

Task:

A sample of hard water contains about $2.0 \times 10^{-3} \text{ M Ca}^{2+}$. A soluble fluoride containing salt such as NaF is added to fluoridate the water. what is the maximum concentration of F^- that can be presented without precipitation of CaF_2 ? K_{sp} for $\text{CaF}_2 = 5.3 \times 10^{-11}$

Solution:

The chemical equation for this reaction is
 $\text{Ca}^{2+}(\text{aq}) + 2\text{F}^-(\text{aq}) = \text{CaF}_2(\text{s})$

The equation for solubility constant is
 $K_{sp} = [\text{Ca}^{2+}][\text{F}^-]^2$

The precipitation forms when the concentration of fluoride ion is
 $[\text{F}^-] = (K_{sp} / [\text{Ca}^{2+}])^{1/2}$

That's why the maximum concentration of F^- must be less than
 $[\text{F}^-] = (5.3 \cdot 10^{-11} / 2.0 \cdot 10^{-3})^{1/2} = 1.63 \cdot 10^{-4} \text{ M}$

Answer: $[\text{F}^-] < 1.63 \cdot 10^{-4} \text{ M}$