Q1

(a) Three laws of chemical combination:

1. *Law of Conservation of Mass* – Mass is neither created nor destroyed in a chemical reaction but in only in nuclear reaction .

Law of Definite Proportions – A compound always contains it elements in a fixed proportion by mass.

Law of Multiple Proportions – When two elements form more than one compound, the masses of one element that combine with a fixed mass of the other are in a simple whole-number ratio.

(b) Standard solution: A solution of *known concentration*, typically prepared by dissolving an accurately weighed amount of a primary standard in a definite volume of solvent.

(c) Bromine (liquid) vs. iodine (solid) at ordinary conditions: Bromine has weaker van der Waals forces than iodine due to its smaller molecular size/polarizability, but stronger forces than expected for its size due to some polarity; overall, its melting/boiling points allow it to be liquid at room temperature, whereas iodine's larger atoms have stronger dispersion forces → solid.

(d) Dalton's law of partial pressures: The total pressure of a mixture of non-reacting gases is equal to the *sum of the partial pressures* of each individual gas.

(e) Two properties of real gases causing deviation from ideal behaviour:

1. *Finite volume of gas particles*.

2. *Intermolecular forces* (attractive/repulsive) between particles.

(f) Molten aluminium chloride:

(i) Reason it doesn't conduct electricity: It exists as *covalent Al_2Cl_6 dimers* (or $AlCl_3$ molecules) with no free ions.

(ii) Two factors:

- Presence of covalent bonding in the molten state.

- Absence of mobile ions.

(g) Period 3 elements:

(i) Metals: *Sodium (Na)*, *Magnesium (Mg)*.

(ii) Non-metals: *Sulfur (S)*, *Chlorine (Cl)* (other valid pairs possible).

(h) Two uses of alkenes:

1. *Manufacture of plastics* (e.g., polyethylene, polypropylene).

2. *Production of alcohols* via hydration reactions.

(i) Covalent bond vs. dative bond:

- *Similarity*: Both involve sharing of electron pairs between atoms.

- *Difference*: In a covalent bond, each atom contributes *one electron*; in a dative (coordinate) bond, *one atom donates both* electrons.

(j) Redox reaction: $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$:

(i) *Oxidizing agent*: Cl_2 (gains electrons, gets reduced).

(ii) *Product of reduction*: Cl^- (chloride ions).

Q4

4. (a) Define the term hybridization.

Hybridization is the process of mixing atomic orbitals to form new hybrid orbitals that are suitable for the pairing of electrons in chemical bonds.

(b) State the type of hybridization of the central atom in each of the following compounds:

(i) $BeCl_2$: sp

(ii) BF_3: sp^2

(iii) CH_4: sp^3

(iv) NH_3: sp^3

(v) CO_2: sp

(c) Name the shape of each of the molecules in (b).

(i) $BeCl_2$: Linear

(ii) BF_3: Trigonal planar

(iii) CH_4: Tetrahedral

(iv) NH_3: Trigonal pyramidal

(v) CO_2: Linear

(d)

(i) Calculate the concentration of the stock solution.

Given: Assay = 36%, Relative molar mass = 36.5, Relative density = 1.18.

Concentration = (36 g HCl / 100 g solution) * (1.18 g/mL * 1000 mL/L) / 36.5 g/mol = 11.64 mol/L

(ii) Volume of stock solution required to prepare 2 dm^3 of 0.1 mol dm^{-3} HCl.

Using $C_1V_1 = C_2V_2$: 11.64 mol/L * V_1 = 0.1 mol/L * 2 L

V_1 = (0.1 * 2) / 11.64 = 0.0172 L or 17.2 mL

(e)

(i) Define the term Brønsted-Lowry base.

A Brønsted-Lowry base is a species that accepts a proton (H^+).

(ii) Ionic equation for the reaction between ClO^- and H_2O.

$ClO^- + H_2O \rightleftharpoons HClO + OH^-$

(f) Give three uses of cement.

1. Construction of buildings and bridges.

2. Making concrete for paving roads.

3. Binding aggregates in mortar for masonry.