UNIT 7: STOICHIOMETRY

Section 1: What is Stoichiometry?

More than 3000 silk cocoons are needed to make just one kimono. Like silk manufacturers, chemists must know how much reactant they need to make a certain amount of product.

Determining the quantities of reactants and products in a reaction requires a balanced chemical equation.

Using Balanced Chemical Equations

chemists use balanced chemical equations to calculate how much reactant is needed or product is formed in a reaction.

stoichiometry:

the **calculation of quantities in chemical reactions**.

Interpreting Chemical Equations

A balanced chemical equation can tell the amount of:
atoms, molecules, or moles;
and mass.

$$N_2(g) + 3H_2(g) \longrightarrow 2\,NH_3(g)$$

The most important info is the

mol-to-mol ratios

Interpreting Chemical Equations

Atoms

$N_2(g)$ + $3H_2(g)$ → $2NH_3(g)$

2 atoms N	+	6 atoms H	→	2 atoms N and 6 atoms H

Interpreting Chemical Equations

Molecules

$N_2(g)$ + $3H_2(g)$ → $2NH_3(g)$

2 atoms N	+	6 atoms H	→	2 atoms N and 6 atoms H
1 molecule N_2	+	3 molecules H_2	→	2 molecules NH_3

Interpreting Chemical Equations

Moles

$N_2(g)$ + $3H_2(g)$ → $2NH_3(g)$

2 atoms N	+	6 atoms H	→	2 atoms N and 6 atoms H
1 molecule N_2	+	3 molecules H_2	→	2 molecules NH_3
1 mol N_2	+	3 mol H_2	→	2 mol NH_3

# of molecules = # of moles

Interpreting Chemical Equations

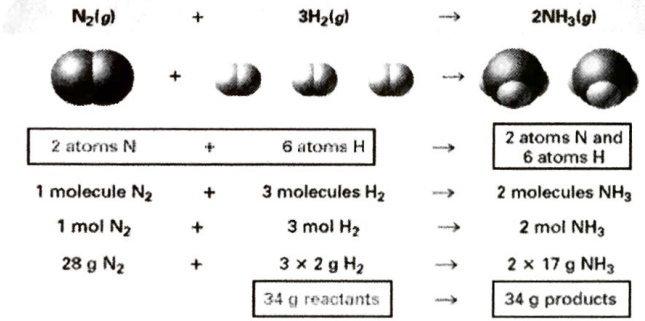
Mass

$N_2(g)$ + $3H_2(g)$ → $2NH_3(g)$

2 atoms N	+	6 atoms H	→	2 atoms N and 6 atoms H
1 molecule N_2	+	3 molecules H_2	→	2 molecules NH_3
1 mol N_2	+	3 mol H_2	→	2 mol NH_3
28 g N_2	+	3 × 2 g H_2	→	2 × 17 g NH_3
		34 g reactants	→	34 g products

Interpreting Chemical Equations

Mass & Atoms



Mass and **atoms** are **conserved** in every chemical reaction

Interpreting a Balanced Chemical Equation

Hydrogen sulfide, which smells like rotten eggs, is found in volcanic gases. The balanced equation for the burning of hydrogen sulfide is:

$$2H_2S(g) + 3O_2(g) \longrightarrow 2SO_2(g) + 2H_2O(g)$$

Interpret this equation in terms of

12 Atoms **12**

164.18 g Mass **164.18 g**

5 Molecules **4**

5 Moles **4**

Mole Ratios

A **mole ratio** is a ratio between the numbers of moles of any two substances in a balanced equation.

Mole ratios convert moles of one substance to moles of another substance.

Mol to Mol Ratios

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

2 mol H_2 for every 1 mol O_2

Mol to Mol Ratios

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

2 mol H_2 for every 2 mol H_2O

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

There are 6 mol to mol ratios that can be written from this balanced equation:

$$\frac{2\text{ mol } H_2}{1\text{ mol } O_2} \quad \frac{1\text{ mol } O_2}{2\text{ mol } H_2} \quad \frac{2\text{ mol } H_2O}{2\text{ mol } H_2}$$

$$\frac{2\text{ mol } H_2}{2\text{ mol } H_2O} \quad \frac{1\text{ mol } O_2}{2\text{ mol } H_2O} \quad \frac{2\text{ mol } H_2O}{1\text{ mol } O_2}$$

Mole to Mole Conversion

How many moles of hydrogen gas (H_2) are produced from 4.0 mol Mg?

$$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$$

$$4.0\text{ mol Mg} \times \frac{1\text{ mol } H_2}{1\text{ mol Mg}} = \boxed{\mathbf{4.0\text{ mol } H_2}}$$

mol ratio

Mole to Mole Conversion

How many moles of hydrogen gas (H_2) are produced from 4.0 mol HCl?

$$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$$

$$4.0\text{ mol HCl} \times \frac{1\text{ mol } H_2}{2\text{ mol HCl}} = \boxed{\mathbf{2.0\text{ mol } H_2}}$$

mol ratio

Name: _____ Period: _____ Date_____

WS Intro to Stoichiometry

1. Methane reacts with oxygen as shown in the combustion reaction below.

$$2\ CH_3OH + 3\ O_2 \rightarrow 2\ CO_2 + 4\ H_2O$$

a) Complete the table using information represented in the chemical equation above.

