1) The solubility product constant, $K_{sp}$, for calcium hydroxide is $6.5 \times 10^{-6}$ at $25^\circ C$.
   a. Write the balance chemical equation for this dissociation in water.

   \[
   \text{Ca(OH)}_2(s) \rightarrow \text{Ca}^{2+}(aq) + 2 \text{OH}^-(aq)
   \]

   b. Write the equilibrium expression.

   \[K_{sp} = [\text{Ca}^{2+}][\text{OH}^-]^2\]

   c. Find the molar concentration of all ions in this solution, and the molar solubility of the solution.

   \[
   K_{sp} = [\text{Ca}^{2+}][\text{OH}^-]^2 \\
   = (s)(2s)^2 \\
   = 4s^3 \\
   = 6.5 \times 10^{-6} \\
   \]

   \[
   s = \sqrt[3]{\frac{6.5 \times 10^{-6}}{4}} = [\text{Ca}^{2+}] = 1.2 \times 10^{-2} M; \\
   [\text{OH}^-] = 2s = 2(1.2 \times 10^{-2} M) = 2.4 \times 10^{-2} M
   \]

   d. Calculate the maximum mass of calcium hydroxide that will dissolve in 100 mL of distilled water at $25^\circ C$.

   \[
   100 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.012 \text{ mol Ca(OH)}_2}{1 \text{ L}} \times \frac{74.10 \text{ g Ca(OH)}_2}{1 \text{ mol Ca(OH)}_2} = 8.9 \times 10^{-2} \text{ g Ca(OH)}_2
   \]

2) A 1.0 L saturated solution of zinc hydroxide is prepared, and the concentration of $\text{Zn}^{2+}$ is measured to be $4.22 \times 10^{-6}$ M at $25^\circ C$.
   a. Write the balanced chemical equation for the dissociation of zinc hydroxide in water.

   \[
   \text{Zn(OH)}_2(s) \rightarrow \text{Zn}^{2+}(aq) + 2 \text{OH}^-(aq)
   \]

   b. Calculate the molar concentration of $\text{OH}^-$ in solution.

   \[
   [\text{OH}^-] = 2[\text{Zn}^{2+}] = 2(4.22 \times 10^{-6} M) = 8.44 \times 10^{-6} M
   \]
c. Calculate the value of the solubility product constant, \( K_{\text{sp}} \).

\[
K_{\text{sp}} = [\text{Zn}^{2+}][\text{OH}^-]^2 = (4.22 \times 10^{-6})(8.44 \times 10^{-6})^2 = 3.01 \times 10^{-16} \text{M}
\]

d. Calculate the maximum mass of zinc hydroxide that will dissolve in 150 mL of distilled water at 25°C

\[
150 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{4.22 \times 10^{-6} \text{ mol Zn(OH)}_2}{1 \text{ L}} \times \frac{99.41 \text{ g Zn(OH)}_2}{1 \text{ mol Zn(OH)}_2} = 6.3 \times 10^{-5} \text{ g Zn(OH)}_2
\]

e. What is the molar concentration of \( \text{Zn}^{2+} \) if 200 mL of water evaporates from the solution?

\[ [\text{Zn}^{2+}] = 4.22 \times 10^{-6} \text{ M} \quad \text{Concentration is not affected by changes in volume.} \]

3) Will a precipitate form when 350 mL of 5.5 \times 10^{-2} M lead (II) nitrate is mixed with 250 mL of 4.8 \times 10^{-2} M sodium iodide. (\( K_{\text{sp}} \) for \( \text{PbI}_2 \) is 9.77 \times 10^{-10}.)

Find \([\text{Pb}^{2+}]\)

\[
0.35 \text{ L solution} \times \frac{5.5 \times 10^{-2} \text{ mol Pb}^{2+}}{1 \text{ L solution}} = 1.9 \times 10^{-2} \text{ mol Pb}^{2+}
\]

\[
[\text{Pb}^{2+}] = \frac{1.9 \times 10^{-2} \text{ mol Pb}^{2+}}{0.35 \text{ L} + 0.25 \text{ L}} = 3.2 \times 10^{-2} \text{ M}
\]

Find \([\text{I}^-]\)

\[
0.25 \text{ L solution} \times \frac{4.8 \times 10^{-2} \text{ mol I}^-}{1 \text{ L solution}} = 1.2 \times 10^{-2} \text{ mol I}^-
\]

\[
[\text{I}^-] = \frac{1.2 \times 10^{-2} \text{ mol I}^-}{0.35 \text{ L} + 0.25 \text{ L}} = 0.020 \text{ M}
\]

\[
Q = [\text{Pb}^{2+}][\text{I}^-]^2 = (3.2 \times 10^{-2})(0.020)^2 = 1.28 \times 10^{-5} \text{ M}
\]

\( Q > K_{\text{sp}} \), so a precipitate will form
4) If a 0.50 $M$ solution of $K_2SO_4$ is slowly poured into a beaker containing 0.25 $M$ barium nitrate and 0.30 $M$ lead (II) nitrate at 25°C, what will be the first precipitate that forms? $K_{sp}$ for barium sulfate is $1.1 \times 10^{-10}$ and $K_{sp}$ for lead (II) sulfate is $1.6 \times 10^{-8}$.

$$\text{BaSO}_4(s) \rightarrow \text{Ba}^{2+}(aq) + \text{SO}_4^{2-}(aq) \quad K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$$

$$[\text{SO}_4^{2-}] = \frac{K_{sp}}{[\text{Ba}^{2+}]} = \frac{1.1 \times 10^{-10}}{0.30M} = 3.7 \times 10^{-10} M$$

$$\text{PbSO}_4(s) \rightarrow \text{Pb}^{2+}(aq) + \text{SO}_4^{2-}(aq) \quad K_{sp} = [\text{Pb}^{2+}][\text{SO}_4^{2-}]$$

$$[\text{SO}_4^{2-}] = \frac{K_{sp}}{[\text{Pb}^{2+}]} = \frac{1.6 \times 10^{-8}}{0.25M} = 6.4 \times 10^{-8} M$$

BaSO$_4(s)$ will be the first precipitate that forms, as [SO$_4^{2-}$] will reach $3.7 \times 10^{-10} M$ before it reaches $6.4 \times 10^{-8} M$.

5) Explain why NO$_{(g)}$ is more soluble in water than O$_2(g)$.

NO is larger than O$_2$, as nitrogen has a bigger radius than oxygen, and the bond between nitrogen and oxygen is slightly polar (electronegativity different of 0.5). Thus, NO experiences larger dispersion force and dipole-dipole forces when it dissolves in water. This makes it more soluble.