Chapter 9

STOICHIOMETRY

Section 9.1: Introduction to Stoichiometry

- <u>Stoichiometry</u>: the calculation of quantities in chemical equations

- From Greek:
  - "Stoikheion" = element
  - "Metron" = to measure

- It's the bookkeeping of chemistry!

Stoichiometry

There are two types of Stoichiometry

Composition Stoichiometry

The mass relationships of elements in compounds
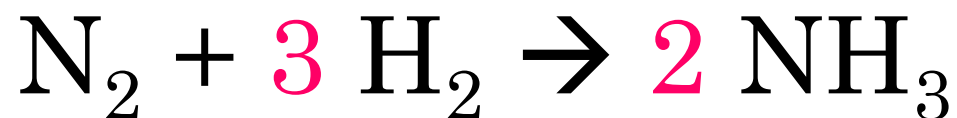
NaCl and H_3PO_4

Reaction Stoichiometry

The mass relationships of reactants and products in a chemical reaction

$$2\,H_2 \;+\; O_2 \;\rightarrow\; 2H_2O$$

Chemical Equations

All balanced equations are always based on the units of the <u>mole</u>

$$N_2 + 3\ H_2 \rightarrow 2\ NH_3$$

Translated:

$$1\ mol\ N_2 + 3\ mol\ H_2 \rightarrow 2\ mol\ NH_3$$

Mrs. Agostine's Lemonade

1 glass of bottled water (8 oz.)

4 lemons

¼ cup sugar

4 ice cubes

Squeeze lemons into water. Add sugar to lemon water. Add ice cubes. Stir. Makes one glass of lemonade.

Mrs. Agostine's Lemonade

1 glass of water (8 oz.)

4 lemons

¼ cup sugar

4 ice cubes

Squeeze lemons into water. Add sugar to lemon water. Add ice cubes. Stir.

How many glasses of lemonade can you make if you have 20 lemons, 10 cups sugar and an unlimited amount of water and ice cubes?

Mrs. Agostine's Lemonade

1 glass of water (8 oz.)
4 lemons
¼ cup sugar
4 ice cubes

Squeeze lemons into water. Add sugar to lemon water. Add ice cubes. Stir.

➤ Will there be any leftover ingredients (not including the water or ice cubes)?

➤ How much will be left over?

Mrs. Agostine's Lemonade

1 glass of water (8 oz.)

4 lemons

¼ cup sugar

4 ice cubes

Squeeze lemons into water. Add sugar to lemon water. Add ice cubes. Stir.

How many glasses of lemonade can you make if you have 20 lemons, 10 cups sugar and an unlimited amount of water and ice cubes?

5 cups of lemonade

Excess reagent:

8 ¾ cups sugar

Mole Ratio

- The mole ratio is a conversion factor that relates the number of moles of any two substances involved in a chemical reaction.

- The information comes directly from the balanced chemical equation for the reaction.

Five Types of Reaction Stoichiometry Problems

Section 9.2: Stoichiometric Calculations

Types of Equations

1. Mole-Mole
2. Mole-Mass, Mass-Mole
3. Mass-Mass
4. Volume-Volume
5. Particle-Particle
6. Mixed Problems

Stoichiometry Problems

1. Mole-Mole Problems

moles of A $\longrightarrow$ moles B

MOLE RATIO

MOLES OF A	MOLE RATIO	MOLES OF B
A	$\dfrac{B}{A}$	B

Stoichiometry Problems

2. Mole-Mass Problems

moles of A $\longrightarrow$ mass B

Mole to Mass Problems

moles of A	MOLE RATIO	moles of B	grams of B
→	→	→	→

Stoichiometry Problems

2. Mass-Mole Problems

mass of A $\longrightarrow$ mole B

Mass to Mole Problems

grams of A	moles of A	MOLE RATIO	moles of B
→	→	→	→

Stoichiometry Problems

3. Mass-Mass Problems

mass A → moles A → moles B → mass B

Mass to Mass Problems

grams of A	moles of A	MOLE RATIO	moles of B	grams of B
→	→	→	→	→

Stoichiometry Problems

4. Volume-Volume Problems

volume A →moles A →moles B → volume B

Volume – Volume Problems

volume of A	moles of A	MOLE RATIO	moles of B	volume of B
→	→	→	→	→

Stoichiometry Problems

5. Particle-Particle Problems

particles A → moles A →moles B →particles B

Particle - Particle Problems

particles of A	moles of A	MOLE RATIO	moles of B	particles of B
→	→	→	→	→

Stoichiometry Problems

6. Mixed-Mole Problems

? unit A → moles A → moles B → ?unit B

Mixed Problems

? unit of A	moles of A	MOLE RATIO	moles of B	? unit of B
→	→	→	→	→

Grilled cheese sandwich

3 slices cheese
2 slices bread
Excess butter

Assemble sandwich.
Grill in lots of melted butter.

How many grilled cheese sandwiches can you make if you have a package of 24 slices of cheese and a loaf of bread with 30 slices?

Is anything left over? How much?

Sect. 9.3: Limiting Reagent

➤ <u>Limiting Reagent</u>: the reactant that limits the amount of products made

- ❑ Gets completely used up in a reaction

➤ <u>Excess Reagent</u>: the reactant that is not used up completely

- ❑ There is more then enough leftover