Ionic Equilibriums in Water

#9

15.00 mL 0.120 $\frac{\text{mol}}{\text{L}}$ $Zn(NO_3)_2$ and 10.00 mL 0.100 $\frac{\text{mol}}{\text{L}}$ Na_2CrO_4 are poured together. The solubility product of $ZnCrO_4$ is $2.5.10^{-9}$. Will a precipitation be formed or not? If so, which one?

Solution

The following ions are present in the mixture: Zn^{2+}, NO_3^-, Na^+ and CrO_4^{2-}.

In theory, two precipitations can be formed: $ZnCrO_4$ and $NaNO_3$.

The precipitation of $NaNO_3$ will not be formed: the solubility of $NaNO_3$ in water is very large.

$Zn^{2+}(aq) + CrO_4^{2-}(aq) \rightleftharpoons ZnCrO_4(s)$

This precipitation will only occur when $\left[Zn^{2+}\right]\times\left[CrO_4^{2-}\right] > K_{sp_{ZnCrO_4}} \left(=2.5\times10^{-9}\right)$.

The concentration of Zn^{2+} in the mixture is

$$\frac{15.00\times10^{-3}\text{L}\times0.120\frac{\text{mol}}{\text{L}}}{25.00\times10^{-3}\text{L}} = \frac{1.80\times10^{-3}\text{mol}}{25.00\times10^{-3}\text{L}} = 7.20\times10^{-2}\frac{\text{mol}}{\text{L}}.$$

The concentration of CrO_4^{2-} in the mixture is

$$\frac{10.00\times10^{-3}\text{L}\times0.100\frac{\text{mol}}{\text{L}}}{25.00\times10^{-3}\text{L}} = \frac{1.00\times10^{-3}\text{mol}}{25.00\times10^{-3}\text{L}} = 4.00\times10^{-2}\frac{\text{mol}}{\text{L}}.$$

So:

$$\left[Zn^{2+}\right]\times\left[CrO_4^{2-}\right] = \left(7.20\times10^{-2}\right)\times\left(4.00\times10^{-2}\right) = 2.88\times10^{-3} > K_{sp_{ZnCrO_4}} \left(=2.5\times10^{-9}\right)$$

So there will be a precipitation of $ZnCrO_4$.