

**Marks**  
**2**

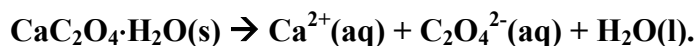
- Calcium oxalate is a major constituent of kidney stones. Calculate the solubility product constant for calcium oxalate given that a saturated solution of the salt can be made by dissolving 0.0061 g of  $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}(\text{s})$  in 1.0 L of water.

**The molar mass of  $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$  is:**

$$(40.08(\text{Ca}) + 2 \times 12.01(\text{C}) + 5 \times 16.00(\text{O}) + 2 \times 1.008(\text{H})) \text{ g mol}^{-1} = 146.116 \text{ g mol}^{-1}$$

Hence, 0.0061 g corresponds to  $\frac{0.0061 \text{ g}}{146.116 \text{ g mol}^{-1}} = 4.2 \times 10^{-5} \text{ mol}$ . As this amount dissolves in 1.0 L, the molar solubility =  $S = 4.2 \times 10^{-5} \text{ M}$ .

**The dissolution equilibrium is:**



**As one mol of cation and one mol of anion is produced, the solubility product is:**

$$K_{\text{sp}} = [\text{Ca}^{2+}(\text{aq})][\text{C}_2\text{O}_4^{2-}(\text{aq})] = (S)(S) = S^2 = (4.2 \times 10^{-5})^2 = 1.7 \times 10^{-9}$$

Answer:  $1.7 \times 10^{-9}$

**3**

- A sample of 2.0 mg of  $\text{Cu}(\text{OH})_2$  is added to 1.0 L of a solution buffered at a pH of 8.00. Will all of the  $\text{Cu}(\text{OH})_2$  dissolve? Show all working. (The  $K_{\text{sp}}$  of  $\text{Cu}(\text{OH})_2$  is  $4.8 \times 10^{-20} \text{ M}^3$ .)

As  $\text{pH} + \text{pOH} = 14.00$ ,  $\text{pOH} = 14.00 - 8.00 = 6.00$ . Hence,  $[\text{OH}^-(\text{aq})] = 10^{-6} \text{ M}$ .

**The dissolution equilibrium is:**  $\text{Cu}(\text{OH})_2(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$

Hence, if  $S$  is the molar solubility,  $K_{\text{sp}} = [\text{Cu}^{2+}(\text{aq})][\text{OH}^-(\text{aq})]^2 = S \times [\text{OH}^-(\text{aq})]^2$ .

$$\text{As } K_{\text{sp}} = 4.8 \times 10^{-20}, S = \frac{4.8 \times 10^{-20}}{(10^{-6})^2} = 4.8 \times 10^{-8} \text{ M}$$

**The molar mass of  $\text{Cu}(\text{OH})_2$  is  $(63.55 (\text{Cu}) + 2 \times (16.00 (\text{O}) + 1.008 (\text{O})) \text{ g mol}^{-1} = 97.566 \text{ g mol}^{-1}$ .**

**The solubility in  $\text{g L}^{-1}$  is therefore  $(4.8 \times 10^{-8}) \times 97.566 = 4.7 \times 10^{-6}$ .**

Hence, only  $4.7 \times 10^{-3} \text{ mg}$  will dissolve.

Answer: **NO**