Marks 4

A solution is prepared that is 0.10 M in potassium bromide and 0.10 M in potassium chromate. A concentrated aqueous solution of silver nitrate is added with stirring. What is the concentration of $Ag^+(aq)$ ions when silver bromide first appears?
K_{sp} of AgBr = 5.0×10^{-13}

When precipitation occurs, the following equilibrium is established and $[Ag^+(aq)]$ and $[Br^-(aq)]$ are controlled by the value of the solubility product:

$$\mathbf{AgBr(s) \rightleftharpoons Ag^+(aq) + Br^-(aq)}$$
$$\mathbf{K_{sp} = [Ag^+(aq)][Br^-(aq)] = 5.0 \times 10^{-13}}$$

As the solution is 0.10 M in KBr, $[Br^-(aq)] = 0.10$ M:

$$\mathbf{[Ag^+(aq)] \times (0.10) = 5.0 \times 10^{-13} \quad so\ [Ag^+(aq)] = 5.0 \times 10^{-12}\ M}$$

Answer: **5.0×10^{-12} M**

What is the concentration of $Ag^+(aq)$ ions when silver chromate first appears?
K_{sp} of Ag_2CrO_4 = 2.6×10^{-12}

When precipitation occurs, the following equilibrium is established and $[Ag^+(aq)]$ and $[CrO_4^{2-}(aq)]$ are controlled by the value of the solubility product:

$$\mathbf{Ag_2CrO_4 \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)}$$
$$\mathbf{K_{sp} = [Ag^+(aq)]^2[CrO_4^{2-}(aq)] = 2.6 \times 10^{-12}}$$

As the solution is 0.10 M in K_2CrO_4, $[CrO_4^{2-}(aq)] = 0.10$ M:

$$\mathbf{[Ag^+(aq)]^2 \times (0.10) = 2.6 \times 10^{-12} \quad so\ [Ag^+(aq)] = 5.1 \times 10^{-6}\ M}$$

Answer: **5.1×10^{-6} M**

What is the concentration of $Br^-(aq)$ ions when silver chromate first appears?

$[Br^-(aq)]$ is control by the K_{sp} for AgBr and so when $[Ag^+(aq)] = 5.1 \times 10^{-6}$ M,

$$\mathbf{K_{sp} = [Ag^+(aq)][Br^-(aq)] = 5.0 \times 10^{-13}}$$

$$\mathbf{(5.1 \times 10^{-6}) \times [Br^-(aq)] = 5.0 \times 10^{-13} \quad so\ [Br^-(aq)] = 9.8 \times 10^{-8}\ M}$$

Answer: **9.8×10^{-8} M**