

- Following blood donation, a solution of sodium oxalate is added to remove Ca^{2+} ions (as calcium oxalate, $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$, $K_{\text{sp}} 2.3 \times 10^{-9}$), which cause the blood to clot. If the concentration of Ca^{2+} ions in blood is $9.7 \times 10^{-5} \text{ g mL}^{-1}$, and 100.0 mL of 0.1550 M $\text{Na}_2\text{C}_2\text{O}_4$ is added to a 104 mL sample of blood, what will be the concentration (in mol L^{-1}) of Ca^{2+} ions remaining in the blood?

The amount of Ca^{2+} present in 100.0 mL is $9.7 \times 10^{-3} \text{ g}$. As its molar mass is 40.08 g mol^{-1} , this corresponds to:

$$\begin{aligned}\text{number of moles} &= \text{mass} / \text{molar mass} = \\ &= (9.7 \times 10^{-3} \text{ g}) / (40.08 \text{ g mol}^{-1}) = 2.4 \times 10^{-4} \text{ mol}\end{aligned}$$

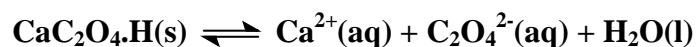
The number of moles of $\text{C}_2\text{O}_4^{2-}(\text{aq})$ added is:

$$\begin{aligned}\text{number of moles} &= \text{concentration} \times \text{volume} \\ &= (0.1550 \text{ mol L}^{-1}) \times (0.1000 \text{ L}) = 0.01550 \text{ mol}\end{aligned}$$

When this is added to the blood, the total volume increases to $(100.0 + 104) \text{ mL} = 204 \text{ mL}$. The concentration of $\text{C}_2\text{O}_4^{2-}(\text{aq})$ is now:

$$\begin{aligned}\text{concentration} &= \text{number of moles} / \text{volume} \\ &= (0.01550 \text{ mol}) / (0.204 \text{ L}) = 0.0760 \text{ mol L}^{-1}\end{aligned}$$

For $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}(\text{s})$, the solubility product is for the reaction:



$$K_{\text{sp}} = [\text{Ca}^{2+}(\text{aq})][\text{C}_2\text{O}_4^{2-}(\text{aq})]$$

The amount of $\text{C}_2\text{O}_4^{2-}$ is *much* larger than the amount of Ca^{2+} present so precipitation of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}(\text{s})$ does not reduce its concentration significantly. Hence:

$$[\text{Ca}^{2+}(\text{aq})] = K_{\text{sp}} / [\text{C}_2\text{O}_4^{2-}(\text{aq})] = (2.3 \times 10^{-9} / 0.0760) \text{ M} = 3.0 \times 10^{-8} \text{ M}$$

Answer: $3.0 \times 10^{-8} \text{ M}$