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PRELIMINARY EXAMINATION 2024

PHYSICAL SCIENCES PAPER 2

MARKING GUIDELINES

GRADE 12

Time: 3 Hours

Marks: 200

Examiner: B. Mandindi

Moderator: Dr S. Wilson/Ms Z. Nguyuza

QUESTION 1 – MULTIPLE CHOICE

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

[2 x 10 = 20]

QUESTION 2 CHEMICAL BONDING

- | | | |
|-------|---------------------|-----|
| 2.1.1 | NH ₃ ✓ | (1) |
| 2.1.2 | MgCl ₂ ✓ | (1) |
| 2.1.3 | Diamond✓ | (1) |
| 2.1.4 | Fe✓ | (1) |
| 2.1.5 | CF ₄ ✓ | (1) |

- 2.2 SiO₂ forms a **giant COVALENT network solid**✓ where each atom is **COVALENTLY bonded** to many others. SO₂ has polar covalent molecules with **dipole-dipole forces**✓ between its molecules. These dipole-dipole forces are much **weaker** than the STRONG covalent bonds in SiO₂✓. **More energy** is needed to break the stronger covalent bonds, hence higher m.pt of SiO₂.✓

(4)

[9]

QUESTION 3 REACTION RATES

- 3.1.1 • Peak shifted to right and lower. ✓
 • End higher (and not cutting through low temperature curve.) ✓ (2)

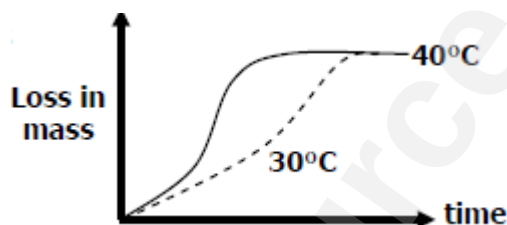
- 3.1.2 Increasing temperature and increases the average kinetic energy of the particles. ✓
 More particles now have energy greater than the activation energy. ✓
 There are more effective collisions per second ✓ ∴ the reaction rate increases ✓. (4)

- 3.2.1 The change in amount or concentration of reactant or product ✓ per unit time. ✓ (2)

- 3.2.2 The reaction is exothermic ✓ thus the extra heat given off allows for more effective collisions per second ✓ and ∴ a greater reaction rate (as shown by the steeper curve.) (2)

- 3.2.3 This is an indication that one (or both) of the reactants has 'run out' by being used up to make product. ✓
 Thus, there will be fewer collisions per second ✓ and the reaction rate will decrease or stop (reaction has reached completion). (2)

3.2.4



Less steep gradient ✓

The graph becomes horizontal after the initial one on the same line. ✓ (2)

- 3.2.5 Reaction rate is INCREASED ✓. (1)

3.2.6

$$\begin{aligned} \text{Zn} \\ n &= \frac{m}{M} = \frac{10}{65,4} \checkmark \\ &= 0,15 \text{ mol Zn } \checkmark \end{aligned}$$

$$\begin{aligned} \text{HCl} \\ n &= c \times v \\ &= 3,6 \times 0,1 \checkmark \\ &= 0,36 \text{ mol HCl } \checkmark \end{aligned}$$

Mol ratio

$$\begin{array}{lcl} \text{Zn} & : & \text{HCl} \\ 1 & : & 2 \\ 0,15 & : & 0,3 \checkmark \end{array}$$

Zn is the limiting reagent, ∴ increasing the concentration of HCl will have no effect on the loss in mass of the system. ✓

(6)

[21]

QUESTION 4:

4.1 Dynamic chemical equilibrium✓ (1)

4.2 For every 1 mol of A✓ used, 2 mols of B is used✓ (2)

4.3 According to LCP:
A temperature increase favours endothermic reaction✓ to use up the heat energy✓
From the graph, the forward reaction is favoured✓
Therefore the forward reaction is endothermic✓ (4)

4.4 [Product] increases✓, [Reactants] decreases✓
 $K_c = \frac{[Products]}{[Reactants]}$ INCREASES✓ (3)

4.5 $K_c = \frac{[AB_2]✓}{[A].[B]^2✓}$ (2)

4.6

	A	B	AB ₂
At 4 mins	0,66	0,42	0,30
Used / Formed	-0,16✓	-0,32✓	+0,16
At $\equiv m$	0,50	0,10✓	0,46✓

$$K_c = \frac{[AB_2]}{[A].[B]^2} = \frac{(0,46)}{(0,5).(0,1)^2} = 92✓ (5)$$

4.7 B is added✓ (1)

4.8 UNCHANGED✓
No change in temperature✓ (2)

4.9 Mixture becomes blue✓✓ (2)

4.10 On Answer Sheet 3 (6)

4.11 On Answer Sheet 4 (3)

[31]

