Marks 9

- The salt calcium oxalate, $CaC_2O_4{\cdot}H_2O$, is sparingly soluble. Write down the chemical equation for its dissolution in water and the expression for K_{sp}.

$CaC_2O_4{\cdot}H_2O(s) \rightarrow Ca^{2+}(aq) + C_2O_4^{2-}(aq) + H_2O(l)$

$K_{sp} = [Ca^{2+}(aq)][C_2O_4^{2-}(aq)]$

What is the molar solubility of calcium oxalate? $K_{sp} = 2.3 \times 10^{-9}$

If x mol of the salt dissolves in one litre, then the molar solubility is x M. If x mol dissolves in one litre then $[Ca^{2+}(aq)] = x$ M and $[C_2O_4^{2-}(aq)] = x$ M.

$K_{sp} = [Ca^{2+}(aq)][C_2O_4^{2-}(aq)] = (x)(x) = x^2 = 2.3 \times 10^{-9}$

$x = 4.8 \times 10^{-5}$ mol L^{-1}

Answer: **4.8×10^{-5} mol L^{-1}**

If additional calcium oxalate is added to a saturated solution, what is the effect on $[Ca^{2+}(aq)]$?

A saturated solid has the maximum possible dissolution. Adding additional solid has no effect on the equilibrium and so no effect on $[Ca^{2+}(aq)]$.

Following blood donation, a solution of sodium oxalate is added to remove $Ca^{2+}(aq)$ ions which cause the blood to clot. The concentration of $Ca^{2+}(aq)$ ions in blood is 9.7×10^{-5} g mL^{-1}. If 100.0 mL of 0.1550 M $Na_2C_2O_4$ is added to 100.0 mL 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 9.7×10^{-3} g. As its molar mass is 40.08 g mol^{-1}, this corresponds to:

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

The number of moles of $C_2O_4^{2-}(aq)$ added is:

number of moles = concentration × volume
= (0.1550 mol L^{-1}) × (0.1000 L) = 0.01550 mol

The amount of $C_2O_4^{2-}$ is *much* larger than the amount of Ca^{2+} present so precipitation of $CaC_2O_4.H_2O(s)$ does not reduce the $C_2O_4^{2-}$ significantly.

When the oxalate is added to the blood, the total volume increases to (100.0 + 100.0) mL = 200.0 mL. The concentration of $C_2O_4^{2-}(aq)$ is now:

ANSWER CONTINUES ON THE NEXT PAGE

concentration = number of moles / volume
= (0.01550 mol) / (0.2000 L) = 0.0775 mol L^{-1}

Using $K_{sp} = [Ca^{2+}(aq)][C_2O_4^{2-}(aq)]$:

$[Ca^{2+}(aq)] = K_{sp} / [C_2O_4^{2-}(aq)] = (2.3 \times 10^{-9} / 0.0775)$ M $= 3.0 \times 10^{-8}$ M

Answer: **3.0×10^{-8} M**