PREPARATORY EXAMINATION
2018
MARKING GUIDELINES

PHYSICAL SCIENCES: CHEMISTRY (PAPER 2) (10842)

10 pages
Marking guidelines:

- functional group correct ✓
- whole structure correct ✓

2.1.1 Compounds which have the same molecular formula but different structural formula. (two ✓ ✓ or zero) (2)

2.1.2 Methyl methanoate (2)

2.1.3 [Chemical structure image]

2.1.4 Ethanoic acid ✓ (1)

2.1.5 Carboxylic acids ✓ (1)

2.2 2.2.1 C\(_n\)H\(_{2n}\) ✓ (1)

2.2.2 2,5-dimethylhept-3-ene ✓ (2)
QUESTION 3

3.1 (Alcohols are flammable.) Do not bring it close to flames. ✓

3.2 3.2.1 propan-1-ol ✓ propan-2-ol ✓

3.2.2 propan-1-ol✓

3.2.3 The position of the –OH group in a chain will influence the boiling point, because of the role of the intermolecular forces in branched structure. OR For a fair test, all alcohols need to be primary alcohols. (1)

3.3 3.3.1 The melting point of butan-1-ol will be higher. ✓

Reasons:
- The hydrogen bond between butan-1-ol molecules are stronger than between the butan-2-ol molecules, because the hydroxyl group is more exposed in the butan-1-ol than in the butan-2-ol, which causes the hydrogen bond to have a stronger influence. ✓
- More energy is required to weaken IMF forces between the butan-1-ol molecules, causing a higher melting point. ✓
- Straight chains have a higher melting point than branched chains.
- Butan-1-ol has a larger surface area (chain length)
- Therefore stronger IMF
- More energy needed to overcome IMF

Any TWO reasons
3.3.2 Butan-2-ol ✓

Reasons:

- If the hydroxyl group is on a terminal carbon atom, the intermolecular force (hydrogen bond) is stronger than when the –OH group is on the second carbon atom, where it is screened and has a smaller influence on the energy needed to cause a phase change (boil) in the second isomer, the butan-2-ol. ✓
- The boiling point of butan-2-ol will be lower and therefore the vapour pressure of butan-2-ol will be higher than the butan-1-ol. Less energy required to overcome the hydrogen bonds and to weaken the bonds. ✓

Any TWO reasons

(3)

3.3.3 Increase ✓

(1)

3.3.4 • Van der Waals forces (London forces) increase with an increase in molecular mass / chain length / size of molecule. ✓
- The longer the chain, the higher the boiling point, the stronger the London forces. ✓

(2)

3.4 3.4.1 Polymerisation ✓

(1)

3.4.2 \[ \text{H}_3\text{C}--\text{CH}_2--\text{CH}_2[\text{-CH}_2--\text{CH}_2]_n--\text{CH}_2--\text{CH}_2--\text{CH}_2--\text{CH}_2--\text{CH}_3 \]

Ethene. ✓

(1)

3.4.3 Any ONE use:
- Packaging material ✓
- Squeeze bottles
- Electrical insulation
- Industrial protective clothing
- Toys, etc.

(1)

QUESTION 4

4.1 4.1.1 Compound X = C\text{3}H\text{5}Br ✓

(1)

4.1.2 Addition / hydrohalogenation ✓

(1)

4.1.3 Propan-2-ol ✓

(1)

4.1.4 An alcohol; where the hydroxyl group is attached to a carbon atom which is bonded to two other carbon atoms. ✓

(1)

4.1.5 Prop-1-ene OR propene ✓

(1)

4.1.6 Dehydrohalogenation ✓

(1)
4.2 4.2.1 Elimination ✓
4.2.2 Hydration ✓
4.2.3 Hydrohalogenation ✓
4.2.4 H₂SO₄ ✓
4.2.5 2-bromo-2-methylpentane ✓

QUESTION 5

5.1 5.1.1 Use powdered CaCO₃ instead of lumps ✓
Use of a more concentrated HCl solution ✓
Heat the reaction mixture ✓
Add a suitable catalyst
Any THREE ways

5.1.2 Measure rate of CO₂ formed by measuring the volume produced at certain time intervals. ✓✓
Measure the rate at which the mass decreases, by placing the reaction container on a sensitive mass-meter and record the decrease in the mass per unit time. ✓✓

