1974 - LEVEL I CHEMISTRY - Q2

Let K_{sp} for $MC_2O_4 = K$

$\therefore$ K_{sp} for $MCO_3 = 25K$

Now at equilibrium : $[M^{2+}].[C_2O_4^{2-}] = K$ - ①
$[M^{2+}].[CO_3^{2-}] = 25K$ - ②

Dividing ② by ① $\Rightarrow$ $\therefore [CO_3^{2-}] = 25.[C_2O_4^{2-}]$ - ③

Now since initially 2.80×10^{-3} mole of M^{2+} were used and 2.000×10^{-3} mole of M^{2+} precipitated, the final $[M^{2+}] = 0.80 \times 10^{-3}$ molar.

i.e. $[M^{2+}] = 0.80 \times 10^{-3}$ molar (at $\equiv$'m) - ④

From ① and ④ : $[C_2O_4^{2-}] = \dfrac{K}{0.80 \times 10^{-3}}$ - ⑤

From ② and ④ : $[CO_3^{2-}] = \dfrac{25K}{0.80 \times 10^{-3}}$ - ⑥

Initially, 2.042×10^{-3} mole of anions (CO_3^{2-}, $C_2O_4^{2-}$) were present and 2.000×10^{-3} mole of anions precipitated.

$\therefore$ At equilibrium : [anions] $= 0.042 \times 10^{-3}$ Molar.

$\therefore [C_2O_4^{2-}] + [CO_3^{2-}] = 0.042 \times 10^{-3}$ - ⑦

Substituting from ⑤, ⑥ into ⑦, we have :

$$\frac{K}{0.80 \times 10^{-3}} + \frac{25\,K}{0.80 \times 10^{-3}} = 0.042 \times 10^{-3}$$

$$\therefore \quad 26\,K = 0.042 \times 10^{-3} \times 0.80 \times 10^{-3}$$

$$\therefore \quad K = 1.29 \times 10^{-9}$$

$$\therefore \quad K_{sp} \text{ for } MC_2O_4 = 1.29 \times 10^{-9}$$