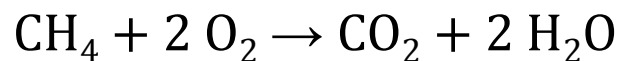


# Chapter 4 Part 3

Dr. Turner

# Mole Ratio

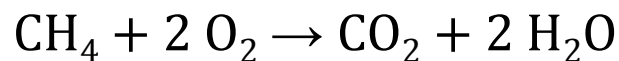
- A mole ratio is the ratio between the amounts in moles of any two compounds involved in a chemical reaction
- They can be found by examining the coefficients in front of compounds in a balanced chemical equation



For example, the mole ratio of  $\text{CH}_4$  to  $\text{O}_2$  is 1:2

# Mole Ratio

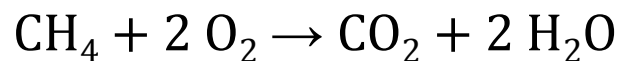
- A mole ratio is the ratio between the amounts in moles of any two compounds involved in a chemical reaction
- They can be found by examining the coefficients in front of compounds in a balanced chemical equation



What is the mole ratio of  $\text{CH}_4$  to  $\text{CO}_2$ ?

# Mole Ratio

- A mole ratio is the ratio between the amounts in moles of any two compounds involved in a chemical reaction
- They can be found by examining the coefficients in front of compounds in a balanced chemical equation



What is the mole ratio of  $\text{H}_2\text{O}$  to  $\text{CO}_2$ ?

# Jumbo Jack's Ham Sandwiches

## "The Jumbo" Recipe

1. 2 slices of bread
2. 6 pieces of ham
3. 1 slice of cheese

# Jumbo Jack's Ham Sandwiches

## "The Jumbo" Recipe

1. 2 slices of bread
2. 6 pieces of ham
3. 1 slice of cheese

How many Jumbos can you make with 8 slices of bread with unlimited pieces of ham and unlimited slices of cheese?

- A. 1
- B. 2
- C. 3
- D. 4

# How can we relate this to chemical reactions?



We combine the ingredients to make the dish in accordance with the recipe

# How can we relate this to chemical reactions?

We combine the  to make the  in accordance with the .

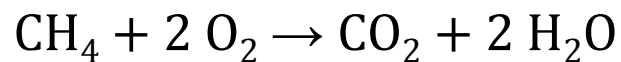
Word bank:

mole ratio, reactants,  
products



# Chemical Reactions

How many moles of water,  $\text{H}_2\text{O}$ , could be produced by the reaction of 3 moles of methane,  $\text{CH}_4$ , with excess oxygen gas,  $\text{O}_2$ ?



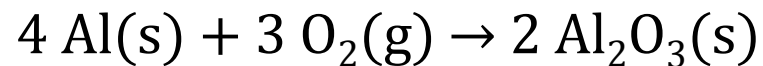
- A. 1.5
- B. 2
- C. 3
- D. 6

# Stoichiometry

- Stoichiometry is the calculation of quantities of any substances involved in a chemical reaction from the quantities of the other substances.
- Stoichiometry refers to the ratios of substances in a chemical reaction and, thus, requires a balanced chemical equation.
- Stoichiometry essentially relates dimensional analysis to chemical reactions by incorporating mole ratios

# Mole Stoichiometry

Calculate the number of moles of aluminum that will react with 3.18 mol oxygen to form aluminum oxide.



# Formula Unit Stoichiometry

A sample of 0.1146 mol solid  $\text{KClO}_3$  decomposes into  $\text{KCl}$  and  $\text{O}_2$  gas. Calculate the number of molecules of oxygen gas produced.



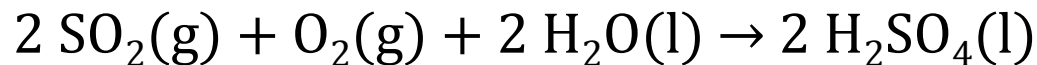
# Mass Stoichiometry

Calculate the mass of chlorine gas in grams that can be produced by the electrolysis of 50.0 g of sodium chloride in concentrated aqueous solution.



# Mass Stoichiometry

Calculate the number of moles of  $\text{SO}_2$  gas required to prepare 50.0 metric tons of liquid  $\text{H}_2\text{SO}_4$  (1 metric ton =  $1 \times 10^6$  g).



# Jumbo Jack's Ham Sandwiches

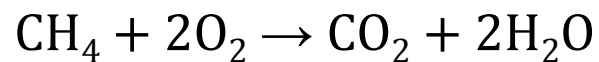
## "The Jumbo" Recipe

1. 2 slices of bread
2. 6 pieces of ham
3. 1 slice of cheese

If you are given 6 slices of bread, 6 pieces of ham, and 8 slices of cheese, how many Jumbos can you make?

