Marks

- The solubility of BaF_2 in water is 1.30 g L^{-1}. Calculate the solubility product for BaF_2. **2**

The molar mass of BaF_2 is (137.34 (Ba) + 2 × 19.00 (F)) g mol^{-1} = 175.34 g mol^{-1}. As 1.30 g dissolves in one litre, this corresponds to:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{1.30\ \text{g}}{175.34\ \text{g mol}^{-1}} = 0.00741\ \text{mol}$$

As BaF_2 dissolves to give Ba^{2+}(aq) + 2F^-(aq), dissolution of 0.00741 mol in one litre will produce [Ba^{2+}(aq)] = 0.00741 M and [F^-(aq)] = 2 × 0.00741 M = 0.0148 M. Hence:

$$K_{sp} = [Ba^{2+}(aq)][F^-(aq)]^2 = (0.00741)(0.0148)^2 = 1.6 \times 10^{-6}$$

Answer: **1.6×10^{-6}**

- A mixture of NaCl (5.0 g) and $AgNO_3$ (5.0 g) was added to 1.0 L of water. What are the concentrations of Ag^+(aq), Cl^-(aq) and Na^+(aq) ions in solution after equilibrium has been established? K_{sp}(AgCl) = 1.8×10^{-10}. **3**

The molar mass of NaCl is (22.99 (Na) + 35.45 (Cl)) g mol^{-1} = 58.44 g mol^{-1}. Hence:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{5.0\ \text{g}}{58.44\ \text{g mol}^{-1}} = 0.0856\ \text{mol}$$

As NaCl dissolves to give Na^+(aq) + Cl^-(aq), dissolution of this amount in one litre will give [Na^+(aq)] = 0.0856 M and [Cl^-(aq)] = 0.0856 M.

The molar mass of $AgNO_3$ is (107.87 (Ag) + 14.01 (N) + 3 × 16.00 (O)) g mol^{-1} = 169.88 g mol^{-1}. Hence:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{5.0\ \text{g}}{169.88\ \text{g mol}^{-1}} = 0.0294\ \text{mol}$$

As $AgNO_3$ dissolves to give Ag^+(aq) + NO_3^-(aq), dissolution of this amount in one litre will give [Ag^+(aq)] = 0.0294 M.

Precipitation of AgCl(s) follows Ag^+(aq) + Cl^-(aq) → AgCl(s). As 0.0294 mol of Ag^+ ions and 0.0856 mol of Cl^- ions are present, the former is limiting and so 0.0294 mol of AgCl(s) will form leaving (0.0856 – 0.0294) mol = 0.0562 mol of Cl^- ions. Hence, after precipitation, [Cl^-(aq)] = 0.0562 M.

AgCl(s) has a very low solubility and dissolves to give Ag^+(aq) and Cl^-(aq) with

$$K_{sp} = [Ag^+(aq)][Cl^-(aq)] = 1.8 \times 10^{-10}$$

Hence:

$$[Ag^+(aq)] = K_{sp} / [Cl^-(aq)] = (1.8 \times 10^{-10}) / (0.0562)\ \text{M} = 3.2 \times 10^{-9}\ \text{M}$$

[Ag^+(aq)] = **3.2×10^{-9} M**	[Cl^-(aq)] = **0.0562 M**	[Na^+(aq)] = **0.0856 M**