1. \( \text{CaSO}_4(\text{s}) \rightleftharpoons \text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \)

The molar mass of \( \text{CaSO}_4 \) is \( 40.08 \text{ (Ca)} + 32.07 \text{ (S)} + 4 \times 16.00 \text{ (O)} = 136.07 \text{ g mol}^{-1} \)

The solubility of 2.1 g L\(^{-1} \) therefore corresponds to \( \frac{2.1}{136.07} = 0.015 \text{ mol L}^{-1} \).

As one mole of \( \text{Ca}^{2+}(\text{aq}) \) and one mole of \( \text{SO}_4^{2-}(\text{aq}) \) are produced from every mole of \( \text{CaSO}_4 \) which dissolves:

\[ K_{sp} = [\text{Ca}^{2+}(\text{aq})][\text{SO}_4^{2-}(\text{aq})] = 0.015 \times 0.015 = 2.4 \times 10^{-4} \]

2. \( \text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^- (\text{aq}) \quad \text{Na}_2\text{CrO}_4(\text{s}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq}) \)

Hence, \( [\text{Cl}^- (\text{aq})] = [\text{CrO}_4^{2-}(\text{aq})] = 0.10 \text{ M} \).

(a) For silver chloride, \( \text{AgCl}(\text{s}) \rightarrow \text{Ag}^+(\text{aq}) + \text{Cl}^- (\text{aq}) \) so:

\[ K_{sp} = [\text{Ag}^+(\text{aq})][\text{Cl}^- (\text{aq})] \]

AgCl will first precipitate when \( [\text{Ag}^+(\text{aq})][\text{Cl}^- (\text{aq})] = 2. \times 10^{-10} \). The silver nitrate is added dropwise so the change in the volume of the solution is negligible and can be ignored.

As \( [\text{Cl}^- (\text{aq})] = 0.10 \text{ M} \), the molar concentration of \( \text{Ag}^+(\text{aq}) \) is:

\[ [\text{Ag}^+(\text{aq})] = \frac{2 \times 10^{-10}}{0.10} = 2 \times 10^{-9} \text{ M} \]

(b) For silver chromate, \( \text{Ag}_2\text{CrO}_4(\text{s}) \rightarrow 2\text{Ag}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq}) \) so:

\[ K_{sp} = [\text{Ag}^+(\text{aq})]^2[\text{CrO}_4^{2-}(\text{aq})] \]

Ag\(_2\)CrO\(_4\) will first precipitate when \( [\text{Ag}^+(\text{aq})]^2[\text{CrO}_4^{2-}(\text{aq})] = 3. \times 10^{-12} \).

As \( [\text{CrO}_4^{2-}(\text{aq})] = 0.10 \text{ M} \), the molar concentration of \( \text{Ag}^+(\text{aq}) \) is:

\[ [\text{Ag}^+(\text{aq})] = \sqrt{\frac{3 \times 10^{-12}}{0.10}} = 5 \times 10^{-6} \text{ M} \]

(c) \( [\text{Ag}^+(\text{aq})][\text{Cl}^- (\text{aq})] \geq 2. \times 10^{-10} \) at all stages so the molar concentration of \( \text{Cl}^- (\text{aq}) \) when \( [\text{Ag}^+(\text{aq})] = 5 \times 10^{-6} \text{ M} \) is:
\[
[\text{Cl}^{-}(\text{aq})] = \frac{2 \times 10^{-10}}{5 \times 10^{-6}} = 4 \times 10^{-5} \text{ M}
\]

(d) The initial concentration of Cl\(^{-}\)(aq) is 0.10 M. The concentration of Cl\(^{-}\)(aq) when silver chromate is first precipitated is 4 \(\times\) 10\(^{-5}\) M. Therefore the percentage of Cl\(^{-}\) which has been precipitated is:

\[
\text{percentage} = \frac{0.10 - (4 \times 10^{-5})}{0.10} \times 100 = 99.96\%
\]

3. (b) Dissolution of a solid is always accompanied by the release of enthalpy.

If the lattice enthalpy is larger in magnitude than the solvation enthalpy then the dissolution is exothermic.

However, if the lattice enthalpy is smaller in magnitude than the solvation enthalpy then the dissolution is endothermic.

4. (a) \(\text{K}_2[\text{PtF}_6]\)

Potassium hexafluoroplatinate(IV)

(b) \([\text{CoCl}_2(\text{NH}_3)_4]\text{Cl-2H}_2\text{O}\)

Tetramminedichlorocobalt(III) chloride – 2 – water.

5. (a) tetraamminezinc(II) sulfate-2-water

\([\text{Zn(NH}_3)_4]\text{SO}_4\cdot2\text{H}_2\text{O}\)

(b) tetraaquaoxalatochromium(III) ion

\([\text{Cr(C}_2\text{O}_4)(\text{H}_2\text{O})_4]^+\)

6. \([\text{Pt(NH}_3)_2\text{Cl}_2]\) can exist as two geometric isomers:

\[
\begin{align*}
\text{cis} & \quad \text{trans} \\
\text{cisplatin} & \quad \text{transplatin}
\end{align*}
\]

7. Coordination isomers have a ligand and a counter ion exchanged. \([\text{Cr(H}_2\text{O})_5\text{Cl}]\text{SO}_4\) has a Cl\(^{-}\) ion as a ligand and SO\(_4^{2-}\) as a counter ion.

(c) \([\text{Cr(H}_2\text{O})_5\text{SO}_4]\text{Cl}\) is a coordination isomer: it has a SO\(_4^{2-}\) ion as a ligand and Cl\(^{-}\) as a counter ion. (Note that SO\(_4^{2-}\) coordinates to a metal using oxygen atoms rather than the sulfur.)