# Limiting Reagents

How many carbon dioxide moles can be produced from a reaction of 12 moles of methane with 6.0 moles of oxygen gas?





# Jumbo Jack's Ham Sandwiches

## "The Jumbo" Recipe

1. 2 slices of bread
2. 6 pieces of ham
3. 1 slice of cheese

If you are given 600 grams of ham, 200 grams of bread, and 60 grams of cheese, how many Jumbos can you make?

# Jumbo Jack's Ham Sandwiches

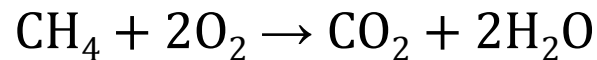
## "The Jumbo" Recipe

1. 2 slices of bread (50 grams per slice)
2. 6 pieces of ham (100 grams per slice)
3. 1 slice of cheese (30 grams per slice)

If you are given 600 grams of ham, 200 grams of bread, and 60 grams of cheese, how many Jumbos can you make?

# Limiting Reagents

How many grams of CO<sub>2</sub> (44 g/mol) could be formed by the reaction of 8.0 g of CH<sub>4</sub> (16 g/mol) with 48 g of O<sub>2</sub> (32 g/mol)?



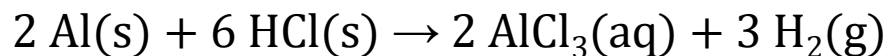
# Limiting Reactants

For  $\text{H}_2\text{O}(\text{l}) + \text{N}_2\text{O}_5(\text{g}) \rightarrow 2 \text{HNO}_3(\text{aq})$  what happens when you have 1 mol  $\text{H}_2\text{O}$  and 0.5 mol  $\text{N}_2\text{O}_5$ ?

- A. The reaction cannot proceed.
- B. The reaction can proceed to form 0.5 mol  $\text{HNO}_3$ .
- C. The reaction can proceed to form 1 mol  $\text{HNO}_3$ .
- D. The reaction can proceed to form 1.5 mol  $\text{HNO}_3$ .
- E. The reaction can proceed to form 2 mol  $\text{HNO}_3$ .

# Limiting Reagents

If 1.84 g of Al are allowed to react with 75.0 mL of 2.95 M HCl (36.46 g/mol), (A) what is the limiting reactant? (B) How many grams of H<sub>2</sub> are produced by the reaction? (C) How many grams of the excess reactant are remaining?



# Actual Yield vs. Theoretical Yield

## Actual Yield

- The actual yield is the amount of product that is actually obtained in an experiment.
- Comes from an experiment
- Indicated by words like (isolated, separated, produced, etc.)

## Theoretical Yield

- The theoretical yield is the maximum amount of product that can be formed from a reaction, based on the amounts of reactants available.
- Found using a stoichiometry calculation (usually a limiting reagent calculation)

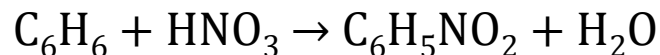
# Percent Yield

- The percent yield is defined as 100% times the ratio of the actual yield to the theoretical yield.

$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

# Forming Nitrobenzene

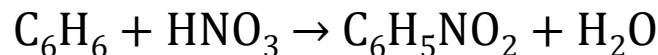
(A) How many grams of nitric acid,  $\text{HNO}_3$  (63.0 g/mol), are required to fully react with 15.6 grams of benzene,  $\text{C}_6\text{H}_6$  (78.1 g/mol)? (B) How many grams of nitrobenzene,  $\text{C}_6\text{H}_5\text{NO}_2$  (123.1 g/mol), are produced by this reaction? (C) If a student is able to successfully isolate 24.2 g of nitrobenzene,  $\text{C}_6\text{H}_5\text{NO}_2$  (123.1 g/mol). What is the percent yield of this reaction?





# Forming Nitrobenzene (Part C)

(A) How many grams of nitric acid,  $\text{HNO}_3$  (63.0 g/mol), are required to fully react with 15.6 grams of benzene,  $\text{C}_6\text{H}_6$  (78.1 g/mol)? (B) How many grams of nitrobenzene,  $\text{C}_6\text{H}_5\text{NO}_2$  (123.1 g/mol), are produced by this reaction? (C) If a student is able to successfully isolate 24.2 g of nitrobenzene,  $\text{C}_6\text{H}_5\text{NO}_2$  (123.1 g/mol). What is the percent yield of this reaction?



(C)

$$\frac{24.2 \text{ g C}_6\text{H}_5\text{NO}_2}{24.6 \text{ g C}_6\text{H}_5\text{NO}_2 \text{ (from part A)}} \times 100 = 98.4 \%$$

# Percent Yield

How many grams of nitric acid,  $\text{HNO}_3$  (63.0 g/mol), would be consumed in the production of 45.3 g of nitrobenzene,  $\text{C}_6\text{H}_5\text{NO}_2$  (123.1 g/mol), at 89.0% yield?