QUESTION 5 ACIDS AND BASES

5.1.1 **Salt** is a substance in which the hydrogen of an acid has been replaced by a cation. ✓✓ (2)

5.1.2 MgCl_2 ✓ (1)

5.1.3 $n = C \times V$ ✓
 $= 2 \times 0,1$ ✓
 $= \underline{0,2 \text{ mol}}$ ✓ (3)

5.1.4 $n = c \times v = (0,6 \times 0,04)$ ✓
 $= \underline{0,024 \text{ mol}}$ ✓ (2)

5.1.5 $n = 0,2 - 0,024 = \underline{0,176 \text{ mol}}$ ✓ (1)

5.1.6 **mol ratio** $\text{MgO} : \text{HCl}$
 $1 : 2$
(Pure) $0,088$ ✓ : $0,176$
 $N = \frac{m}{M} = \frac{5}{40,3}$ ✓ Mass can be used instead after ratios
 $= 0,124 \text{ mol impure MgO}$ ✓ $m = nM$
% purity $\frac{0,088 \times 100}{0,124 \times 1}$ ✓ $= 0,088 \times 40,3$ ✓
 $= \underline{70,93 \%}$ ✓ $= 3,5464 \text{ g}$ ✓
% purity $= 3,5464 / 5 \times 100$ ✓
 $= 70,93 \%$ ✓ (5)

5.1.7 MgO is a giant ionic solid ✓. It has many ✓ strong ionic ✓ bonds. A lot of energy is required to break ✓ these ionic bonds (4)

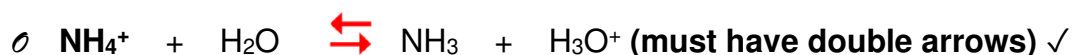
5.1.8 Burette ✓ (1)

5.1.9.1 **Neutralisation** is the point where an acid and base have reacted so neither is in excess. ✓✓ (2)

5.1.9.2 B ✓
(Strong acid + strong base) ✓
= neutral end point ✓ (3)

5.1.10 Distilled water is neutral. ✓
OR It does not affect the number of mols of acid and base in the flask. (1)

5.2. The **ammonium ion** from the salt is a conjugate **ACID** ✓ (of the weak base, NH_4OH), and will thus DONATE protons (H^+ ions) to water according to the following equation...



- o The SO_4^{2-} ion from the salt, which forms from a strong acid H_2SO_4 does not hydrolyse water and it remains fully ionized.
- o Thus, the concentration of H_3O^+ ions in solution increases✓
- o causing the solution at the end point to be slightly acidic (having a $\text{pH} < 7$). ✓
- o Gave 1 mark for saying weak base + strong acid therefore acidic solution produced

5.3.1 **Sulphurous acid** is stronger. ✓

A strong acid **ionises almost completely**✓ in aqueous solution.
Sulphurous acid has a **higher K_a** ✓ meaning more of the molecules ionise✓
making it a stronger acid. (4)

5.3.2 $K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$ ✓

-1 if not []

-1 if – or + not with ions

(2)

5.3.3 At Eqm: $[\text{H}_3\text{O}^+] = [\text{CH}_3\text{COO}^-] = x$

✓ $1,8 \times 10^{-5} = \frac{[x][x]}{0,2}$ ✓

$x^2 = 3,6 \times 10^{-6}$

$x = 1,9 \times 10^{-3}$

$[\text{CH}_3\text{COO}^-] = \underline{1,9 \times 10^{-3} \text{ mol.dm}^{-3}}$ ✓ (3)

[38]

QUESTION 6:

6.1 Chemical✓ to electrical✓ (2)

6.2 1 mol.dm^{-3} ✓ (1)

6.3 HCl ✓✓ (KCl) (2)

6.4 Co (2)

6.5 $\text{Cl}_2 + 2e^- \rightarrow 2\text{Cl}^-$ ✓✓ (2)

6.6 $\text{Co} \rightarrow \text{Co}^{2+} + 2e^-$ ✓

$\text{Cl}_2 + \text{Co} \rightarrow 2\text{Cl}^- + \text{Co}^{2+}$ ✓✓ (3)

6.7 Cobalt to Chlorine✓
(Anode to Cathode) (2)

6.8 ✓ ✓ ✓
 $\text{Co (s)} \mid \text{Co}^{2+} (1 \text{ mol. dm}^{-3}) \parallel \text{Cl}^- (1 \text{ mol. dm}^{-3}) \mid \text{Cl}_2 (\text{g}) \mid \text{Pt (s)}$ (3)

6.9 $\text{emf} = E_{\text{cath}}^o - E_{\text{an}}^o = 1,36 \checkmark - (-0,28 \checkmark) = 1,64 \text{ V}$ ✓ (3)

