K_{sp} "solubility product" constant

solubility = a measure of the amount of a solid that will dissolve

molar solubility (s) $\Rightarrow$ $\frac{\#\text{ moles solid}}{1\text{ L of soln}}$

$s \propto M_{sm} = \frac{\#g}{L}$

$M_aX_{b\,(s)} \overset{H_2O}{\rightleftharpoons} aM^{b+}_{(aq)} + bX^{a-}_{(aq)}$

$K_{sp} = [M^{b+}]^a[X^{a-}]^b$

$MX_{2\,(s)} \rightleftharpoons M^{2+}_{(aq)} + 2X^-_{(aq)}$; $K_{sp} = [M^{2+}][X^-]^2$

$M_3X_{2\,(s)} \rightleftharpoons 3M^{2+}_{(aq)} + 2X^{3-}_{(aq)}$; $K_{sp} = [M^{2+}]^3[X^{3-}]^2$

$\downarrow K_{sp}$, the less soluble the solid *only compare "like" salts*

Q $\Rightarrow$ "ion product"

- NON-EQ situations "will a ppt form?"

$Q < K_{sp} \Rightarrow$ dissolving is favored $\Rightarrow$ NO PPT

$Q = K_{sp} \Rightarrow$ saturated solution $\Rightarrow$ NO PPT (NO additional solid)

$Q > K_{sp} \Rightarrow$ forming a solid is favored $\Rightarrow$ PPT Form

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$s \propto M_{sn} = \#g/L$

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- NON-EQ SITUATIONS "will a ppt form?"

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ex1 The solubility of PbI_2 in H_2O is 0.70 g/L, K_{sp} = ?

$PbI_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2I^-_{(aq)}$

$K_{sp} = [Pb^{2+}][I^-]^2$ (×2)

$\frac{0.70\ g}{L} \times \frac{1\ mol}{461\ g} = 1.5 \times 10^{-3} M = [PbI_2]$

$K_{sp} = (1.5 \times 10^{-3} M)(3.0 \times 10^{-3} M)^2 = 1.4 \times 10^{-8}$

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ex2 Ag_2SO_4 $K_{sp} = 1.4 \times 10^{-5}$

What is the solubility of Ag_2SO_4 in g/L in H_2O?

$Ag_2SO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + SO_4^{2-}_{(aq)}$

$2s \quad s$

$\sqrt[3]{K_{sp} = 1.4 \times 10^{-5}} = [Ag^+]^2[SO_4^{2-}] = (2s)^2(s) = \sqrt[3]{4s^3}$

$\frac{1.4 \times 10^{-5}}{4}$ $\qquad \frac{4}{4}$

$s = [Ag_2SO_4] = 1.5 \times 10^{-2} M \times \frac{311.81\ g}{1\ mol}$

$[Ag^+] = 3.0 \times 10^{-2} M$

$[SO_4^{2-}] = 1.5 \times 10^{-2} M$ $\qquad = 4.7\ g/L$

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will it ppt? M^+, X^- from separate sources

$Q > K_{sp}$ DILUTION $M_2 = \frac{M_1 V_1}{V_2}$

* COEFFICIENT TRAP *

If 10.0mL of 0.010 M $AgNO_3$ is added to 15.0mL of 0.010 M Na_2SO_4, will a ppt form?

Ag^+, NO_3^-, Na^+, SO_4^{2-}

$M_2 = \frac{M_1V_1}{V_2}$ $\quad [Ag^+] = \frac{(0.010M)(0.010L)}{(0.025L)} = 0.0040M$

$[SO_4^{2-}] = \frac{(0.010M)(0.015L)}{(0.025L)} = 0.0060M$

$Ag_2IO_4 \rightleftharpoons 2Ag^+_{(aq)} + SO_4^{2-}_{(aq)}$

0.0040 $\quad$ 0.0060

$Q = [Ag^+]^2[SO_4^{2-}] = (0.0040)^2(0.0060) = 9.6 \times 10^{-8}$

$K_{sp} = 1.4 \times 10^{-5}$

$Q < K_{sp}$ NO PPT