MARKING GUIDE

CHEMISTRY PAPER 1 JUNE 2025

SECTION "A"

1.

(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
B	D	A	B	C	C	E	E	C	C

10 Marks

2.

06 Marks

SECTION "B"

(i)	(ii)	(iii)	(iv)	(v)	(vi)
H	F	G	I	E	C

3. (a) (i) Nitrogen is distilled over first, because it has the lowest boiling point (-196^{0}C) **[02 marks]**

(ii) Uses

- Manufacture of fertilizers like di-ammonium phosphate (DAP)
- Refrigeration due to its low boiling point
- Fiber industries manufacturing of synthetic fiber like polyamides commonly known as nylons.
- Manufacture of ammonia
- Manufacture of nitric acid
- Manufacture of medicines and pharmaceutical
- Pollution control **[Any 2. 01@ = 02 marks]**

(b) (i) Reasons of why evaporation is not good option

- Some solute may decompose at high temperature
- Crystals formed might be impure **[01@ = 02 marks]**

(ii) Conditions to be considered in solvent extraction process

- The solvent chosen should dissolve the component of interest.
- The solvent must not react with the component of interest.
- The solution formed between the component of interest and the chosen solvent must be easily separated. **[01@ = 03 marks]**

4. (a) Required: The excess reactant

Balanced chemical equation:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

- From the equation, 2 moles of H_2 react with 1 mole of O_2.
- Given: 0.64 moles of H_2 and 0.32 moles of O_2.

- Required ratio: **[03 marks]**
  - H_2 needed = 2 × 0.32 = 0.64 moles
  - O_2 needed = 0.64 ÷ 2 = 0.32 moles

  Since both react in the exact stoichiometric ratio, there was no excess reactant.

(b) Required: mass of reactant left in the container.

Since both reactants react completely, no reactant was left in the container. Therefore, 0 g of reactant was left. **[01 mark]**

(c) Required: moles of steam were produced

From the balanced equation:

- 2 moles of H_2 produce 2 moles of H_2O
- Given 0.64 moles of H_2, the amount of H_2O produced was 0.64 moles Therefore, the amount of steam (H_2O) produced **=** 0.64 moles **[02 marks]**

(d) Required: Volume of steam produced at STP.

Volume of steam = moles of H_2O × GMV

GMV means At STP, 1 mole of gas occupies 22.4 L.

Volume of steam = 0.64 mole × 22.4 L/mole **[03 marks]**

= 14.34 L

Therefore, **14.34 L** of steam (H_2O) was produced at STP.

5. (a) Statement of the Problem **[01 mark]**

To investigate the effect of temperature on the solubility of potassium nitrate (KNO_3) in water.

(b) Hypothesis

The solubility of potassium nitrate in water increases as temperature increases. **[01 mark]**

(c) Identification of Variables

(i) **Dependent Variable**: The mass of potassium nitrate dissolved (solubility).

(ii) **Independent Variable**: Temperature of the solution.

(iii) **Controlled Variable**:

- Volume of water (150 cm^3 in each case). **[01@ = 03 marks]**
- Type of solute (potassium nitrate).
- Experimental conditions such as pressure and purity of water.

(d) Interpretation of Data

The data shows that as temperature increases, a greater mass of potassium nitrate dissolves in 150 cm^3 of water. This indicates a direct relationship between solubility and temperature. For example:

- At **0°C**, only **10 g** dissolves. **[02 marks]** ·

  At **30°C**, **50 g** dissolves.

- At **60°C**, **113 g** dissolves.

This suggests that potassium nitrate is more soluble in water at higher temperatures.

(e) Conclusion

The experiment confirms that the solubility of potassium nitrate in water increases with

an increase in temperature. This supports the hypothesis that temperature positively

affects solubility. **[02 marks]**

6. (a) Reasons behind gentle heating versus strong heating of metal nitrates solutions towards crystallization.

- Prevent explosive decomposition of the solute
- Allows formation of well-shaped crystals
- Ensures purity of the product **[Any 3. 01@ = 03 marks]** - Controls gas release
- Removes water of crystallization without breaking down of the nitrate itself

(b) (i) Reactivity order: C > A > B **[01 mark]**

(ii) Names of the metals

- A: Calcium, Magnesium, Aluminium, Zinc, Iron, Lead, Copper **[Any 1. 01@ = 01 mark]**
- B: Silver and Mercury **[Any 1. 01@ = 01 mark]**
- C: Potassium and Sodium **[Any 1. 01@ = 01 mark]** (iii) Dilute nitric acid reacts with potassium hydroxide in neutralization reaction to form potassium nitrate and water.

