ICSE CLASS 10 CHEMISTRY – PRACTICE PAPER

STEP-BY-STEP SOLUTIONS AND MARKING SCHEME

Chapter 2: Chemical Bonding | Maximum Marks: 40

SECTION A (20 Marks)

Question 1 [8 × 1 = 8]

Part	Ans	Step-by-step reasoning
(i)	(d)	Atomic number 12 is magnesium (2, 8, 2), a metal, and 9 is fluorine (2, 7), a non-metal. Magnesium transfers 2 electrons, one to each of two fluorine atoms, forming the electrovalent compound MgF_2. The other pairs are non-metals (6 and 17, 7 and 1, 17 and 17), which only share electrons.
(ii)	(c)	Argon is 2, 8, 8. Ca^{2+} is formed when calcium (2, 8, 8, 2) loses 2 electrons, giving 2, 8, 8. Na^+, O^{2-} and Al^{3+} all have 10 electrons (2, 8), the configuration of neon.
(iii)	(b)	Q has a low melting point, dissolves in water, does not conduct when molten (no ions) but conducts in aqueous solution, because the polar molecules ionise in water (e.g. HCl). P and S have high melting points and conduct when molten, so they are ionic. R is insoluble and non-conducting, so it is non-polar covalent.
(iv)	(a)	Sugar is a covalent compound. Its solution contains only molecules and no ions, so no current flows and the bulb does not glow. Sodium chloride, hydrochloric acid and copper sulphate solutions contain free ions.
(v)	(d)	A nitrogen molecule has a triple covalent bond, i.e. 3 shared pairs = 3 × 2 = **6** electrons.
(vi)	(c)	(A) is true: in the solid the ions are held in fixed positions, and in the molten state they are free to move. (R) is true and is the reason for (A).
(vii)	(a)	Carbon (4 valence electrons) shares one pair with each of four chlorine atoms, giving four single covalent bonds. The molecule is symmetrical, the shared pairs are equally attracted, and so it is non-polar.
(viii)	(b)	In H_3O^+ the oxygen atom of water donates a lone pair to H^+, forming a coordinate bond. CH_4 and HCl contain only covalent bonds and NaCl only an ionic bond.

Question 2 [3 + 3 = 6]

(i) **[3 × 1]**

(a) **non-polar** – carbon and hydrogen have nearly equal electronegativity (2.5 and 2.1) and the molecule is symmetrical, so there is no charge separation.

(b) **insoluble** – ionic compounds dissolve in polar solvents like water, not in non-polar organic solvents.

(c) **$CaCl_2$** – calcium has 2 valence electrons (valency 2), each chlorine atom accepts only 1 electron, so two chlorine atoms are needed.

(ii) **[3 × 1]**

(a) Sodium chloride → **2** (ionic compound, conducts when molten).

(b) Carbon tetrachloride → **1** (non-polar covalent, insoluble in water).

(c) Hydrogen chloride → **3** (polar covalent, ionises in water to give ions).

Statement 4 is the extra option and is not matched.

Question 3 [3 + 3 = 6]

(i) **[3 × 1]**

(a) Ion P: 19 protons and 2 + 8 + 8 = 18 electrons, so the charge = 19 − 18 = **+1** (P^+). Ion Q: 16 protons and 18 electrons, so the charge = 16 − 18 = **−2** (Q^{2-}).

(b) Two P^+ ions balance one Q^{2-} ion, so the formula is $\mathbf{P_2Q}$ (P and Q are potassium and sulphur, so the compound is K_2S).

(c) **Electrovalent (ionic) bond**, formed by the electrostatic force of attraction between the oppositely charged ions.

(ii) **[3 × 1]**

(a) In solid NaCl the Na^+ and Cl^- ions are held rigidly by strong electrostatic forces and cannot move. On melting, the ions become free and carry the current.

(b) Water is a polar solvent, but CCl_4 is a non-polar covalent compound. Non-polar compounds dissolve in non-polar organic solvents, not in water.

(c) HCl is a polar covalent compound. In water the polar HCl molecules ionise: $HCl + H_2O \rightarrow H_3O^+ + Cl^-$. The free ions carry the current.

SECTION B (20 Marks)

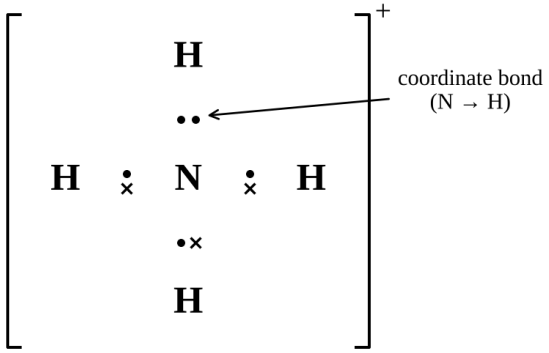
Question 4 [4 + 3 + 3 = 10]

(i) **[4]**

(a) X is a **lone pair** (unshared pair, which belongs only to nitrogen). Y is a **shared pair** (bond pair; one electron from N and one from H). [1]

(b) **Donor:** the nitrogen atom of ammonia, which gives its lone pair. **Acceptor:** the hydrogen ion H^+, which has no electron and accepts the pair to attain the duplet. [1]

(c) The lone pair of nitrogen is shared with H^+. The coordinate bond is shown by an arrow pointing from the donor (N) to the acceptor (H). Diagram of the ammonium ion: [2 – correct dot diagram 1, label of coordinate bond 1]



Ammonium ion (NH_4^+)

(ii) **[3 × 1]**

(a) The **oxygen** atom. After forming two shared pairs with hydrogen atoms it still has two lone pairs, and one of them is donated to H^+.

