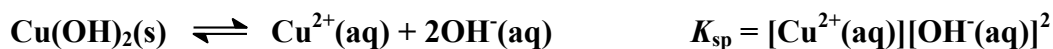


- What is the solubility of $\text{Cu}(\text{OH})_2$ in mol L^{-1} ? $K_{\text{sp}}(\text{Cu}(\text{OH})_2)$ is 1.6×10^{-19} at 25°C .

Marks
6

The dissolution reaction and associated solubility product are:



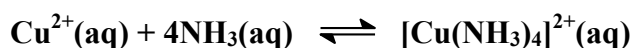
If x mol dissolve in one litre, $[\text{Cu}^{2+}(\text{aq})] = x \text{ M}$ and $[\text{OH}^{-}(\text{aq})] = 2x$. Hence:

$$K_{\text{sp}} = (x)(2x)^2 = 4x^3 = 1.6 \times 10^{-19}$$

$$x = 3.4 \times 10^{-7} \text{ M}$$

Answer: $3.4 \times 10^{-7} \text{ M}$

The overall formation constant for $[\text{Cu}(\text{NH}_3)_4]^{2+}$ is 1.0×10^{13} . Write the equation for the reaction of Cu^{2+} ions with excess ammonia solution.



Calculate the value of the equilibrium constant for the following reaction.



This reaction can be considered to occur via (i) $\text{Cu}(\text{OH})_2$ dissolving followed by (ii) the $\text{Cu}^{2+}(\text{aq})$ ions that form being complexed by ammonia.

For the formation of $[\text{Cu}(\text{NH}_3)_4]^{2+}$, the equilibrium constant is:

$$K_{\text{stab}} = \frac{[\text{Cu}(\text{NH}_3)_4]^{2+}}{[\text{Cu}^{2+}][\text{NH}_3]^4} = 1.0 \times 10^{13}$$

For the reaction of $\text{Cu}(\text{OH})_2(\text{s})$ with $\text{NH}_3(\text{aq})$, the equilibrium constant is:

$$K = \frac{[\text{Cu}(\text{NH}_3)_4]^{2+}[\text{OH}^{-}(\text{aq})]^2}{[\text{NH}_3]^4}$$

To obtain K , K_{sp} is multiplied by K_{stab} :

$$\begin{aligned} K &= K_{\text{sp}} \times K_{\text{stab}} \\ &= [\text{Cu}^{2+}(\text{aq})][\text{OH}^{-}(\text{aq})]^2 \times \frac{[\text{Cu}(\text{NH}_3)_4]^{2+}}{[\text{Cu}^{2+}][\text{NH}_3]^4} = \frac{[\text{Cu}(\text{NH}_3)_4]^{2+}[\text{OH}^{-}(\text{aq})]^2}{[\text{NH}_3]^4} \\ &= (1.6 \times 10^{-19}) \times (1.0 \times 10^{13}) = 1.6 \times 10^{-6} \end{aligned}$$

Answer: 1.6×10^{-6}

Would you expect $\text{Cu}(\text{OH})_2(\text{s})$ to dissolve in 1 M NH_3 solution? Briefly explain your answer.

No. Equilibrium constant K is very small so the reaction lies heavily in favour of reactants.