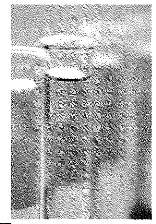

Precipitation Conditions

Ion Product (Q)

AKA rxn. quotient
*use initial concentrations

ex: $CaF_{2(s)} \rightleftharpoons Ca^{+2}_{(aq)} + 2F^-_{(aq)}$

*Precipitation will occur when ion product is greater than Ksp

If $Q > K_{sp}$ precipitation will occur ~ more solid formed

If $Q \leq K_{sp}$ no (more) precipitation occurs

$(.750L)(4.00\times10^{-3}\frac{mol}{L}) = 3.00\times10^{-3} mol\ Ce^{+3}$

Ex 1: A solution is prepared by adding 750.0 ml of 4.00 x 10^{-3} M $Ce(NO_3)_3$ to 300.0 ml of 2.00 x 10^{-2} M KIO_3. Will $Ce(IO_3)_3$ (K_{sp} = 1.9 x 10^{-10}) precipitate from this solution?

$(0.300L)(2.00\times10^{-2}\frac{mol}{L}) = 6.00\times10^{-3} mol\ IO_3^-$

$Ce(IO_3)_{3(s)} \rightleftharpoons Ce^{+3}_{(aq)} + 3IO_3^-{}_{(aq)}$
x mol/L

$K_{sp} = [Ce^{+3}][IO_3^-]^3$

$Q = [Ce^{+3}]_o [IO_3^-]_o^3$
$= (2.86\times10^{-3}M)(5.71\times10^{-3}M)^3$
$= 5.32\times10^{-10}$

$[Ce^{+3}] = \frac{3.00\times10^{-3} mol}{1.05 L} = 2.86\times10^{-3} M\ Ce^{+3}$

$[IO_3^-] = \frac{6.00\times10^{-3} mol}{1.05 L} = 5.71\times10^{-3} M\ IO_3^-$

$Q > K_{sp}$ ∴ precipitation will occur

SELECTIVE PRECIPITATION

→ "separating ions by precipitation"

*Selective Precipitation is often utilized to separate ions present in solution.

Ex: A solution of Ag^{+1}, NO_3^{-1} and Ba^{+2} ions

NaCl is added to solution → Na^{+1} ~ soluble w/ NO_3^-
Cl^- → AgCl insoluble

Na_2SO_4 is added to original solution → Na^+ ~ soluble w/ NO_3^{-1}
SO_4^{-2} → $BaSO_4$ insoluble

**Ions are separated by precipitation. **

**Metal sulfides vary greatly in their solubility, therefore sulfide ion is often utilized in selective precipitation.

Ex: A solution contains 1.0×10^{-4} M Cu^+ and 2.0×10^{-3} M Pb^{+2}. If a source of I^- is gradually added to this solution, will PbI_2 ($K_{sp} = 1.4 \times 10^{-8}$) or CuI ($K_{sp} = 5.3 \times 10^{-12}$) precipitate first? Specify the concentration of I^- necessary to begin precipitation of each salt.

For PbI_2: $PbI_{2(s)} \rightleftharpoons Pb^{+2}_{(aq)} + 2I^{-1}_{(aq)}$ (2.0×10^{-3} M)

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

$1.4 \times 10^{-8} = (2.0 \times 10^{-3} M)[I^-]^2$

$2.6 \times 10^{-3} M = [I^-]$

* any I^- in excess of 2.6×10^{-3} M will cause $PbI_{2(s)}$ to form

For CuI: $CuI_{(s)} \rightleftharpoons Cu^{+1}_{(aq)} + I^-_{(aq)}$ (1.0×10^{-4} M)

$K_{sp} = [Cu^{+1}][I^-]$

$5.3 \times 10^{-12} = (1.0 \times 10^{-4} M)[I^-]$

$5.3 \times 10^{-8} M = [I^-]$

* any I^- in excess of 5.3×10^{-8} M will cause $CuI_{(s)}$ to form

$CuI_{(s)}$ will precipitate first (requires less I^-)

∴ Cu^+ would be separated by Pb^{+2} when $[I^-] > 5.3 \times 10^{-8}$ M

Ex: A solution contains 1.0×10^{-3} M $Fe(NO_3)_2$ and 1.0×10^{-3} M $MnSO_4$. Both Fe^{+2} and Mn^{+2} form sulfide salts: FeS ($K_{sp} = 3.7 \times 10^{-19}$) and MnS ($K_{sp} = 1.4 \times 10^{-15}$). If sulfide ion is added to the solution containing 10^{-3} M Fe^{+2} and 10^{-3} M Mn^{+2}, which sulfide salt will precipitate first and at what $[S^{-2}]$ will precipitation occur?

FeS: $FeS_{(s)} \rightleftharpoons Fe^{+2}_{(aq)} + S^{-2}_{(aq)}$

1.0×10^{-3} M

$K_{sp} = [Fe^{+2}][S^{-2}] = 3.7 \times 10^{-19}$

$(1.0 \times 10^{-3} M)[S^{-2}] = 3.7 \times 10^{-19}$

$[S^{-2}] = 3.7 \times 10^{-16}$ M

MnS: $MnS_{(s)} \rightleftharpoons Mn^{+2}_{(aq)} + S^{-2}_{(aq)}$

1.0×10^{-3} M

$K_{sp} = [Mn^{+2}][S^{-2}] = 1.4 \times 10^{-15}$

$(1.0 \times 10^{-3} M)(S^{-2}) = 1.4 \times 10^{-15}$

$[S^{-2}] = 1.4 \times 10^{-12}$ M

$\therefore$ FeS will precip. first when $[S^{-2}] > 3.7 \times 10^{-16}$ M