Introduction to Physical Science

Classifying Chemical Reactions

Presented by Robert Wagner

Types of Chemical Reactions

- Precipitation Reaction
  - Dissolved substances react to form solids
- Acid-Base Reaction
  - The hydrogen ion ( ) is transferred from one chemical species to another
- Oxidation-Reduction Reaction
  - Reaction involving transfer of electrons

Precipitation Reactions

- Solubility
  - Maximum concentration of a substance that can be achieved
- Soluble
  - A substance that has a high solubility
- Insoluble
  - A substance with a low solubility
- Precipitate
  - Occurs when the concentration exceeds the solubility

Solubility Table

- Soluble compounds are less likely to precipitate than insoluble compounds

	contain these ions	exceptions
Soluble Ionic Compounds	NH_4^+ group I cations: Li^+ Na^+ K^+ Rb^+ Cs^+	none
	Cl^- Br^- I^-	compounds with Ag^+, Hg_2^{2+}, and Pb^{2+}
	F^-	compounds with group 2 metal cations, Pb^{2+}, Fe^{3+}, and Ag^+
	$C_2H_3O_2^-$ HCO_3^- NO_3^- ClO_3^-	none
	SO_4^{2-}	compounds with Ag^+, Ba^{2+}, Ca^{2+}, Hg_2^{2+}, Pb^{2+} and Sr^{2+}
Insoluble Ionic Compounds	contain these ions	exceptions
	CO_3^{2-} CrO_4^{2-} PO_4^{3-} S^{2-}	compounds with group 1 cations and NH_4^+
	OH^-	compounds with group 1 cations and Ba^{2+}

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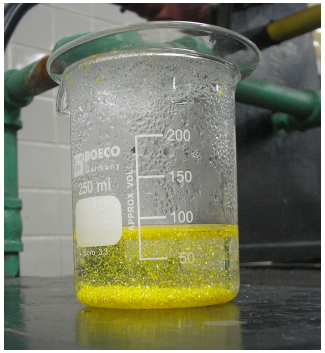
Example

- Mixture of potassium iodide ( ) and lead Nitrate ( )
-
- Net Equation:
  -



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Example

- Mixing silver nitrate ( ) and sodium fluoride ( )

Ions Formed:

Ag^+ ; NO_3^- ; Na^+ ; F^-

Other compounds that can form:

$NaNO_3$ & AgF

Review solubility guidelines

$NaF(aq) + AgNO_3(aq) \longrightarrow AgF(s) + NaNO_3(aq)$

Or,

$Ag^+(aq) + F^-(aq) \longrightarrow AgF(s)$

Examples

- Determine the precipitate for each of the following reactions. Write the net ionic equation
  - Potassium Sulfate & Barium Nitrate
  - Lithium Chloride & Silver Acetate

$K_2SO_4 + Ba(NO_3)_2 \longrightarrow 2KNO_3 + BaSO_4$

$BaSO_4$ *is insoluble*

$Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow BaSO_4(s)$

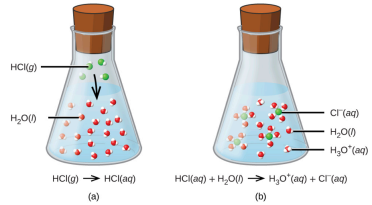
$LiCl + AgC_2H_3O_2 \longrightarrow AgCl + LiC_2H_3O_2$

$AgCl$ *is insoluble*

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$

Acid-Base Reactions

- In these reactions, a hydrogen ion is transferred
  - An acid is a substance that will give hydronium ions ( ) when dissolved in water
- Example:
  -
  - Strong acid - All of the compound dissociates
  - Weak acid - only some of the compound dissociates



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Acid-Base Reactions

- In these reactions, a hydrogen ion is transferred
  - A base is a substance that yields hydroxide ions ( ) when dissolved in water
- Example:
  -
  - Strong base - All of the compound dissociates
  - Weak base - only some of the compound dissociates
  - Ex:

Neutralization Reaction

- An acid and a base react together to produce a salt and water
  -
- Example:
  -
  - Salt - magnesium chloride

Example

- Write balanced equations for the acid-base reactions described:
  - Weak acid hydrogen hypochlorite reacts with water
  - A solution of barium hydroxide is neutralized with a solution of nitric acid

$$HOCl(aq) + H_2O(l) \rightleftharpoons ?$$

$$HOCl(aq) + H_2O(l) \rightleftharpoons OCl^-(aq) + H_3O^+$$

$$Ba(OH)_2(aq) + HNO_3(aq) \longrightarrow ?$$

$$Ba(OH)_2(aq) + 2HNO_3(aq) \longrightarrow Ba(NO_3)_2(aq) + 2H_2O(l)$$

Oxidation-Reduction Reactions

- Oxidation-reduction reactions (redox)
  - Oxidation - loss of electrons
  - Reduction - gain of electrons
  - Reducing agent - species that is oxidized
  - Oxidizing agent - species that is reduced

Oxidation Number

- Oxidation number or oxidation state:
  - Oxidation number of an atom in an elemental substance is zero
  - Oxidation number of a monatomic ion is equal to the ion's charge
  - Oxidation numbers for common non-metals
    - Hydrogen: +1 when combined with nonmetals, -1 when combined with metals
    - Oxygen: -2 in most compounds
    - Halogens: -1 for Fluorine (always) Generally -1 for other halogens
  - Sum of oxidation numbers in a molecule is equal to the charge on the molecule or ion

Example

- Assign oxidation numbers to the following:
  -
  -

H_2S: H has oxidation number of +1

Charge on H_2S = 0

2 hydrogens: oxidation of +2

0 = +2 + ? ; Oxidation of S must be -2

SO_3^{2-}: O has an oxidation number of -2

Charge on SO_3^{2-} is -2

-2 = -2(3) + ?

-2 = -6 + ?

Oxidation of S must be +4

Summary

- Three types of reactions: Precipitation, Acid-Base, & Oxidation-Reduction
- The solubility of a substance tells how much of it can remain dissolved under specific circumstances
- Acids give hydronium ions in water ; bases give hydroxide ions
- Oxidation is a loss of electrons while reduction is a gaining of electrons