CHAPTER THREE
CHEMICAL EQUATIONS & REACTION STOICHIOMETRY

Goals

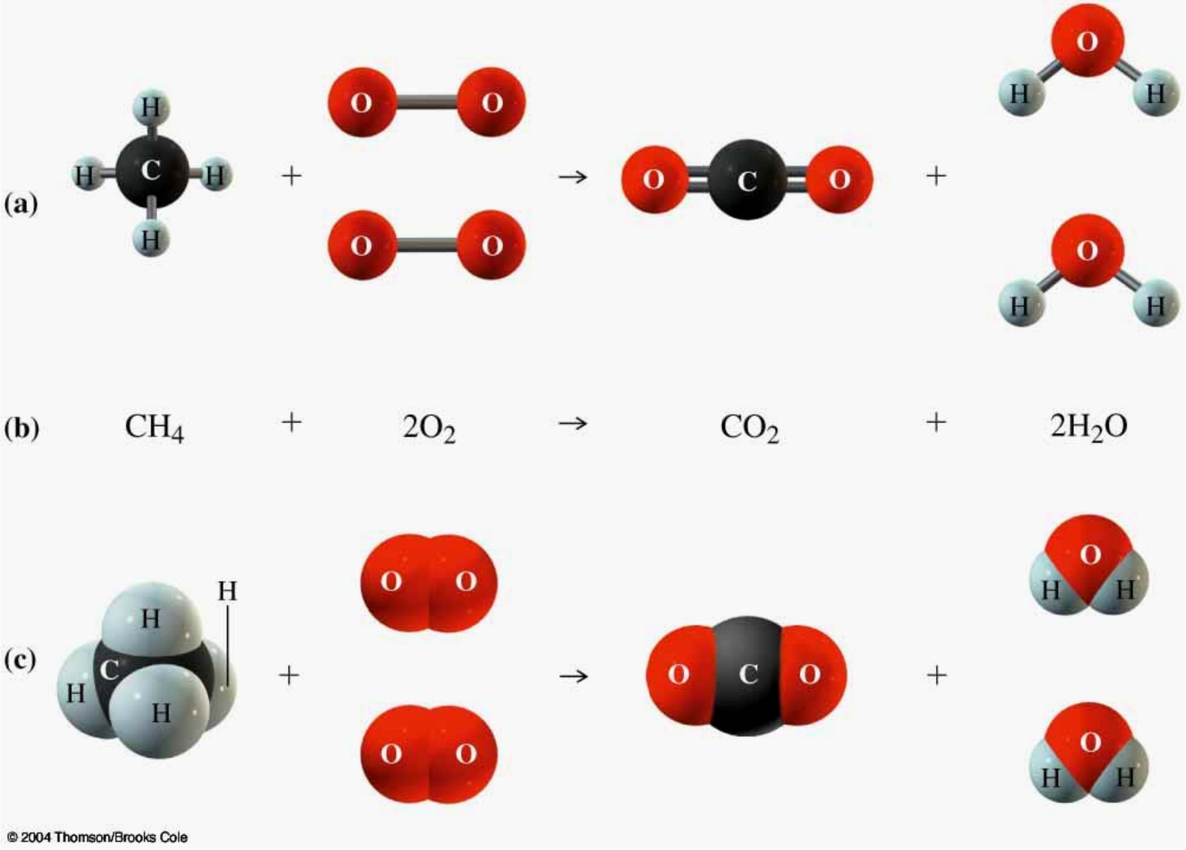
- Chemical Equations
- Calculations Based on Chemical Equations
- The Limiting Reactant Concept
- Percent Yields from Chemical Reactions
- Sequential Reactions
- Concentrations of Solutions
- Dilution of solutions
- Using Solutions in Chemical Reactions

Chemical Equations

- Symbolic representation of a chemical reaction that shows:

1. reactants on left side of reaction
2. products on right side of equation
3. relative amounts of each using stoichiometric coefficients

Chemical Equations



Chemical Equations

- Look at the information an equation provides:

$$Fe_2O_3 + 3\,CO \xrightarrow{\Delta} 2\,Fe + 3\,CO_2$$

reactants		yields	products	
1 formula unit	3 molecules		2 atoms	3 molecules
1 mole	3 moles		2 moles	3 moles
159.7 g	84.0 g		111.7 g	132 g

Chemical Equations

- Law of Conservation of Matter
  - There is **no detectable change** in quantity of matter in an ordinary chemical reaction.
  - Balanced chemical equations must always include the **same number** of each kind of atom on both sides of the equation.

$$C_3H_8 + 5\,O_2 \xrightarrow{\Delta} 3\,CO_2 + 4\,H_2O$$

Law of Conservation of Matter

- NH_3 burns in oxygen to form NO & water

$$2\,NH_3 + \tfrac{5}{2}\,O_2 \xrightarrow{\Delta} 2\,NO + 3\,H_2O$$

or correctly

$$4\,NH_3 + 5\,O_2 \xrightarrow{\Delta} 4\,NO + 6\,H_2O$$

Law of Conservation of Matter

- C_7H_{16} burns in oxygen to form carbon dioxide and water.

$$C_7H_{16} + 11\,O_2 \xrightarrow{\Delta} 7\,CO_2 + 8\,H_2O$$

- **<u>Balancing equations is a skill acquired only with lots of practice</u>**

Calculations Based on Chemical Equations

- How many CO molecules are required to react with 25 formula units of Fe_2O_3?

$25\ Fe_2O_3 + ?\ CO \rightarrow$ Product

$1Fe_2O_3$ needs 3 CO

$25Fe_2O_3$ needs ? CO

$$?\ \text{CO molecules} = 25\ \text{formula units}\ Fe_2O_3 \times \frac{3\ \text{CO molecules}}{1\ Fe_2O_3\ \text{formula unit}}$$

$$= 75\ \text{molecules of CO}$$

Calculations Based on Chemical Equations

- How many iron atoms can be produced by the reaction of 2.50 x 10^5 formula units of iron (III) oxide with excess carbon monoxide?

Fe_2O_3 + excess CO → 2 Fe +

1Fe_2O_3 gives 2 Fe

2.5 X 10^5 Fe_2O_3 gives ? Fe

$$? \text{ Fe atoms} = 2.50 \times 10^5 \text{ formula units } Fe_2O_3$$

$$\times \frac{2 \text{ Fe atoms}}{1 \text{ formula units } Fe_2O_3} = 5.00 \times 10^5 \text{ Fe atoms}$$

Calculations Based on Chemical Equations

- What mass of CO is required to react with 146 g of iron (III) oxide?

Fe_2O_3 + 3CO → Product

MW(Fe_2O_3) needs 3MW(CO)

146 g needs ?g CO

$$? \text{ g CO} = 146 \text{ g } Fe_2O_3 \times \frac{1 \text{ mol } Fe_2O_3}{159.7 \text{ g } Fe_2O_3} \times \frac{3 \text{ mol CO}}{1 \text{ mol } Fe_2O_3}$$

$$\times \frac{28.0 \text{ g CO}}{1 \text{ mol CO}} = 76.8 \text{ g CO}$$

Chemistry is fun!