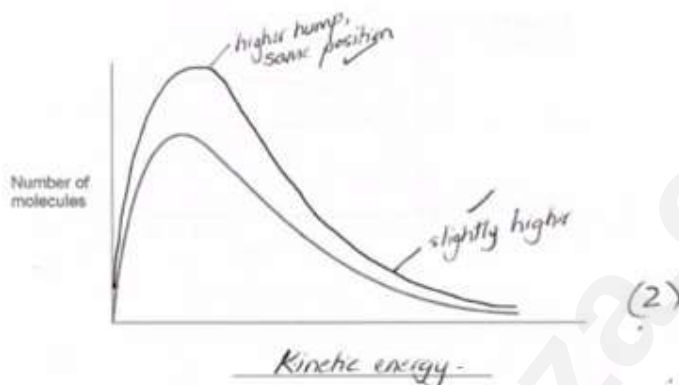
[23]

QUESTION 3 – Energy Changes and Rates of Reaction

(adapted from St Mary's DSG Trials 2019)

3.1

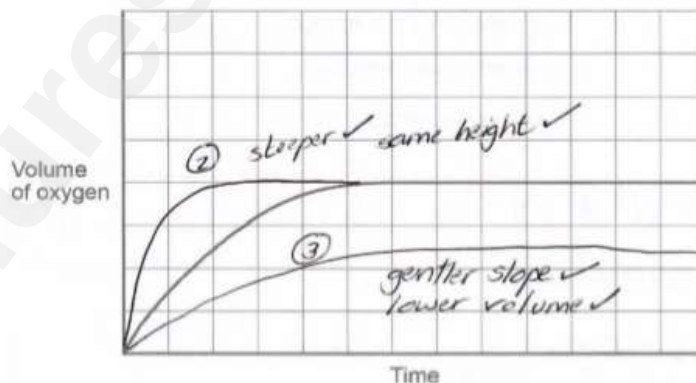
- 3.1.1 Kinetic energy ✓ (1)
 3.1.2 Concentration: Amount of solute ✓ per unit volume of solution ✓ (2)
 3.1.3 (2)



- 3.1.4 Increase in temperature increases the average kinetic energy ✓ of the particles. They therefore move faster and there are more effective collisions per unit time ✓ and more molecules with the required activation energy ✓ (or sufficient E_k) ∴ a faster rate. (3)

3.2

- 3.2.1 Catalyst: a substance that increases the rate of the reaction ✓ but remains unchanged at the end of the reaction ✓ (2)
 3.2.2 (4)



3.3

- 3.3.1 Yield: 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 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. Moderate pressure ensures equipment is safe ✓ and not expensive. ✓

(4)

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

$$\text{theoretical mass} = \frac{\text{actual mass} \times 100}{\% \text{ yield}} = \frac{504 \times 100}{40} \checkmark = 1260 \text{ g} \checkmark \text{ of } \text{HNO}_3$$

$$n(\text{HNO}_3) = \frac{m}{M} = \frac{1260}{1 + 14 + 3(16)} \checkmark = 20 \text{ mol} \checkmark$$

$$n(\text{NO}_2) = 20 \text{ mol} \checkmark$$

$$m(\text{NO}_2) = nM = 20 \times (14 + 32) \checkmark = 920 \text{ g} \checkmark$$

(7)

[28]

QUESTION 4 – Chemical Equilibrium

(Hilton Trials 2019)

4.1

4.1.1 Le Chatelier's Principle: 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)

4.1.2 Decrease ✓

Increasing pressure means reaction producing fewer moles of gas is favoured ✓

Reverse reaction favoured ✓ therefore decreasing yield

(3)

4.1.3 Removing hydrogen gas favours the forward reaction ✓ to increase the concentration of hydrogen gas. ✓ This will increase the yield. ✓

(3)

4.2

4.2.1

4.2.1.1 larger than ✓ as $K_c > 1$ ✓

(2)

