III. Long Answer Type Questions

Question 1. (i) Point out the differences between ionic product and solubility product.
(ii) The solubility of AgCl in water at 298 K is 1.06×10^5 mole per litre. Calculate its solubility product at this temperature.
Answer: (i)

Ionic Product	*Solubility Product*
(*a*) It is applicable to all types of solutions. (*b*) Its value changes with the change in concentration of the ions.	(*a*) It is applicable to the saturated solutions. (*b*) It has a definite value for an electrolyte at a constant temperature.

(*ii*) The solubility equilibrium in the saturated solution is

$$AgCl\ (s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

The solubility of AgCl is 1.06×10^{-5} mole per litre.

$$[Ag^+(aq)] = 1.06 \times 10^{-5}\ mol\ L^{-1}$$
$$[Cl^-(aq)] = 1.06 \times 10^{-5}\ mol\ L^{-1}$$
$$K_{sp} = [Ag^+(aq)]\ [Cl^-(aq)]$$
$$= (1.06 \times 10^{-5}\ mol\ L^{-1}) \times (1.06 \times 10^{-5}\ mol\ L^{-1})$$
$$= \mathbf{1.12 \times 10^{-2}\ mol^2\ L^{-2}}$$

Question 2. At certain temperature and under a pressure of 4 atm, PCl_5 is 10% dissociated. Calculate the pressure at which PCl_5 will be 20% dissociated at temperature remaining constant.
Answer: Calculation of K_p

$$\underset{1}{PCl_5(g)} \rightleftharpoons \underset{0}{PCl_3(g)} + \underset{0}{Cl_2(g)}$$
$$\underset{(1-\alpha)}{\quad} \quad \underset{\alpha}{\quad} \quad \underset{\alpha}{\quad}$$

Total no. of moles in the equilibrium mixture $= 1 - \alpha + \alpha + \alpha$
$= (1 + \alpha)$ mol.

Let the total pressure of equilibrium mixture = p atm
Partial pressure of PCl_5

$$p_{PCl_5} = \frac{1-\alpha}{1+\alpha} \times p\ atm$$

Partial pressure of $PCl_3 = \frac{\alpha}{1+\alpha} \times p$ atm

Partial pressure of Cl_2

$$p_{Cl_2} = \frac{\alpha}{(1+\alpha)} \times p\ atm$$

$$K_p = \frac{p_{PCl_3} \times p_{Cl_2}}{p_{PCl_5}}$$

$$= \frac{\left(\frac{\alpha}{1+\alpha} p\ atm\right) \times \left(\frac{\alpha}{1+\alpha} p\ atm\right)}{\frac{1-\alpha}{1+\alpha} p\ atm} = \frac{\alpha^2 p}{1-\alpha^2}\ atm$$

$$P = 4\ atm \text{ and } \alpha = 10\% = \frac{10}{100} = 0.1$$

$$K_p = \frac{(0.1) \times (0.1) \times (4\ atm)}{1-(0.1)^2}$$

$$= \frac{0.04}{0.99} = 0.04\ atm.$$

Calculation of P under new condition

$$\alpha = 0.2,\ K_p = 0.04\ atm$$

$$K_p = \frac{\alpha^2 p}{1-\alpha^2} \text{ or } p = \frac{K_p(1-\alpha^2)}{\alpha^2}$$

$$= \frac{(0.04 \text{ atm})[(1-(0.2)^2]}{(0.2)^2} = \frac{0.04 \text{ atm} \times 0.96}{0.04}$$

$$= \mathbf{0.96 \text{ atm.}}$$

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