Practical Applications of Low Solubility Salts

Limestone Caverns

1. How is limestone ($CaCO_3$) formed?
2. Write the equilibrium equation for limestone in water.
3. What causes the chemical erosion of limestone?
4. Explain using Le Châtelier's Principle how the erosion works.

Osteoporosis

Approximately 99% of the body's calcium is stored in the bone of the skeletal system. It is stored in the bones as calcium phosphate ($Ca_3(PO_4)_2$).

1. Write the chemical equation to represent the equilibrium system.
2. What happens if the concentration of calcium in the blood decreases? Explain how this affects the equilibrium with respect to Le Châtelier's Principle.
3. How can osteoporosis be prevented?

Tooth Decay

The major constituent of tooth enamel is hydroxyapatite ($Ca_5(PO_4)_3OH$, $k_{sp} = 6.8x10^{-37}$). In the mouth the following equilibrium is established:

$$Ca_5(PO_4)_3OH_{(s)} \leftrightarrow Ca_5(PO_4)_3^+{}_{(aq)} + OH^-_{(aq)}$$

When sugar ferments on the teeth, the hydronium ion (H_3O^+) is produced. It reacts with the hydroxide ion in the previous reaction to form water.

1. Explain, with reference to Le Châtelier's Principle, what happens to the hydroxyapatite.
2. Fluoride was added to water and toothpaste to combat this problem. The fluoride ion replaces the hydroxide ion in hydroxyapapitite to create fluorapatite ($Ca_5(PO_4)_3F$, $k_{sp}=1.0x10^{-60}$). Explain with reference to ksp values why this prevents tooth decay.
3. Too much fluoride can lead to fluorosis. How much fluoride will lead to fluorisis? How many tubes of toothpaste would you have to swallow for this to be a problem?