$KOH_{(aq)} + HNO_{3(aq)} \rightarrow KNO_{3(aq)} + H_2O_{(l)}$

White crystals of potassium nitrate are formed where the solution of potassium nitrate is heated to saturation, and then cooled. **[02 marks]**

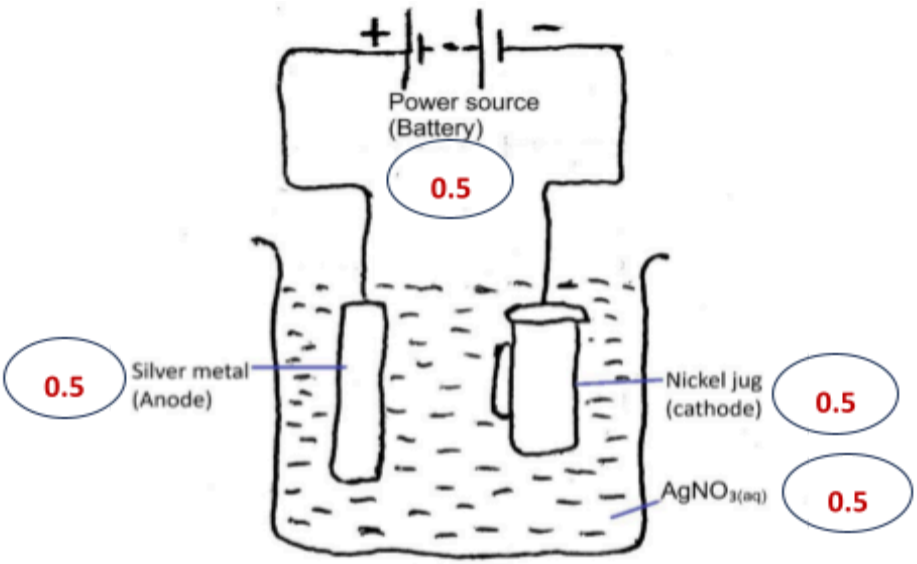
7. (a) **Sodium metal** is a good conductor of electricity because it consists of **free-moving electrons** in its metallic structure. These delocalized electrons carry electric current throughout the metal. **[01 mark]**

Solid sodium chloride (NaCl), however, cannot conduct electricity. In the solid state, its ions (Na^+ and Cl^-) are **fixed in position** within a crystal lattice and **cannot move freely**, so they

cannot conduct electricity. However, **when molten or dissolved in water**, the ions become

mobile and **can conduct electricity**. **[01 mark]**

(b) Electroplating a nickel jug with silver metal



correctness = **01**

(c) Electrolysis of molten sodium chloride (NaCl)

Electrode reactions:

- **At Cathode (Reduction):** $Na^{+}_{(l)} + e^{-} \rightarrow Na_{(s)}$ **[001/2 *mark*]**
- **At Anode (Oxidation):** $2Cl^{-} \rightarrow Cl_{2(g)} + 2e^{-}$ **[001/2 *mark*]**

Calculation of mass of sodium produced:

- Faraday's Law of Electrolysis:

From the cathode half reaction equation,

1 Faraday ≡ 23 g

500 Faradays ≡ x? **[02 marks]**

Mass of Na = 500 × 23 = 11,500 grams = 11.5 kg

Answer:

11.5 kg of sodium metal would be produced when 500 Faradays of electricity are passed through molten sodium chloride. **[01 mark]**

8. (a) When a reaction has reached equilibrium:

(i) Forward and Reverse Reaction Rates:

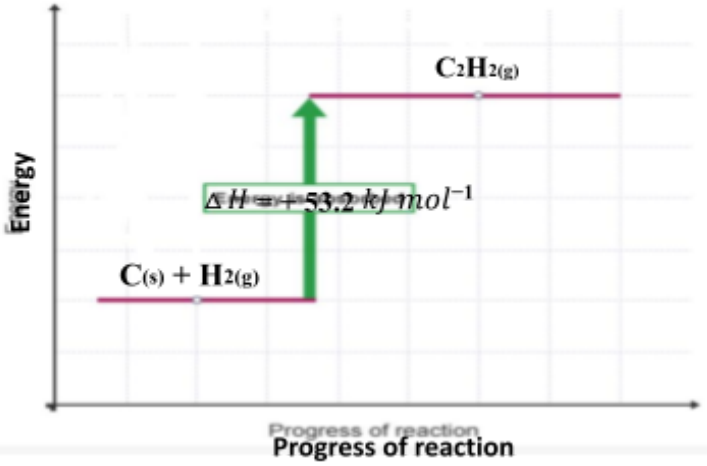
- The rate of the forward reaction equals the rate of the reverse reaction.
- The reaction continues in both directions, but there is no net change in the amounts of reactants and products. **[01 mark]**

(ii) The Amounts or Concentrations of Reactants and Products:

- The concentrations of reactants and products remain constant over time.
- This does not mean they are equal, but rather that they do not change because the rates of formation and consumption are balanced. **[01 mark]**

(b) Energy Level Diagram for the Reaction

- Since ΔH is positive, the reaction is **endothermic**, meaning energy is absorbed.
- The energy level diagram should show:
  - Reactants (C and H_2) at a lower energy level.
  - Products (C_2H_2) at a higher energy level.
  - An upward arrow representing the heat absorbed (53.2 kJ/mol).