(b) $H_2O + H^+ \rightarrow H_3O^+$

(c) NH_4Cl has **covalent** bonds (three N–H), a **coordinate** bond (one N→H) within the NH_4^+ ion, and an **ionic (electrovalent)** bond between NH_4^+ and Cl^-.

(iii) **[3 × 1]**

(a) **Four** shared pairs (three covalent and one coordinate, each N–H bond being one shared pair).

(b) **One** lone pair. Oxygen has 6 valence electrons: two are used in two covalent bonds, and one lone pair is donated to H^+, which leaves one lone pair.

(c) Once the coordinate bond is formed, the shared pair is shared by both atoms like any other pair. It cannot be distinguished from the covalent bonds, so all four N–H bonds have the same length and strength.

Question 5 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **NaCl and $MgCl_2$** (melting points 801 °C and 714 °C).

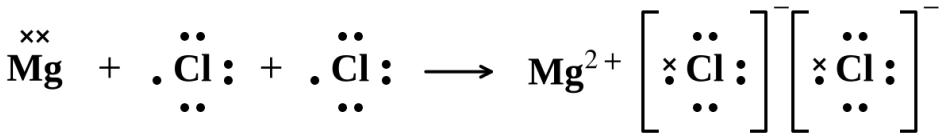
(b) Strong electrostatic forces of attraction exist between the oppositely charged ions, so a large amount of energy is required to break them.

(c) **HCl**. (CCl_4 and CH_4 are symmetrical, non-polar molecules.)

(d) Covalent compounds consist of molecules, and the forces of attraction between molecules are weak, so very little energy is needed to separate them.

(ii) **[2 + 1]**

(a) Mg (2, 8, 2) has 2 valence electrons and Cl (2, 8, 7) has 7. Each of the two Cl atoms takes one electron from Mg. [2]



(b) Mg has two valence electrons, so it forms Mg^{2+}. A chlorine atom needs only one electron to complete its octet, so two chlorine atoms are needed for each magnesium atom. The ratio $Mg^{2+} : Cl^- = 1 : 2$, so the formula is $MgCl_2$. [1]

(iii) **[3 × 1]**

Write one difference for each point:

Point	Sodium chloride	Carbon tetrachloride
(a) Physical state	Hard crystalline solid	Liquid
(b) Solubility in water	Soluble	Insoluble
(c) Conductivity in molten state	Conducts (free ions)	Does not conduct (no ions)

Question 6 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **Molecule P**. Three pairs of electrons are shared between the two X atoms, so X≡X is a triple covalent bond (X has 5 valence electrons).

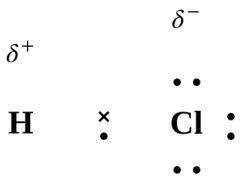
(b) Each Y atom has 7 valence electrons: one is used in the shared pair, so 6 remain, which form **3 lone pairs**.

(c) Y has 7 valence electrons and 3 shells (period 3): **chlorine** (2, 8, 7). Molecule Q is Cl_2.

(d) In each molecule the two atoms are identical and have the same electronegativity, so the shared pairs are equally attracted by both atoms. There is no separation of charge, so the molecules are non-polar.

(ii) **[3 × 1]**

(a) H has 1 electron and Cl has 7. They share one pair, so H gets a duplet and Cl gets an octet (one shared pair and three lone pairs on Cl). The partial charges are shown in the diagram.



(b) Chlorine is more electronegative (3.0) than hydrogen (2.1), so the shared pair is pulled towards Cl. Cl develops a slight negative charge (δ−) and H a slight positive charge (δ+), so the molecule is polar.

(c) $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

(iii) **[3 × 1]**

(a) Oxidation (loss of electrons by sodium): $2Na \rightarrow 2Na^+ + 2e^-$ (or $Na - e^- \rightarrow Na^+$).

(b) Reduction (gain of electrons by chlorine): $Cl_2 + 2e^- \rightarrow 2Cl^-$.

(c) Sodium donates electrons, so it is the **reducing agent**. Chlorine accepts electrons, so it is the **oxidising agent**.

Marks summary	Section A: Q1 = 8, Q2 = 6, Q3 = 6 → **20** | Section B: any two of Q4, Q5, Q6 at 10 each → **20** | Total = **40**