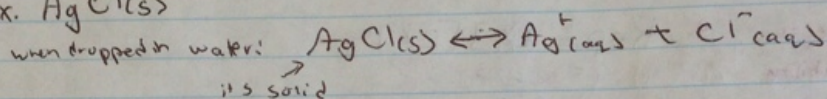


## Solubility and Equilibrium: 7.6

Solubility = maximum amount of Solute dissolved in an amount of Solvent

equilibrium  $\leftarrow$  saturated:  $\overset{\text{(solid)}}{\text{precipitate}} \rightleftharpoons \text{dissolved ions}$   
 not at Equilibrium  $\leftarrow$  unsaturated: Solid  $\rightleftharpoons$  dissolved ions  
 not in equilibrium  $\leftarrow$  supersaturated: Precipitate  $\rightleftharpoons$  dissolved ions

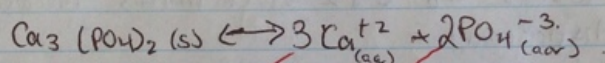
Ex.  $\text{AgCl(s)}$



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

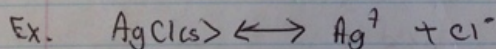
$$K = [\text{Ag}^+][\text{Cl}^-] \rightarrow K_{sp} = [\text{Ag}^+][\text{Cl}^-]$$

Ex.  $\text{Ca}_3(\text{PO}_4)_2(\text{s})$



$$K_{sp} = [\text{Ca}^{2+}]^3 [\text{PO}_4^{3-}]^2$$

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



I some amount

C -X

E some amount  
-X

0 0

+X +X

(X) X

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

$$= [X][X]$$

$$K_{sp} = X^2$$

solid  
not a concern

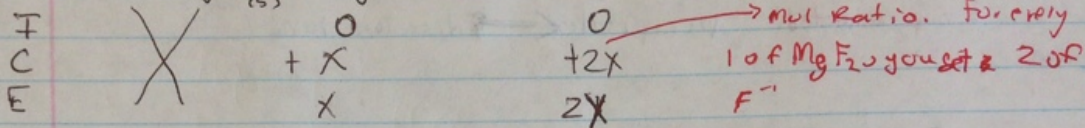
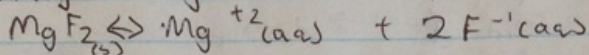
solubility of  
the chemical  
(AgCl)

Textbook ex. Pg 485

Textbook ex. Pg 485

(i)  $\text{g/100mL} \rightarrow \text{mol/L}$

Solubility of  $\text{MgF}_2 = 2.8 \times 10^{-4} \text{ mol/L} = 'x'$



connects  $K_{sp}$  & solubility

$$\begin{aligned} K_{sp} &= [x][2x]^2 \\ &= 4x^3 \\ &= 4(2.8 \times 10^{-4} \text{ mol/L})^3 \\ &= 8.4 \times 10^{-11} \end{aligned}$$

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

### Predicting Precipitate Formation

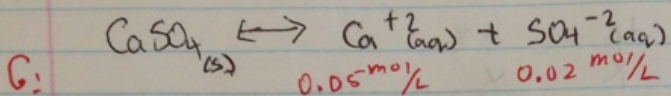
- Given volumes and  $[ ]$ 's of chemicals involved in a double displacement
- Required - will a precipitate form
- $K_{sp}$  will be provided of the possible precipitate
- $\star$  calculate the  $[ ]$  of the ions involved
- Calculate a 'Q' value (trial ion product)
- Compare to  $K_{sp}$ 
  - $Q < K_{sp}$  = No precip  $\rightarrow$  everything would dissolve (unsaturated)
  - $Q > K_{sp}$  = yes precip (supersaturated)

$\star$  = when volumes are being <sup>mixed</sup> added together, don't forget to add volumes. Ex. 488.

Ex. Pg 488.



Pg 488,

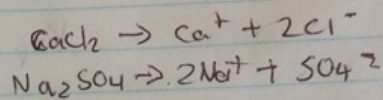


$$K_{sp} = [\text{Ca}^{2+}][\text{SO}_4^{2-}]$$

$$Q = [0.05][0.02] \\ = 1 \times 10^{-3}$$

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

$\because Q > K_{sp}$   
 $\therefore$  precipitate forms



$$\begin{aligned} \text{Ca}^{2+} &= cxv \\ &= 0.1 \text{ M} \times 0.1 \text{ L} \\ &= 0.01 \text{ mol} \end{aligned}$$

$$\begin{aligned} \text{SO}_4^{2-} &= cxv \\ &= 0.04 \text{ M} \times 0.1 \text{ L} \\ &= 0.004 \text{ mol} \end{aligned}$$

$$\begin{aligned} [\text{Ca}^{2+}] &= 0.01 \text{ mol} / 0.2 \text{ L} \quad \text{total volume} \\ &= 0.05 \text{ mol/L} \\ [\text{SO}_4^{2-}] &= 0.004 \text{ mol} / 0.2 \text{ L} \\ &= 0.02 \text{ mol/L} \end{aligned}$$