03 marks

(c) Reaction Between Potassium and Iodine

$$2K_{(s)} + I_{2(s)} \longrightarrow 2KI_{(s)}$$

(i) Identifying the Oxidizing and Reducing Agents:

Oxidizing agent: I_2 because it gains electrons and gets reduced to $2I^-$. **[01 mark]**

Reducing agent: K because it loses electrons and gets oxidized to K^+. **[01 mark]**

(ii) Balanced Half-Reactions:

Oxidation half-reaction (loss of electrons): $K_{(s)} \rightarrow K^+_{(s)} + e^-$ **[01 mark]**

Reduction half-reaction (gain of electrons): $I_{2(s)} + 2e^- \rightarrow 2I^-_{(s)}$ **[01 mark]**

SECTION "C"

9. (a) Carboxylic acids have higher melting and boiling points than their corresponding alcohols because of their ability to form strong hydrogen bonds between molecules. Carboxylic acids exist as dimers due to intermolecular hydrogen bonding between two molecules, which effectively increases their molecular mass and the strength of the intermolecular forces, requiring more energy to break these forces compared to alcohols, which can only form one hydrogen bond per molecule. **[02 marks]**

(b) Two chemical properties of carboxylic acids.

· **Reaction with metals (Formation of hydrogen gas)**

Carboxylic acids react with reactive metals like magnesium to produce a carboxylate salt and hydrogen gas. **[01 mark]**

$2CH_3COOH + Mg \rightarrow (CH_3COO)_2Mg + H_2$ **[01 mark]**

· **Reaction with alcohols (Esterification reaction)**

Carboxylic acids react with alcohols in the presence of concentrated sulfuric acid

(H_2SO_4) to form an ester and water. **[01 mark]**

$CH_3COOH + C_2H_5OH \xrightarrow{conc\ H2SO4} CH_3COOC_2H_5 + H_2O$ **[01 mark]**

(c) Molecular structures and IUPAC names of three isomers whose molecular formula is C_4H_9Cl.

· 1-Chlorobutane

Structure: **CH_3-CH_2-CH_2-CH_2Cl**

· 2-Chlorobutane

Structure: **CH_3-CHCl-CH_2-CH_3**

· 2-Chloro-2-methylpropane

Structure: **$(CH_3)_3CCl$** **[$00^{1}/_{2}$@ = 03 *marks*]**

(d) Determining the names and the structures of B, C and D

- B is butanoic acid

  The structure is CH_3-CH_2-CH_2-COOH

- C is butene

  The structure is CH_3-CH_2-CH=CH_2

- D is butane

  The structure is CH_3-CH_2-CH_2-CH_3 **[01@= 06 *marks*]**

10. (a) Raw materials: Nitrogen (from air) and Hydrogen (from natural gas) **[02 mark]**

Process: Haber process, under high temperature and pressure

$$3H_{2(g)} + N_{2(g)} \rightarrow 2NH_{3(g)}$$ **[01 mark]**

(b) Ammonia is collected by upward delivery (downward displacement of air). This is because it is less dense than air. **[02 marks]**

(c) Ammonia gas turns moist red litmus paper blue because it is alkaline. **[02 marks]**

(d) Chemical reactions of ammonia

- Reaction with hydrogen chloride gas to form a dense white fume of ammonium chloride.

$$NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$$ **[02 marks]**

- Oxidation of ammonia: Ammonia is oxidized to nitrogen by oxidizing agents such as copper (II) oxide.

$$2NH_{3(g)} + 3CuO_{(s)} \rightarrow 3H_2O_{(l)} + N_{2(g)} + 3Cu_{(s)}$$ **[02 marks]**

(e) Uses of ammonia (**explain**)

- Manufacture of fertilizers
- Cleaning
- Refrigeration
- Manufacture of nitric acid
- Water treatment
- Manufacture of various organic substances **[Any 2. 01@ = 02 marks]** (f) The environmental impacts of excessive ammonia gas release into the atmosphere and water bodies (**explain**)
- Excess ammonia causes acidic rain, damaging plants and soil
- Water pollution leading to eutrophication and fish death
- Air pollution and human health effects
- Loss of soil fertility
- Global warming
- Contaminated water can be harmful if consumed **[Any 2. 01@ = 02 marks]**