Chem 130 Unit 4

Chemical Reaction Types
Acidity/Basicity, pH
Oxidation/Reduction

Chemical Change

- How do we know when a chemical reaction occurs?

Chemical Change

- How do we know when a chemical reaction occurs?

- Color Change
- Light production
- Heat production
- Gas emission
- Precipitate formation

Chemical Reactions

8 Types of Chemical Reaction:

Combination
Decomposition
Single Replacement
Double Replacement
Combustion
Precipitation
Acid/Base
Oxidation/Reduction

Chemical Reactions

Combination:

2 elements, or 2 compounds combine to form 1 new compound

$Mg(s) + O_2(g) \text{-------} > MgO(s)$

Chemical Reactions

Decomposition:

A compound is broken down into its elements

$HgO(s) \text{-------} > Hg(l) + O_2(g)$

Chemical Reactions

Single Replacement:

A free element displaces another element from a compound producing a different compound and element

$K(s) + H_2O(l) \text{--------} > KOH(aq) + H_2(g)$

Chemical Reactions

Double Replacement:

Two compounds exchange ionic partners to form new compounds

$K_2CrO_4(aq) + 2\ AgNO_3(aq) \text{------} > Ag_2CrO_4(s) + 2\ KNO_3(aq)$

Chemical Reactions

Combustion:

Involves oxygen as a reactant and produces heat and flame

$CH_4(g) + O_2(g) \text{ ------> } CO_2(g) + 2\,H_2O(g)$

Chemical Reactions

- Precipitation

$AgNO_3 + NaCl \text{ ----------> } AgCl(s) + Na^+ + NO_3^-$

Chemical Reactions

- Acid + Base ----------> Water is formed
- Acids release H^+:
  - $HCl \text{ ----------> } H^+ + Cl^-$
- Bases release OH–
  - $KOH \text{ ----------> } K^+ + OH^-$
  - $HCl + KOH \text{ ----------> } H_2O + K^+ + Cl^-$

Net Ionic Equations

❖ $HCl + KOH \text{ ----------> } H_2O + K^+ + Cl^-$

$H^+ + Cl^- + K^+ + OH^- \text{ ----------> } H_2O + K^+ + Cl^-$

$H^+ + \underline{Cl^-} + \underline{K^+} + OH^- \text{ ----------> } H_2O + \underline{K^+} + \underline{Cl^-}$

$H^+ + OH^- \text{ ----------> } H_2O$

Chemical Reactions

- Oxidation/Reduction (Electron Transfer)

$2\ AgNO_3 + Cu \dashrightarrow Cu(NO_3)_2 + 2\ Ag$

$Ag^+ \dashrightarrow Ag$ Reduction

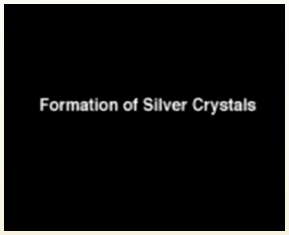
$Cu \dashrightarrow Cu^{2+}$ Oxidation

Electron Transfer

Oxidation and Reduction must occur together:

$Cu \dashrightarrow Cu^{2+} + 2e^-$

$2\ Ag^+ + 2e^- \dashrightarrow Ag$



Electron Transfer

Oxidation and Reduction must occur together:

$Cu \dashrightarrow Cu^{2+} + 2e^-$ oxidation

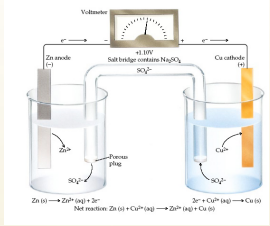
$2\ Ag^+ + 2e^- \dashrightarrow Ag$ reduction

Electron Transfer

Voltaic Cells

$Zn \dashrightarrow Zn^{2+} + 2e^-$ oxidation

$Cu^{2+} + 2e^- \dashrightarrow Cu$ reduction

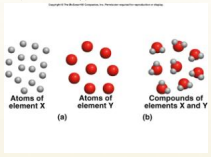


Chemical Reactions

- Conservation of Matter:

In any chemical transformation, matter is neither created nor destroyed but is only changed in form

$2\,X + Y \text{ -----> } X_2Y$ balanced

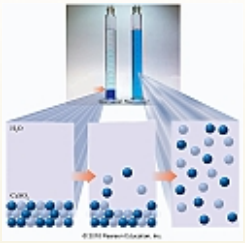


Homogeneous Solutions

Solute uniformly dispersed in the Solvent

Solute: $CuSO_4$

Solvent: H_2O



Solutions

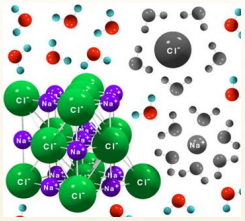
Gas & Water: Carbonated Drinks

Liquid & Water: Vinegar

Solid & Water:

Electrolytic Solutions

$NaCl_{(s)} + H_2O_{(l)} \text{ -----> } Na^+_{(aq)} + Cl^-_{(aq)}$



Electrolytic Solutions

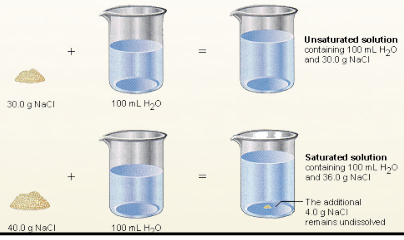
$NaCl_{(s)} + H_2O_{(l)} \text{ -----> } Na^+_{(aq)} + Cl^-_{(aq)}$

Conduct Electricity

Solubility

How much will dissolve in the solvent?

