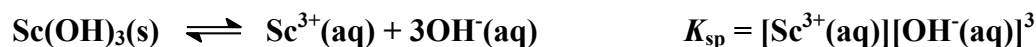


- What is the solubility of scandium hydroxide, $\text{Sc}(\text{OH})_3$, ($K_{\text{sp}} = 2 \times 10^{-30}$) in water? Give your answer in g per 100 mL.

Marks
2

The dissolution reaction and solubility product are:



If S mol in one litre, $[\text{Sc}^{3+}(\text{aq})] = S$ M and $[\text{OH}^{-}(\text{aq})] = 3S$ M. Hence:

$$K_{\text{sp}} = (S)(3S)^3 = 27S^4 = 2 \times 10^{-30}$$

$$S = 1.6 \times 10^{-8} \text{ M}$$

This is the number of moles that dissolve in one litre. The number of moles that dissolve in 100 mL is therefore 1.6×10^{-9} mol.

The molar mass of $\text{Sc}(\text{OH})_3$ is:

$$\begin{aligned} \text{molar mass} &= (44.96 \text{ (Sc)} + 3 \times 16.00 \text{ (O)} + 3 \times 1.008 \text{ (H)}) \text{ g mol}^{-1} \\ &= 95.984 \text{ g mol}^{-1} \end{aligned}$$

The mass corresponding to 1.6×10^{-9} mol is therefore:

$$\begin{aligned} \text{mass} &= \text{number of moles} \times \text{molar mass} \\ &= (1.6 \times 10^{-9} \text{ mol}) \times (95.984 \text{ g mol}^{-1}) = 1.6 \times 10^{-7} \text{ g} \end{aligned}$$

The solubility is 1.6×10^{-7} g per 100 mL.

Answer: 1.6×10^{-7} g per 100 mL

- How does the interplay of ΔH and ΔS affect the spontaneity of the phase change between solid and liquid water?

4

$$\Delta G = \Delta H - T\Delta S$$

Any process is spontaneous if $\Delta G < 0$, i.e. if $T\Delta S > \Delta H$.

For the melting of ice, both ΔS and ΔH are positive, so this process is spontaneous at higher temperatures.

Conversely, for the freezing of water, both ΔS and ΔH are negative, so this process is spontaneous at lower temperatures.