4.2.1.2 At equilibrium

$$n(\text{CO}) = \frac{m}{M} = \frac{168}{12 + 16} \checkmark = 6 \text{ mol} \checkmark$$

$$[\text{CO}] = \frac{n}{V} = \frac{6}{2} \checkmark = 3 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark \therefore [\text{CO}_2] = \frac{[\text{CO}]^2}{K_c} = \frac{3^2}{14} \checkmark = 0.64 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

$$n(\text{CO}_2) = cV = 0.64 \times 2 \checkmark = 1.28 \text{ mol} \checkmark$$

Initially

	CO ₂	2CO
Initial	4.28 mol ✓	0
Change	-3 mol ✓	+6 mol
Equilibrium	1.28 mol	6 mol

(9)

4.2.2

4.2.2.1 Remains the same ✓

(1)

4.2.2.2 Decrease ✓

(1)

4.2.2.3 Increase ✓

(1)

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QUESTION 5 – Acids and Bases

(Adapted from St John's DSG Trial 2019)

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5.1

- 5.1.1 Monoprotic ✓ (1)
5.1.2 Phenolphthalein ✓, weak acid reacting with a strong base ✓ (2)
5.1.3 Hydrolysis of a salt: a reaction of an ion (from a salt) with water ✓✓ (2)
5.1.4 $C_2H_5COO^-$ ✓ (1)
5.1.5 $C_2H_5COO^- + H_2O \rightarrow C_2H_5COOH + OH^-$ ✓✓ (2)

5.2

- 5.2.1 Strong acid: An acid that ionises completely in an aqueous solution, ✓✓ (2)
5.2.2 Greater than ✓; stronger acid ✓ (2)
5.2.3 Nitric acid ✓; more ions in solution ✓ (coe from 5.2.2) (2)
5.2.4 $2HNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$ ✓ (-1 if not balanced) (3)

5.3

5.3.1 $[OH^-] = \frac{K_w}{[H_3O^+]} \checkmark = \frac{10^{-14} \checkmark}{2 \times 0.4 \checkmark} = 1.25 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3} \checkmark$ (4)

5.3.2 $\frac{n_A}{n_B} = \frac{c_A V_A}{c_B V_B} \therefore c_B = \frac{n_B c_A V_A}{n_A c_B V_B} \checkmark = \frac{2 \times 0.4 \times 20 \checkmark}{1 \times 30 \checkmark} = 0.53 \text{ mol} \cdot \text{dm}^{-3} \checkmark \checkmark$ (5)

Or

$$n_A = cV = 0.4 \times 0.02 \checkmark = 0.008 \text{ mol} \checkmark$$

$$n_B = 0.016 \text{ mol} \checkmark$$

$$c_B = \frac{n}{V} = \frac{0.016}{0.03} \checkmark = 0.53 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

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QUESTION 6 – Electrochemistry

(Adapted from St John's DSG Trials 2019 & Marist Brothers Prelim 2019)

6.1

- 6.1.1 Reduction reaction: one where electrons are gained ✓✓ (2)
 6.1.2 $\text{Co}^{2+} + 2\text{e}^- \rightarrow \text{Co}$ ✓✓ (2)
 6.1.3 Co^{2+} (1)
 6.1.4 $\text{Al(s)} \mid \text{Al}^{3+}(1 \text{ mol} \cdot \text{dm}^{-3}) \parallel \text{Co}^{2+}(1 \text{ mol} \cdot \text{dm}^{-3}) \mid \text{Co(s)}$ ✓ at 25°C ✓
 Concentrations ✓, phase indicators ✓ (5)

6.2

- 6.2.1 It is the reference cell set at standard conditions against which all electrode potentials are measured ✓✓ (2)
 6.2.2 Platinum ✓ (1)
 6.2.3 completing the circuit ✓; maintaining electrical neutrality in the half-cells ✓ (2)
 6.2.4 Chromium ✓✓ Cr (2)
 6.2.5 anode ✓ (1)
 6.2.6 $2\text{Cr} + 6\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{H}_2$ ✓✓ (2)
 6.2.7 Decrease ✓ as reverse reaction favoured ✓ (2)

