Can use K_{sp} to calculate:

molar solubility AND/OR solubility

$\frac{mol}{L}$ $\frac{g}{L}$

ex: let's calculate molar sol. of CaF_2 in water. $K_{sp}(CaF_2) = 4.0 \times 10^{-11}$ @ 25°C.

K_{sp} eqn: (s) $\rightleftharpoons$ ions (aq)   s = molar solubility

$$CaF_2(s) \rightleftharpoons Ca^{2+}(aq) + 2F^-(aq)$$

	$CaF_2(s)$	$Ca^{2+}(aq)$	$2F^-(aq)$
I	—	0	0
C	"−s"	+s	+2s
E	—	(s)	(2s)

$$K_{sp} = [Ca^{2+}][F^-]^2_{eq}$$

$$4.0 \times 10^{-11} = (s)\underbrace{(2s)^2}_{4s^2} = 4s^3$$

s? $\sqrt[3]{\frac{4.0 \times 10^{-11}}{4}} = \sqrt[3]{\frac{4s^3}{4}}$

$$s = \sqrt[3]{1.0 \times 10^{-11}} = 2.2 \times 10^{-4}$$

calculator... (1.0×10^{-11}) ^ 0.333 ...

$\Rightarrow$ molar solubility is $2.2 \times 10^{-4} \frac{mol}{L}$

what about solubility? g/L

$$\frac{2.2 \times 10^{-4} \text{ mol } CaF_2}{1 L} \times \frac{78.08 \text{ g } CaF_2}{1 \text{ mol } CaF_2} = 0.017 \text{ g/L}$$

We can go in reverse!

ex: sol. of silver phosphate is 6.7×10^{-3} g/L.

Q. What's molar sol? Q. What's K_{sp}?

Ag^{+} PO_4^{3-} (3, 1) $= Ag_3PO_4$

$$\frac{6.7\times10^{-3}\,g\ Ag_3PO_4}{1\,L} \times \frac{1\,mol\ Ag_3PO_4}{418.67\,g\ Ag_3PO_4} = 1.6\times10^{-5}\,\frac{mol}{L}$$

Ksp rxn

$$Ag_3PO_4(s) \rightleftharpoons 3Ag^{+}(aq) + PO_4^{3-}(aq)$$

	$Ag_3PO_4(s)$	$3Ag^{+}(aq)$	$PO_4^{3-}(aq)$
I	—	0	0
C	"−s"	+3s	+s
E	—	(3s)	(s)

$$K_{sp} = [Ag^{+}]^3[PO_4^{3-}]$$
$$= (3s)^3(s) = 27s^4$$
$$= 27(1.6\times10^{-5})^4$$
$$= 1.8\times10^{-18}$$

Ksp rxn: $(s) \rightleftharpoons$ ions (aq)

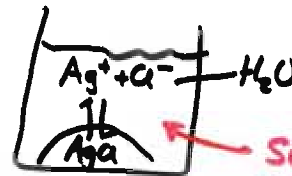
→ solubility

← ppt

Predicting ppt rxns

ex: AgCl : $K_{sp} = 1.6\times10^{-10}$.

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq)$$
$$K_{sp} = [Ag^{+}][Cl^{-}]_{eq}.$$



saturated sol^n @ eq^m.

Q. What if we have a sol^n where:

$$[Ag^{+}]_i = 4.0\times10^{-5}M$$

and $[Cl^{-}]_i = 4.0\times10^{-6}M$

what happens?

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq).$$
$$Q_{sp} = [Ag^{+}]_i[Cl^{-}]_i$$

$Q_{sp} = 4.0\times10^{-5} \times 4.0\times10^{-6}$

$= 1.6\times10^{-10}$

$= K_{sp}\ (AgCl)$

$\Longrightarrow$ @ eq^m // sat'd sol^n

For ex: if $[Ag^+] = 5.0\times10^{-5}M$

+ $[Cl^-] = 4.0\times10^{-6}M$

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

$= 5.0\times10^{-5} \times 4.0\times10^{-6}$

$= 2.0\times10^{-10}$

$Q_{sp} > K_{sp}$ (not @ eq^m)

$Q\downarrow \sim \frac{P\downarrow}{R\uparrow}$ too large → ; (s) ⇌ ions(aq) ← PPT

ex: Mix 5.0mL of $7.0\times10^{-5}M$ $AgNO_{3(aq)}$ with 10.0mL of $4.0\times10^{-5}M$ $MgCl_{2(aq)}$ will a ppt form?

$AgNO_3 \longrightarrow Ag^+ + NO_3^-$

$7.0\times10^{-5}M \longrightarrow 7.0\times10^{-5}M \quad 7.0\times10^{-5}M$

$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$

$4.0\times10^{-5}M \quad 4.0\times10^{-5}M \quad 8.0\times10^{-5}M$

Upon mixing, we get dilution!

$M_1V_1 = M_2V_2 \longrightarrow M_2 = \frac{M_1V_1}{V_2}$

$[Ag^+]_i = \frac{7.0\times10^{-5}M \times 5.0mL}{15.0mL} = 2.\underline{3}3\times10^{-5}M$

$[Cl^-]_i = \frac{8.0\times10^{-5}M \times 10.0mL}{15.0mL} = 5.\underline{3}3\times10^{-5}M$

$Q_{sp} = [Ag^+]_i [Cl^-]_i = 1.2\times10^{-9}$

$K_{sp}(AgCl) = 1.6\times10^{-10} \quad Q_{sp} > K_{sp}$

$Q\downarrow$ to reach eqm.

$Q \sim \frac{P\downarrow}{R\uparrow}$

(s) $\rightleftharpoons$ ions (aq)

$\longleftarrow$

ppt