

IX) Type B Problems: Calculating Solubility

In Type B problems, you must calculate the solubility of a salt using the K_{sp} constant from p.5 of the data booklet.

Remember that **solubility** is the molarity at saturation.

(ie: calc a concentration of the salt)

Example:

→ @saturation @equilibrium

1. Calculate the solubility of $CaCO_3$ in water at $25^\circ C$.

$[CaCO_3] = ?$

$K_{sp} = [Ca^{2+}][CO_3^{2-}]$
* look up value in table *

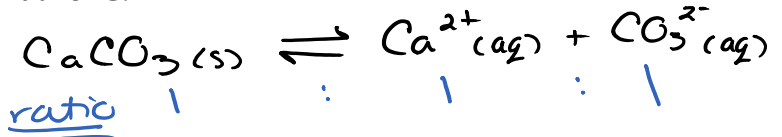
$K_{sp} = 5.0 \times 10^{-9}$

let $x = [Ca^{2+}]$

$\therefore x = [CO_3^{2-}]$

$\sqrt{5.0 \times 10^{-9}} = (x)(x) = x^2$

$x = 7.071 \times 10^{-5} M = [Ca^{2+}] = [CO_3^{2-}]$



$\therefore [CaCO_3] = 7.071 \times 10^{-5} M$

* The solubility of $CaCO_3$ is $7.1 \times 10^{-5} M$

2. Calculate the solubility of PbI_2 in g/L. $m = \frac{mol}{L} \Rightarrow \frac{g}{L}$

solve for $[PbI_2]$ @ saturation

$K_{sp} = [Pb^{2+}][I^-]^2$

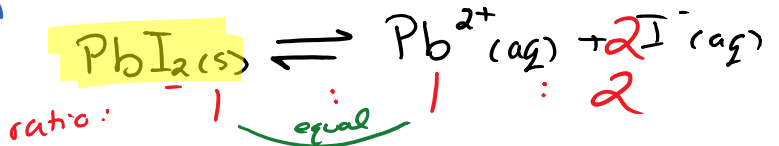
$K_{sp} = 8.5 \times 10^{-9}$ (from table)

let $x = [Pb^{2+}]$

$\therefore 2x = [I^-]$

$K_{sp} = (x)(2x)^2 = 4x^3$

$\sqrt[3]{\frac{8.5 \times 10^{-9}}{4}} = \sqrt[3]{4x^3}$
 $x = 1.28564 \times 10^{-3} M$



$[PbI_2] = x = 1.28564 \times 10^{-3} M = \frac{mol}{L}$

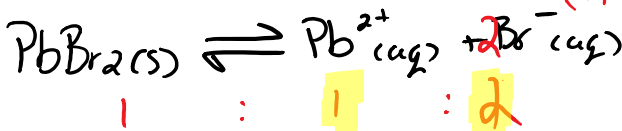
$\frac{1.28564 \times 10^{-3} mol}{L} \times \frac{461.0 g}{1 mol}$

$= 0.59268 g/L$

$\therefore 0.59 g$ of PbI_2 can be added to 1L of water to reach a point of saturation. (before a ppt will form)

3. How many grams of $PbBr_2$ can be dissolved in 250.0mL of water at $25^\circ C$?

($\frac{1}{4}$ of 1L. $\div 4$)



$K_{sp} = [Pb^{2+}][Br^-]^2$
 $K_{sp} = 1.1 \times 10^{-6}$ (from table)

$1.18167 \times 10^{-2} M = \frac{mol}{L} \Rightarrow \frac{g}{250ml}$
 $\frac{1.18167 \times 10^{-2} mol}{L} \times \frac{367.0 g}{1 mol}$

$$K_{sp} = [Pb^{2+}][Br^-]^2$$

$$K_{sp} = 6.6 \times 10^{-6} \text{ (from table)}$$

$$\text{let } x = [Pb^{2+}]$$

$$\therefore 2x = [Br^-]$$

$$6.6 \times 10^{-6} = (x)(2x)^2$$

$$\sqrt[3]{\frac{6.6 \times 10^{-6}}{4}} = \sqrt[3]{\frac{4x^3}{4}}$$

$$x = 1.18167 \times 10^{-2} M = [Pb^{2+}]$$

$$\therefore [PbBr_2] = 1.18167 \times 10^{-2} M$$

$$\frac{1.18167 \times 10^{-2} \text{ mol}}{1 \text{ mol}} \times \frac{367.0 \text{ g}}{1 \text{ mol}} = 4.34 \text{ g/L}$$

$$\frac{4.34 \text{ g}}{1000 \text{ mL}} \times \frac{?}{250 \text{ mL}}$$

$$= 1.1 \text{ g of } PbBr_2$$

in 250.0 mL, you can add 1.1 g of $PbBr_2$ before a precipitate forms. (@ saturation)

Assignment 7: Type B Exercises

1. The K_{sp} at a certain temperature for $Ni(OH)_2$ is 1.6×10^{-16} . Calculate the solubility of $Ni(OH)_2$.
2. Find the solubility of $CaSO_4$ in g/L.
3. Which saturated solutions at $25^\circ C$ will have a greater $[Ag^+]$, $AgCl$ or Ag_2CO_3 ?
4. Calculate the mass of $MgCO_3$ which could be dissolved in 3.0L of water at $25^\circ C$.