5.1.3 It is not a closed system. ✓
The CO₂ gas escapes from the reaction.

5.2 5.2.1 5 cm³ / min OR 5 cm³ / min⁻¹ ✓
5.2.2 Steeper gradient ✓
5.2.3 The rate of production of hydrogen gas will be faster per unit time ✓ because the reaction proceeds at a higher rate at a higher temperature. ✓
5.2.4 The rate of production of hydrogen gas will increase as the length / surface area of the magnesium ribbon increases. ✓✓
DO NOT ACCEPT: Graph is directly proportional; does not go through the origin.
QUESTION 6

6.1 If a stress is applied to a system in equilibrium, the system will respond in such a way as to relieve the stress and restore the equilibrium under a new set of conditions. ✔ ✔

6.2 6.2.1 ✔

   6.2.2 The forward reaction is endothermic. Decreasing the temperature from the equilibrium system favours the reverse reaction. ✔ The reverse reaction is an exothermic reaction. Therefore more iodine and hydrogen molecules are formed and less HI will be in the reaction mixture. ✔

6.3 6.3.1 $K_c = [\text{H}_3\text{O}^+][\text{CH}_3\text{COO}^-]$ ✔ 

   = $(1.34 \times 10^{-3})(1.34 \times 10^{-3})$ ✔

   = $1.80 \times 10^{-6}$ ✔

6.3.2 INCREASES. ✔

6.3.3 When sodium ethanoate, $\text{CH}_3\text{COONa}$, dissolves in aqueous ethanoic (acetic) acid, $\text{CH}_3\text{COOH}$, it dissociates into $\text{Na}^+$ ions and acetate ions, $\text{CH}_3\text{COO}^-$. ✔ The acetate ion increases the total acetate ion concentration in the solution. ✔ The equilibrium re-establishes to the left and more ethanoic (acetic) acid forms, ✔ decreasing the $[\text{H}_3\text{O}^+]$ concentration, therefore the pH increases.

6.4 6.4.1 0.5 mol of gas $\text{X}_2\text{Y}_3$ ✔

6.4.2

<table>
<thead>
<tr>
<th></th>
<th>2X(g)</th>
<th>3Y(g)</th>
<th>$\text{X}_2\text{Y}_3$(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial no. of moles</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>No of moles formed</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>No of moles used</td>
<td>1</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>No of moles at equilibrium</td>
<td>3</td>
<td>2.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Equilibrium concentration</td>
<td>1.5</td>
<td>1.25</td>
<td>0.25 $\div 2$</td>
</tr>
</tbody>
</table>

$K_c = \frac{[\text{X}_2\text{Y}_3]}{[\text{X}]^2[\text{Y}]^3}$ ✔

= $(0.25)$ ✔

= $(1.5)^2(1.25)^3$ ✔

= 0.057 ✔

$[20]$
QUESTION 7

7.1  7.1.1  HSO$_4^-$  ✓

DO NOT ACCEPT: Hydrogen sulphate ion  (1)

7.1.2  CN$^-$  ✓  ✓  ✓  (1)

7.2  7.2.1  Na$_2$CO$_3$.10H$_2$O + 2HCl $\rightarrow$ 2NaCl + 11H$_2$O + CO$_2$  (2)

7.2.2  Methyl orange ✓  (1)

7.2.3  Strong acid is titrated with a weak base ✓ / The equivalence point is in the pH range (3 – 4.4) / Low pH / Acidic solution after titration end point. Any ONE answer will be correct  (2)

7.2.4  Red to yellow. ✓  (1)

7.2.5  Option 1:

\[ c_{\text{HCl}} = \frac{n}{V} \] ✓

\[ \therefore n_{\text{HCl}} = CV \]

\[ = 0.1 \times \frac{24.8}{1000} \]

\[ = 2.48 \times 10^{-3} \text{ mol HCl} \] ✓

1 mol Na$_2$CO$_3$ reacts with 2 mol HCl ✓

\[ n(\text{Na}_2\text{CO}_3) \text{ in 500 cm}^3: \]

\[ = \left(2.48 \times 10^{-3}\right) \times \frac{500}{25} \]

\[ = 2.48 \times 10^{-3} \text{ mol Na}_2\text{CO}_3 \] ✓

\[ n = \frac{m}{M} \]

\[ m = nM \]

\[ = 2.48 \times 10^{-3} \times 286 \text{ g mol}^{-1} \]

\[ = 7.092 \text{ g} \] ✓

Marking guidelines:

