

## Ch 100: Fundamentals for Chemistry

### Ch 9: Calculations from Chemical Reactions Lecture Notes (Sections 9.1 to 9.5)

## Chemical Equations: What do they tell us?

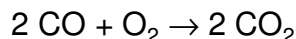
A properly written chemical equation will provide the following information:

1. All reactants & products involved in the reaction
2. The physical state of all reactants & products
3. The presence of any catalysts involved in the chemical reaction
4. The relative quantity of all reactants & products
  - a. Molecule to molecule ratios
  - b. Mole to mole ratios
  - c. Even mass to mass ratios can be determined (with use of molar mass values)

## Information Given by the Chemical Equation

A balanced chemical equation provides the relationship between the relative numbers of reacting molecules and product molecules

**Example:** *The formation of carbon dioxide from carbon monoxide and oxygen gas*



In this chemical equation, it is indicated that 2 CO molecules react with every 1 O<sub>2</sub> molecule to produce 2 CO<sub>2</sub> molecules

**Alternative interpretation:** *there is a 2:1 (numerical) ratio of CO to O<sub>2</sub> for this completed reaction, 2 CO:1 O<sub>2</sub>:2 CO<sub>2</sub>*

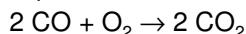
## Interpretation of the Chemical Equation

- Since the information given in a balanced chemical reaction is relative:  

$$2 \text{ CO} + \text{O}_2 \rightarrow 2 \text{ CO}_2$$
 the following are alternative interpretations of the chemical equation:
  - a. 200 CO molecules react with 100 O<sub>2</sub> molecules to produce 200 CO<sub>2</sub> molecules
  - b. 2 billion CO molecules react with 1 billion O<sub>2</sub> molecules to produce 2 billion CO<sub>2</sub> molecules
  - c. 2 moles CO molecules react with 1 mole O<sub>2</sub> molecules to produce 2 moles CO<sub>2</sub> molecules
  - d. 12 moles CO molecules react with 6 moles O<sub>2</sub> molecules to produce 12 moles CO<sub>2</sub> molecules
- **Note:** *The coefficients in the balanced chemical equation also shows the molecules and mole ratio of the reactants and products*
- Since moles can be converted to masses, we can determine the mass ratio of the reactants and products as well

## Mole and Mass Ratios in Chemical Equations

For the following chemical equation:



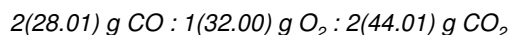
The following mole relations are implied:



Note the molar masses of the compounds in this reaction:

- 1 mole of CO = 28.01 g
- 1 mole O<sub>2</sub> = 32.00 g
- 1 mole CO<sub>2</sub> = 44.01 g

*The mass ratio of the compounds in this reaction can be determined using the molar mass values:*



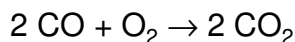
The mass ratio of the compounds in this reaction are:



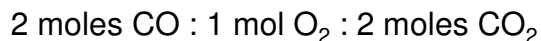
## Example

Determine the Number of Moles of Carbon Monoxide required to react with 3.2 moles Oxygen, and the moles of Carbon Dioxide produced

- Write the balanced equation



- Use the coefficients to find the mole relationship



- Use dimensional analysis to obtain the # of moles

- The # mol of CO:

$$3.2 \text{ moles O}_2 \times \left( \frac{2 \text{ moles CO}}{1 \text{ mole O}_2} \right) = 6.4 \text{ moles CO}$$

- The # mol of CO<sub>2</sub>:

$$3.2 \text{ moles O}_2 \times \left( \frac{2 \text{ moles CO}_2}{1 \text{ mole O}_2} \right) = 6.4 \text{ moles CO}_2$$