Solubility and Equilibrium : 7.6

Solubility = maximum amount of solute dissolved in an amount of solvent

equilibrium ← saturated: (solid) precipitate ⟷ dissolved ions

not at Equilibrium ← unsaturated: solid ⟶ dissolved ions

not in equilibrium ← supersaturated: precipitate ⟵ dissolved ions

Ex. $AgCl(s)$

when dropped in water: $AgCl(s) \leftrightarrow Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$

it's solid

So it won't change concentration, therefore not included in equilibrium expression

$$K = [Ag^{+}][Cl^{-}] \rightarrow K_{sp} = [Ag^{+}][Cl^{-}]$$

Ex. $Ca_3(PO_4)_2(s)$

$$Ca_3(PO_4)_2(s) \leftrightarrow 3Ca^{+2}_{(aq)} + 2PO_4^{-3}_{(aq)}$$

$$K_{sp} = [Ca^{2}]^{3}[PO_4^{-3}]^{2}$$

- Equilibrium means ions are at a saturated level.
- The 'X' in the ICE table is the solubility of that chemical.

Ex. $AgCl(s) \leftrightarrow Ag^{+} + Cl^{-}$

		Ag^{+}	Cl^{-}
I	some amount	0	0
C	$-X$	$+X$	$+X$
E	some amount $-X$	X	X

$K_{sp} = [Ag^{+}][Cl^{-}]$

$= [X][X]$

$K_{sp} = X^2$

solid: not a concern

solubility of the chemical ($AgCl$)

Textbook ex. Pg 485

Textbook ex. Pg 485

① g/100mL → mol/L

Solubility of MgF_2 = 2.8×10^{-4} mol/L = 'x'

$MgF_{2(s)} \rightleftharpoons Mg^{+2}_{(aq)} + 2F^{-1}_{(aq)}$

I		0	0
C		+x	+2x
E		x	2x

→ mol Ratio. For every 1 of MgF_2 you get 2 of F^{-1}

connects Ksp & solubility

* $K_{sp} = [x][2x]^2$

$= 4x^3$

$= 4(2.8 \times 10^{-4} \text{ mol/L})^3$

$= 8.4 \times 10^{-11}$

Textbook ex. Pg 485 (btm) - 486 (table 3).

Predicting Precipitate Formation

① Given volumes and [ ]'s of chemicals involved in a double displacement
② Required - will a precipitate form
③ Ksp will be provided of the possible precipitate
* ④ Calculate the [ ] of the ions involved
⑤ Calculate a 'Q' value (trial ion product)
⑥ Compare to Ksp

Q < Ksp = No precip → everything would dissolve (unsaturated)

Q > Ksp = yes precip (supersaturated)

* = when volumes are being mixed together, don't forget to add volumes. Ex. 488.

Ex. Pg 488.

Pg 488.

6: $CaSO_{4(s)} \rightleftarrows Ca^{+2}_{(aq)} + SO_4^{-2}{}_{(aq)}$

$0.05\ mol/L$ $0.02\ mol/L$

$K_{sp} = [Ca^{+2}][SO_4^{-2}]$

$Q = [0.05][0.02]$

$= 1 \times 10^{-3}$

$K_{sp} = 3.6 \times 10^{-5}$

$\therefore Q > K_{sp}$

$\therefore$ precipitate forms

$CaCl_2 \rightarrow Ca^{+} + 2Cl^{-}$

$Na_2SO_4 \rightarrow 2Na^{+} + SO_4^{-2}$

$[Ca^{+2}] = CxV$

$= 0.1M \times 0.1L$

$= 0.01 mol$

$SO_4^{-2} = CxV$

$= 0.04M \times 0.1L$

$= 0.004 mol$

$[Ca^{+2}] = 0.01 mol / 0.2L$ (total volume)

$= 0.05 mol/L$

$[SO_4^{-2}] = 0.004 mol / 0.2L$

$= 0.02 mol/L$

Hw: Pg 469 #5a.

5a). $AgNO_3 + KCl \rightarrow AgCl + KNO_3$