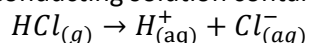


C12 - 3.0 - Solubility

Assume 25°C*

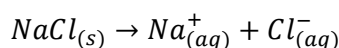
Solution : A homogeneous mixture of two or more substances. (Saturated when solvent dissolved maximum solute.) Solvent : Able to dissolve other substances. Solute : Minor component in a solution.

Electrolyte - A substance which dissolves to give it an electrically conducting solution containing ions.

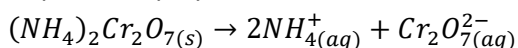


Ionic Solution - Contains ions.

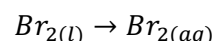
Ionic Compounds - Metal/Non-metal likely ionic in solution.



A compound of polyatomic ions will be ionic in solution.

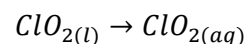


Non-Electrolyte - A substance which dissolves to give it a non-conducting solution containing only neutral molecules.



Molecular Solution - Contains only neutral molecules.

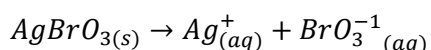
Molecular/Covalent Compounds - Non-metals/Non-metals, especially organic compounds, generally form molecular solutions.



Solubility - Maximum amount of substance which can dissolve in a given amount of solvent at given temperature. (C12 - The []_{eq}) (Negligible Solubility - Dissolves an extremely small extent.)

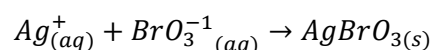
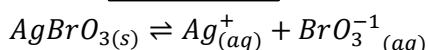
(Low Solubility - If a saturated solution of a substance is less than 0.1M.)

Saturated - Solution has dissolved maximum amount. (C12 - Dissolved substance in Eq with some of the undissolved substance.) (Supersaturation - Concentrated solution contains more than when saturated.)



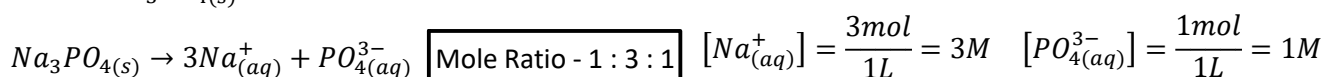
Dissolving

Eventually



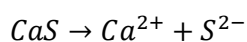
Recrystallization

1 mol $Na_3PO_{4(s)}$ dissolved and diluted to a 1L volume.



If two ions from a compound have "low solubility," mixing of the two ions will cause a precipitate to form.

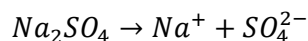
0.2M CaS & 0.2M Na_2SO_4 solutions are mixed.



Examine Cross
Combinations

$Na^+ + S^{2-}$; Soluble See Table

$Ca^{2+} + SO_4^{2-}$; Low solubility $CaSO_4$ precipitate will form.



Qualitative Analysis - Experimental procedures to determine which elements or ions are present in a substance.

Assume aqueous solution contains either or both Ag^+ or Sr^{2+} .

Possible Reactions

	Cl^-	SO_4^{2-}	S^{2-}	OH^-	PO_4^{3-}
Originals*	Ag^+	ppt	ppt	ppt	ppt
	Sr^{2+}	----	ppt	----	ppt

Basically start with the addition that ppt's by most originals with that doesn't precipitate others. Repeat.

ppt : Precipitate, ---- : No

If only SO_4^{2-} or PO_4^{3-} is added its undetermined which is present.

To test for Ag^+ and/or Sr^{2+} steps :

Precipitate all Ag^+ with sufficient Cl^- , S^{2-} or OH^- .

1) Take 1 mL solution, add a few drops ie. 1 M $NaCl$, Na_2S or $NaOH$.

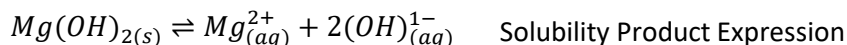
-If precipitate forms Ag^+ is present. (If not absent). Filter off/discard any precipitate.

2) To solution in step 1, add a few drops of 1 M Na_2SO_4 or Na_3PO_4 .

-If precipitate forms Sr^{2+} is present. (If not absent)

C12 - 3.0 - Predicting a Precipitate Solubility

Find the $[Mg^{2+}]$ in a saturated solution of $Mg(OH)_2$

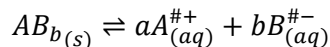


$$K_{sp} = [Mg^{2+}][OH^{-}]^2$$

Larger K_{sp} ;
More soluble salt.

