Molecular and Ionic equations.

(1) **Molecular equations:** When the reactants and products involved in a chemical change are written in molecular forms in the chemical equation, it is termed as molecular equation.

Examples: (i) $MnO_2 + 4\,HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

(ii) $2FeCl_3 + SnCl_2 \rightarrow 2FeCl_2 + SnCl_4$

In above examples, the reactants and products have been written in molecular forms, thus the equation is termed as **molecular equation.**

(2) **Ionic equations:**When the reactants and products involved in a chemical change are ionic compounds, these will be present in the form of ions in the solution. The chemical change is written in ionic forms in chemical equation, it is termed as ionic equation.

Examples**:** (i) $MnO_2 + 4\,H^+ + 4\,Cl^- \rightarrow Mn^{2+} + 2Cl^- + 2H_2O + Cl_2$

(ii) $2Fe^{3+} + 6Cl^- + Sn^{2+} + 2Cl^- \rightarrow 2Fe^{2+} + 4\,Cl^- + Sn^{4+} + 4\,Cl^-$

In above examples, the reactants and products have been written in ionic forms, thus the equation is termed as **ionic equation.**

(3) **Spectator ions:**In ionic equations, the ions which do not undergo any change and equal in number in both reactants and products are termed spectator ions and are not included in the final balanced equations.

Example: $Zn + 2H^+ + 2Cl^- \rightarrow Zn^{2+} + H_2 + 2Cl^-$ (Ionic equation)

$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$ (Final ionic equation)

In above example, the Cl^- ions are the **spectator ions** and hence are not included in the final ionic balanced equation.

(4) **Rules for writing ionic equations**

(i) All soluble ionic compounds involved in a chemical change are expressed in ionic symbols and covalent substances are written in molecular form. H_2O, NH_3,NO_2, NO, SO_2, CO, CO_2, etc., are expressed in molecular form.

(ii) The ionic compound which is highly insoluble is expressed in molecular form.

(iii) The ions which are common and equal in number on both sides, i.e., spectator ions, are cancelled.

(iv) Besides the atoms, the ionic charges must also be balanced on both the sides.

The rules can be explained by following examples,

Example: Write the ionic equation for the reaction of sodium bicarbonate with sulphuric acid, the molecular equation for the chemical change is,

$$NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$$

$NaHCO_3$, H_2SO_4 and Na_2SO_4 are ionic compounds, so these are written in ionic forms.

$$Na^+ + HCO_3^- + 2H^+ + SO_4^{2-} \rightarrow 2Na^+ + SO_4^{2-} + H_2O + CO_2$$

Na^+ and SO_4^{2-} ions are spectator ions; hence these shall not appear in the final equation.

$$HCO_3^- + 2H^+ \rightarrow H_2O + CO_2$$

To make equal charges on both sides, HCO_3^- should have a coefficient 2.

$$2HCO_3^- + 2H^+ \rightarrow H_2O + CO_2$$

In order to balance the hydrogen and carbon on both sides, the molecules of H_2O and CO_2 should have a coefficient 2 respectively.

$$2HCO_3^- + 2H^+ = 2H_2O + 2CO_2 \text{ or } HCO_3^- + H^+ = H_2O + CO_2$$

This is the balanced ionic equation.

Conversion of ionic equation in molecular form can be explained by following example,

Example: Write the following ionic equation in the molecular form if the reactants are chlorides.

$$2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$$

For writing the reactants in molecular forms, the requisite number of chloride ions are added.

$$\underbrace{2Fe^{3+} + 6Cl^-} + \underbrace{Sn^{2+} + 2Cl^-} \quad \text{or} \quad 2FeCl_3 + SnCl_2$$

Similarly 8 Cl^- ions are added on R.H.S. to neutralize the charges.

$$\underbrace{2Fe^{2+} + 4Cl^-} + \underbrace{Sn^{4+} + 4Cl^-} \text{ or } 2FeCl_2 + SnCl_4$$

Thus, the balanced molecular equation is, $2FeCl3 + SnCl_2 = 2FeCl_2 + SnCl_4$