6.10 $\text{Cl}_2 + \text{Co} \rightarrow 2\text{Cl}^- + \text{Co}^{2+}$
Increasing $[\text{Co}^{2+}]$ ✓ will favour the reverse reaction✓ decreasing the emf✓ (3)

[23]

QUESTION 7:

- 7.1 NaCl✓ (aq) (1)
- 7.2 Y✓ (1)
- 7.3 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓✓ (2)
- 7.4 $2Cl^- \rightarrow Cl_2 + 2e^-$ ✓
 $2Cl^- + 2H_2O \rightarrow Cl_2 + H_2 + 2OH^-$ ✓✓ (3)
- 7.5 Na⁺ is a weaker oxidising agent than H₂O✓
 H₂O molecules are more easily reduced at the cathode✓
 (2)
- 7.6 $Q = I \cdot t = (4000) \cdot (150 \text{ ✓}) = 600\,000 \text{ C ✓}$
 $n_{e^-} = \frac{Q}{F} = \frac{600\,000}{96\,500} = 6,2176 \text{ mol ✓}$
 $2Cl^- \rightarrow Cl_2 + 2e^-$
 $e^- : Cl_2$
 $2 : 1$
 $6,2176 : 3,1088 \text{ ✓}$
 $m = n \cdot M = (3,1088) \cdot (71) = 220,73 \text{ g ✓}$ (5)
- 7.7 The membrane only allows Na⁺ ions to pass through✓✓ (2)

[16]**QUESTION 8**

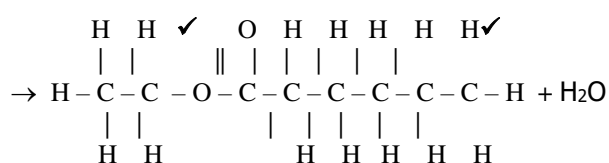
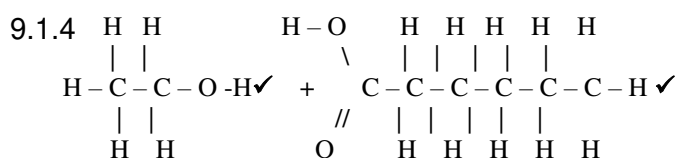
- 8.1.1 A✓ (1)
- 8.1.2 B and D ✓ (1)
- 8.1.3 E✓ (1)
- 8.1.4 C✓ (1)
- 8.2 2-methylbutane ✓✓ (2 is redundant) (2)
- 8.3.1 Test with **Br₂ water**.✓ If it loses its colour ✓rapidly✓ it is an unsaturated compound. (3)
- 8.3.2 butan-2-ol ✓✓ (butanol✓) (2)
- 8.3.3 Water ✓ (1)
- 8.3.4 Elimination✓ (1)
- 8.3.5 $C_4H_8 + 5O_2 \text{ ✓} \rightarrow 4CO_2 + 2 H_2O \text{ ✓}$ ✓ Balancing (3)
- 8.4 **D**, an alkane, (non-polar molecule) has **London forces** between its molecules✓
F, an alcohol, (polar OH group) has **hydrogen bonds and London Forces** between its molecules. ✓ Hydrogen bonds are **stronger** than London forces.✓ **More energy** needed to break stronger hydrogen bonds in F. ✓
 (4)
[19]

QUESTION 9

9.1.1 **Homologous series** is 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)

9.1.2 Ethanol. ✓ (1)

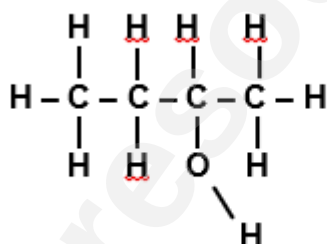
9.1.3 Organic compounds are flammable ✓ don't heat with direct (naked) flame. ✓ (2)



(-1 if no H₂O) (4)

9.1.5 Octanoic Acid
Oct ✓ anoic acid ✓ (2)

9.2.1.1



. ✓. ✓ (2)

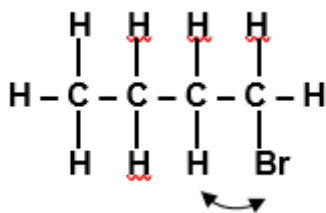
9.2.1.2 Hydration. ✓ (1)

9.2.1.3 butan – 2 – ol OR butan – 1 ol (must match 9.2.1.1) . ✓. ✓ (2)

9.2.2.1 2 – bromobutane **or** bromobutane. ✓. ✓ (2)

9.2.2.2

(2)



Must match 9.2.2.1

9.2.3.1

Heat . ✓ under reflux. with dilute NaOH or KOH . ✓

(2)

9.2.3.2

hydrolysis. ✓

(1)

[23]**Total: 200 marks**