Solubility Product Constant

$$K_{sp} = [A^+]^a[B^-]^b$$



let $x = [Mg(OH)_2]_{dissolved}$

$$x \rightleftharpoons x + 2x$$

Mole Ratio 1 : 1 : 2

$$K_{sp} = [x][2x]^2 \quad \text{See Table}$$

$$5.6 \times 10^{-12} = 4x^3$$

Divide both sides

$$1.4 \times 12^{-12} = x^3$$

Cube root* Both sides

$$x = 1.12 \times 10^{-4}$$

$$[Mg^{2+}] = 1.12 \times 10^{-4} M$$

Note:

Use "Solubility of Common Ions in Water" Table to predict whether a compound has low solubility.

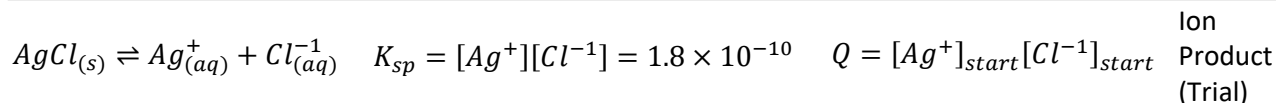
Use "Solubility Product Constants at 25°C" Table (K_{sp}) to compare relative solubilities.

Solubility - Amount of substance required to make a saturated solution $\frac{g}{L}$.

Molar Solubility - Molar concentration of a saturated solution $\frac{mol}{L}$.

Solubility $\neq$ Solubility Constant

Solubility Product - K_{sp} value obtained when concentration of ions in a solution are multiplied together.



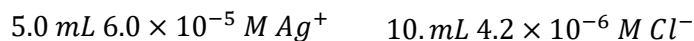
The Product of Ion Concentrations : Q = which actually exist in solution ("what we have.")

K_{sp} = required to establish a solubility Eq (What we need to form a saturated solution.)

Precipitate : $Q < K_{sp}$ Cannot Form

$Q = K_{sp}$ Barely saturated solution formed

$Q > K_{sp}$ Will Form



$$[Ag^{+}]_{diluted} = 6.0 \times 10^{-5} M \times \frac{5.0 \text{ mL}}{15 \text{ mL}} = 2.0 \times 10^{-5} M$$

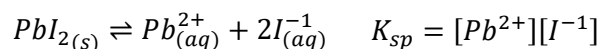
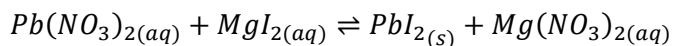
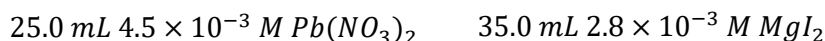
$$c_1v_1 = c_2v_2 \quad 5 \text{ mL} + 10 \text{ mL} = 15 \text{ mL}$$

$$[Cl^{-}]_{diluted} = 4.2 \times 10^{-6} M \times \frac{10. \text{ mL}}{15 \text{ mL}} = 2.8 \times 10^{-6} M$$

$$Q = [Ag^{+}]_{dil}[Cl^{-1}]_{dil} \\ = (2.0 \times 10^{-5})(2.8 \times 10^{-6}) \\ = 5.6 \times 10^{-11}$$

$$5.6 \times 10^{-11} < K_{sp} = 1.8 \times 10^{-10}$$

Precipitate will not form.



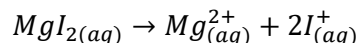
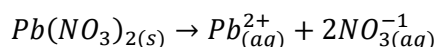
$$[Pb(NO_3)_2]_{dil} = 4.5 \times 10^{-3} M \times \frac{25.0 \text{ mL}}{60.0 \text{ mL}} = 1.88 \times 10^{-3} M$$

$$[MgI_2]_{dil} = 2.8 \times 10^{-3} M \times \frac{35. \text{ mL}}{60 \text{ mL}} = 1.63 \times 10^{-3} M$$

$$Q = [Pb^{2+}]_{dil}[I^{-}]_{dil} \\ = (1.88 \times 10^{-3})(3.26 \times 10^{-3}) \\ = 2.00 \times 10^{-8}$$

$$2.00 \times 10^{-8} < K_{sp} = 8.5 \times 10^{-9}$$

Precipitate will form.



$$1.88 \times 10^{-3} \quad 1.88 \times 10^{-3} \quad 3.76 \times 10^{-3}$$

Molarity

$$1.63 \times 10^{-3} \quad 1.63 \times 10^{-3} \quad 3.26 \times 10^{-3}$$