CHEM1002 Worksheet 12 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: Le Châtelier's Principle and Solubility

1. $K_{sp} = [Pb^{2+}(aq)][Cl^-(aq)]^2$

2. Adding Cl^- ions would push the equilibrium in the direction of reactants: the solubility would decrease.

3. With $[Cl^-(aq)] = 0.5$ M,

    $$[Pb^{2+}(aq)] = K_{sp} / [Cl^-(aq)]^2 = K_{sp} / (0.5)^2 = K_{sp} / 0.25 = 4K_{sp}$$

4. Adding Pb^{2+} ions would also push the equilibrium in the direction of reactants: the solubility would decrease.

5. Adding extra $PbCl_2(s)$ has *no effect*. As the $[Pb^{2+}(aq)]$ and $[Cl^-(aq)]$ are already such that $[Pb^{2+}(aq)][Cl^-(aq)]^2 = K_{sp}$, the solution is saturated and it is not possible to dissolve more solid.

Model 2: Solubility and pH

1. $K_{sp} = [Fe^{3+}(aq)][OH^-(aq)]^3$

2. $pOH = 14.00 - 8.18 = 5.82$. As $pOH = -\log[OH^-(aq)]$, $[OH^-(aq)] = 10^{-5.82}$ M.

3. From Q1, $[Fe^{3+}(aq)] = K_{sp} / [OH^-(aq)]^3 = (1 \times 10^{-39}) / (10^{-5.82})^3 = 3 \times 10^{-22}$.

4. If the pH decreases, $[OH^-(aq)]$ will also decrease. It is predicted that the pH of the ocean will fall by about 0.3 pH units over this century. pOH will thus increase by about 0.3 units.

    As $[Fe^{3+}(aq)] = K_{sp} / [OH^-(aq)]^3$, this will lead to an increase in $[Fe^{3+}(aq)]$. It is uncertain what the effect of this will be for marine life - see, for example:

    http://www.sciencemag.org/cgi/content/full/327/5966/676

5. $[Fe^{3+}(free)] \approx 1 \times 10^{-19}$ M. Most of the Fe^{3+} is complexed in proteins such as transferrin and ferritin.