St Andrew's Junior College

H2 Chemistry 2026

Tutorial 20: Solubility Equilibria

SELF–CHECK QUESTIONS

1. Write an expression for K_{sp} of the following sparingly soluble salts, and calculate the unknown solubility products and solubilities in mol dm^{-3}.

Salt	K_{sp} expression with units	K_{sp} value	Solubility / mol dm^{-3}
$CaCO_3$			6.93×10^{-5}
ZnS		1.6×10^{-23}	
Cu_2O			8.08×10^{-6}
Fe_2S_3		1.0×10^{-88}	

Worked example for Cu_2O

$Cu_2O(s) \rightleftharpoons$

In 1 dm^3 of solution, mol of Cu_2O dissolves, giving

- $[Cu^+]$ =
- $[O^{2-}]$ =

$K_{sp} = [Cu^+]^2[O^{2-}]$

=

=

Worked example for Fe_2S_3

$Fe_2S_3(s) \rightleftharpoons$

Let the solubility be z mol dm^{-3}.

In 1 dm^3 of solution, z mol of Fe_2S_3 dissolves, giving

- $[Fe^{3+}]$ =
- $[S^{2-}]$ =

$K_{sp} = [Fe^{3+}]^2[S^{2-}]^3$

1.0×10^{-88} =

2. [2017/P1/Q15]

Chrome Yellow, lead(II) chromate(VI), $PbCrO_4$, is the pigment used for marking yellow lines on roads. Its solubility in water at 25 °C is 1.3×10^{-7} mol dm^{-3}.

What is the value of the solubility product of lead(II) chromate(VI) at 25 °C?

A 1.7×10^{-14} **B** 6.8×10^{-14} **C** 1.3×10^{-7} **D** 2.6×10^{-7}

3. [2008/P2/Q2]

The solubility of barium hydroxide, $Ba(OH)_2$ at 25 °C is 0.24 g dm^{-3}.

(a) (i) Calculate the concentration of the saturated aqueous solution, in terms of mol dm^{-3}. [1]

(ii) If it is assumed that the solute is completely ionised, calculate the hydroxide ion concentration of the solution. [1]

(b) (i) Write an expression for the solubility product of barium hydroxide. [1]

(ii) Using the values obtained in part **(a)**, calculate the value of the solubility product, stating the units. [1]

(c) Bottles containing aqueous barium hydroxide need to be kept firmly stoppered or white deposit forms on the surface.

(i) What is the white deposit? [1]

(ii) Explain, with the aid of an equation, how it is formed. [2]

4. [2011/P3/Q3b]

One of the most common phosphorous–containing rocks is fluorapatite, $Ca_5(PO_4)_3F$. The first step in the production of phosphate as a mineral supplement for animal feed is defluorination, which is achieved by heating the rock in a rotary kiln at 1500 °C with silica and steam.

The following equation represents this process.

$$6Ca_5(PO_4)_3F + \boldsymbol{a}SiO_2 + \boldsymbol{b}H_2O \rightarrow \boldsymbol{c}SiF_4 + \boldsymbol{d}HF + \boldsymbol{e}CaO + \boldsymbol{f}Ca_3(PO_4)_2$$

(i) Complete the balancing of the above equation by deducing values for ***a***, ***b***, ***c***, ***d***, ***e*** and ***f***. [3]

(ii) Write the expression for the solubility product of calcium phosphate, stating its units. [2]

(iii) The value of K_{sp} for calcium phosphate is 1×10^{-26}. Calculate $[Ca^{2+}]$ in a saturated solution of calcium phosphate. Show your working clearly. [1]

5. A solution **A** is saturated with both calcium hydroxide and calcium sulfate. Both salts are sparingly soluble.

(a) The pH of solution **A** is 12.3. Calculate $[OH^-]$ in mol dm^{-3}. **[1]**

(b) **(i)** Write an expression for the K_{sp} of calcium hydroxide. **[1]**

(ii) The numerical value of the solubility product of calcium hydroxide is 4.0×10^{-5}. Calculate the concentration, in mol dm^{-3}, of calcium ions in solution **A**. **[1]**

(c) **(i)** Write an expression for the K_{sp}, of calcium sulfate. **[1]**

(ii) The numerical value of the solubility product of calcium sulfate is 2.5×10^{-5}. What is $[SO_4^{2-}]$ in solution **A**? **[1]**

(iii) $[SO_4^{2-}]$ in solution **A** is less than 5.0×10^{-3} mol dm^{-3}, i.e., the square root of the K_{sp} value of calcium sulfate. Explain why this is so. **[2]**