Unsaturated vs. Saturated



Concentration

$$\text{Concentration} = \frac{\text{amount of solute}}{\text{amount of solution}}$$

Mass percent (%), mass/volume (m/v) or volume/volume (v/v)

Concentration

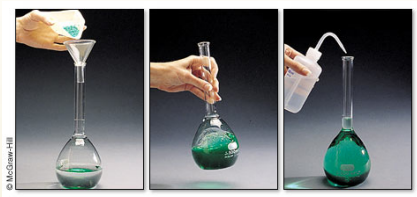
5% m/v Dextrose in 0.9% m/v NaCl : electrolyte replacement

$$\text{Concentration} = \frac{\text{amount of solute}}{\text{amount of solution}} = \frac{50 \text{ gram}}{1.0 \text{ Lite}}$$

$$= 5\%$$

Molarity

Moles of soluteper Liter of solvent



$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{L solution}}$$

Molarity

Moles of soluteper Liter of solvent:

80 g NaOH in 500 mL?

Molarity

Moles of soluteper Liter of solvent:

80 g NaOH in 500 mL?

80 g x 1 mole/40 g = 2 moles
500 mL x 1 Liter/1000 mL = 0.5 L
2 moles
M = 0.5 Liters = 4 M (4 molar)

Molarity

Finding the number of moles in solution:

50 mL of 3 M solution of $Al(NO_3)_3$:

50 mL x 1 L/1000 mL x 3 moles/L = 0.15 moles of $Al(NO_3)_3$

0.15 moles x 213 g/mole = 31.95 g of $Al(NO_3)_3$

Dilution

more concentrated solution ----> less concentrated

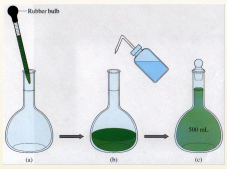
10 mL 6 M HCl solution diluted to 250 mL:

10 mL x 1 L/1000 mL = 0.01 L

0.01 L x 6 moles/L = 0.06 moles

0.06 moles/0.25 L = 0.24 M HCl

$M_1V_1 = M_2V_2$



Stoichiometric Molarity

A metal reacts completely with 34.8 mL of 0.520 M HCl. What is the volume of H_2 gas produced?

$M_{(s)} + HCl_{(aq)} \rightarrow H_{2(g)} + MCl_{3(aq)}$

Stoichiometric Molarity

A metal reacts completely with 34.8 mL of 0.520 M HCl. What is the volume of H_2 gas produced at STP?

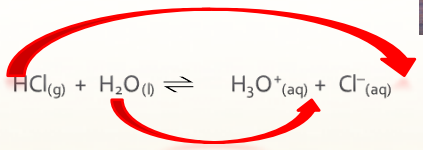
$2\ M_{(s)} + 6\ HCl_{(aq)} \rightarrow 3\ H_{2(g)} + 2\ MCl_{3(aq)}$

0.0348 L x 0.520 moles/L = 0.018 moles HCl

0.018 moles HCl x 3 moles H_2/6 moles HCl = 0.009 moles H_2

V = nRT/p = (0.009 moles)(0.082 Latm/moleK)(273 K)/1 atm
= 0.203 L = 203 mL

Proton Transfer



HCl is losing H^+ H_2O is gaining H^+

Proton Transfer

$HCl_{(g)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$

HCl is losing H^+ H_2O is gaining H^+

ACID **BASE**

Proton Transfer

$NH_{3(g)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

NH_3 is gaining H^+ H_2O is losing H^+

Proton Transfer

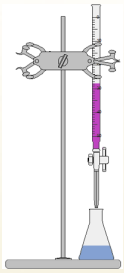
$NH_{3(g)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

NH_3 is gaining H^+ H_2O is losing H^+

BASE **ACID**

Titration

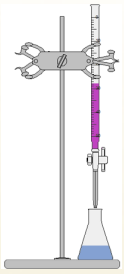
- Using neutralization to determine unknown concentration of acid or base



- Uses an indicator solution to signal when the
  - ENDPOINT is reached

Titration

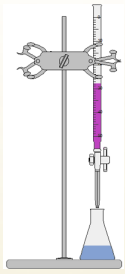
- Using neutralization to determine unknown concentration of acid or base



- 36 mL of 0.25 M HCl used to titrate 100 mL ? M KOH
- HCl + KOH ------> H_2O + KCl

Titration

- Using neutralization to determine unknown concentration of acid or base



36 mL of 0.25 M HCl used to titrate 100 mL ? M KOH

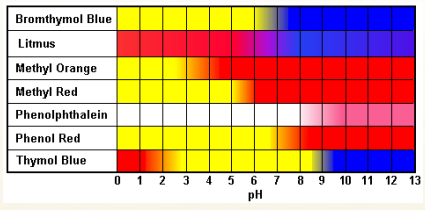
$M_{HCl}V_{HCl} = M_{KOH}V_{KOH}$

(0.036 L)(0.25 M) = 0.009 moles HCl
= 0.009 moles KOH

0.009 moles KOH/0.1 L = **0.09M KOH**

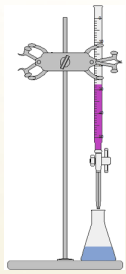
Indicators

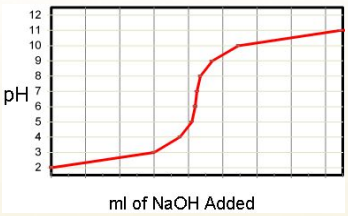
- Choose indicator based on expected endpoint



Titration

- Adding base raises pH





Titration

- At equivalence point:

moles acid = moles base

$M_A V_A = M_B V_B$