6.3

- 6.3.1 electrical potential energy ✓ → chemical potential energy ✓ (2)
 6.3.2 $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ ✓✓ (2)
 6.3.3 Ag is a stronger reducing agent than Au ✓ so Ag will be more readily oxidised ✓ at the anode (silver strip). Au will therefore fall to the bottom as sludge.
 Cu is a stronger reducing agent than Ag ✓ and so Cu will preferentially be oxidised to form Cu^{2+} ions in solution. ✓ (4)
 6.3.4 The Ag^+ ions in solution are a better oxidising agents than the Cu^{2+} ions ✓ in solution and so the Ag^+ ions will be more readily reduced and deposited ✓ than the Cu^{2+} ions. (2)
 6.3.5 $n(\text{Ag}) = \frac{m}{M} = \frac{5.83}{108} \checkmark = 0.05 \text{ mol} \checkmark$
 $n(\text{electrons}) = 0.05 \text{ mol} \checkmark$
 $Q = nF = 0.05 \times 96500 \checkmark = 5209.21 \text{ C} \checkmark$ (accept 4825 – 5210)
 $I = \frac{Q}{t} = \frac{5209.19}{30 \times 60} \checkmark = 2.89 \text{ A} \checkmark$ (accept 2.68 – 2.89) (7)

6.4

- 6.4.1 Membrane cell ✓ (1)
 6.4.2 Concentrated ✓ NaCl solution ✓ (2)
 6.4.3 In contact gases react ✓ (1)

[43]

7.1

7.1.1 Homologous Series: A series of similar compounds which have the same functional group and have the same general formula✓, in which each member differs from the previous one by a single CH₂ unit✓. (2)

7.1.2

7.1.2.1 Ester ✓ (1)

7.1.2.2 Alkene ✓ (1)

7.1.3 C_nH_{2n} ✓ (1)

7.1.4 Pentanoic acid ✓✓ (2)

7.1.5 Higher than ✓ (1)

7.1.6 Next member is hexanoic acid ✓ and hexanoic acid has a larger surface area or longer chain length or molecular mass than pentanoic acid, ✓ and therefore a greater number of intermolecular forces ✓ More energy needed to overcome intermolecular forces in hexanoic acid and therefore a higher boiling point ✓ (4)

7.1.7

7.1.7.1 Structural isomer: Compounds having the same molecular formula but different structural formulae ✓✓ (2)

7.1.7.2 Drawing of Pentan-1-ol or Pentan-3-ol ✓✓ (2)

7.1.7.3 Pentan-1-ol or Pentan-3-ol ✓✓ or accept 1-pentanol (don't accept for pent-1-ol) Pent-3-anol (one mark) (2)

7.1.8 C₆H₁₂ ✓ + 9O₂ ✓ → 6CO₂ ✓ + 6H₂O ✓ balanced ✓ (5)

7.2

7.2.1 Unsaturated compound: molecule contains at least one double or triple bond between C atoms ✓✓ (2)

7.2.2 Hydration ✓ (don't accept addition) (1)

7.2.3 propan-1-ol ✓✓ (propanol ✓) (2)

7.2.4 ester ✓ (1)

7.2.5 methanoic acid ✓ (1)

7.2.6 heat ✓ (under reflux) and conc H₂SO₄ ✓ (2)

7.2.7 C₄H₈O₂ ✓ Ethyl ethanoate ✓✓ or butanoic acid or methyl propanoate (3)

7.2.8 Substitution ✓ (1)

7.2.9 Hot concentrated KOH / NaOH (base) ✓ in ethanol ✓ (in the absence of water) (2)

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Total = 200 marks