- Calculate $n(\text{HCl})$ ✓
- Use formula $C = \frac{n}{V}$ ✓
- Use ratio, 1 : 2 ✓
- Calculate $n(\text{Na}_2\text{CO}_3)$ ✓
- Calculate $m$ of Na$_2$CO$_3$ ✓
Option 2:

\[ \frac{n_a}{n_b} = \frac{C_a V_a}{C_b V_b} \]

\[ \sqrt{\frac{2}{1}} = \frac{(0.1) \left( \frac{24.5}{1000} \right)}{(C_b) \left( \frac{25}{1000} \right)} \]

\[ C_b = 0.0496 \text{ mol dm}^{-3} \]

\[ C = \frac{n}{V} \]

\[ n = (0.0496)(0.5) \]

\[ = 0.0248 \text{ mol Na}_2\text{CO}_3 \]

\[ n = \frac{m}{M} \]

\[ m = nM = (0.0248)(286) = 7.093 \text{ g Na}_2\text{CO}_3 \] \(\text{(5)}\)

7.2.6 Positive marking from question 7.2.6

% Na\(_2\)CO\(_3\) in commercial washing soda:

\[ = \frac{\text{actual mass}}{\text{theoretical mass}} \times 100 \]

\[ = \frac{7.092}{7.6} \times 100 \]

\[ = 93.32 \% \]

If answer of 7.093 g is used then the answer is 93.33 %. \(\text{(3)}\) \([16]\)
QUESTION 8

8.1 8.1.1 Mg|Mg$^{2+}$||Ag$^{+}$|Ag

8.1.2 Silver ✓

8.1.3 $E_{\text{cell}}^\circ = E_{\text{oxidising agent}}^\circ - E_{\text{reducing agent}}^\circ$

$= 0.8 \text{ V} - (-2.36 \text{ V}) ✓$

$= 3.16 \text{ V} ✓$

8.1.4 25°C or 298 K ✓

8.1.5 1 mol·dm$^{-3}$ ✓

8.1.6 **Option 1**

The reaction rate is too low to supply enough charges to maintain a large enough current. ✓

**Option 2**

$I = \frac{P}{V} = \frac{6 \text{ W}}{3 \text{ V}} = 2 \text{ A}$

The light bulb is manufactured to operate effectively if it is connected to a source of 3 V which delivers a current of 2 A. Although the potential difference is sufficiently large, the current is probably too small (due to a too large internal cell resistance).

8.1.7 [12]

QUESTION 9

9.1 9.1.1 To the cathode ✓

9.1.2 $2\text{H}_3\text{O}^+ + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{H}_2\text{O}$ ✓✓

9.1.3 Chlorine ($\text{Cl}_2$) gas ✓

9.2 9.2.1 The covering of the surface or an object with a thin layer of a metal by means of electrolysis. ✓✓

9.2.2 Any ONE use of electroplating.

- Protection of the surface of a base metal. ✓
- Decorative purposes.

9.2.3 Negative electrode / cathode. ✓

9.2.4 [8]
QUESTION 10

10.1 10.1.1 Wheat ✓ (1)

10.1.2 Ammonium nitrate / NH₄NO₃ ✓ (1)

10.1.3 Wheat needs a soil low in potassium, medium in nitrogen and high in phosphorous. ✓ Nitrogen needs to be increased in the soil. ✓ More nitrogen needs to be added and ammonium nitrate has the most nitrogen. ✓ (3)

10.1.4 % nitrogen in NH₄NO₃ = \frac{\text{mass nitrogen}}{\text{molar mass ammonium nitrate}} \times 100 ✓

= \frac{28\checkmark}{80\checkmark} \times 100 = 35\% ✓ (4)

10.1.5 A Nitrogen / N₂ ✓

B Hydrogen / H₂ ✓

C Nitrogen dioxide / NO₂ ✓

D Ammonium nitrate / NH₄NO₃ ✓

E Ammonium sulphate / (NH₄)₂SO₄ ✓ (5)

[14]

TOTAL: 150