Substance	Molar Mass (g/mol)	Number of Molecules	Number of Moles (mol)	Mass (g)
CH_3OH	32.05			
O_2	32.00			
CO_2	44.01			
H_2O	18.02			

b) What are the reactants? _____

c) What are the products? _____

d) What is the total mass of the reactants? _____

e) What is the total mass of the products? _____

f) How do the total masses of the reactants and products compare? _____

g) What is conserved in the reaction? (circle answers)

Atoms moles molecules mass

2. What is a mole ratio?

_____

_____

3. Given this equation: $6\ Na + Fe_2O_3 \rightarrow 3\ Na_2O + 2\ Fe$, write the following molar ratios:

a) Na / Fe_2O_3

b) Na / Na_2O

c) Fe_2O_3 / Fe

d) Na_2O / Fe_2O_3

4. Answer the following questions for this equation: $2\ H_2 + O_2 \rightarrow 2\ H_2O$

   a) What is the H_2 / H_2O mole ratio?

   b) Suppose you had 20 moles of H_2 on hand and plenty of O_2. How many moles of H_2O could you make?

   c) What is the O_2 / H_2O mole ratio?

   d) Suppose you had 20 moles of O_2 and enough H_2. How many moles of H_2O could you make?

5. Answer the following questions for this equation: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$

   a) What is the C_4H_{10} / CO_2 mole ratio?

   b) If 10 moles of C_4H_{10} were used, how many moles of CO_2 would be produced?

   c) What is the O_2 / H_2O mole ratio?

   d) If 3.00 moles of O_2 were used, how many moles of H_2O would be produced?

   e) If 6.00 moles of H_2O were produced, how many moles of O_2 were required?

Name KEY Per ____ Date 4/6/16

Homework WS Stoichiometry

1. Methane reacts with oxygen as shown in the combustion reaction below.

$$2\ CH_3OH + 3\ O_2 \rightarrow 2\ CO_2 + 4\ H_2O$$

a) Complete the table using information represented in the chemical equation above.

Substance	Molar Mass (g/mol)	Number of Molecules	Number of Moles (mol)	Mass (g)
CH_3OH	32.05	2	2	64.10
O_2	32.00	3	3	96.00
CO_2	44.01	2	2	88.02
H_2O	18.02	4	4	72.08

b) What are the reactants? CH_3OH , O_2

c) What are the products? CO_2 , H_2O

d) What is the total mass of the reactants? 160.10 g

e) What is the total mass of the products? 160.10 g

f) How do the total masses of the reactants and products compare? equal

g) What is conserved in the reaction? (circle answers)

(Atoms) moles molecules (mass)

2. What is a mole ratio? The ratio between amounts of any 2 substances in a rxn.

3. Given this equation: $6\ Na + Fe_2O_3 \rightarrow 3\ Na_2O + 2\ Fe$, write the following molar ratios:

a) Na / Fe_2O_3 $\frac{6\ mol\ Na}{1\ mol\ Fe_2O_3}$

b) Na / Na_2O $\frac{6\ mol\ Na}{3\ mol\ Na_2O}$

c) Fe_2O_3 / Fe $\frac{1\ mol\ Fe_2O_3}{2\ mol\ Fe}$

d) Na_2O / Fe_2O_3 $\frac{3\ mol\ Na_2O}{1\ mol\ Fe_2O_3}$

4. Answer the following questions for this equation: $2\ H_2 + O_2 \rightarrow 2\ H_2O$

a) What is the H_2 / H_2O mole ratio? $\frac{2\ mol\ H_2}{2\ mol\ H_2O}$

b) Suppose you had 20 moles of H_2 on hand and plenty of O_2. How many moles of H_2O could you make?

$$20\ mol\ H_2 \left| \frac{2\ mol\ H_2O}{2\ mol\ H_2} \right. = 20\ mol\ H_2O$$

c) What is the O_2 / H_2O mole ratio? $\frac{1\ mol\ O_2}{2\ mol\ H_2O}$

d) Suppose you had 20 moles of O_2 and enough H_2. How many moles of H_2O could you make?

$$20\ mol\ O_2 \left| \frac{2\ mol\ H_2O}{1\ mol\ O_2} \right. = 40\ mol\ H_2O$$

5. Answer the following questions for this equation: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$

a) What is the C_4H_{10} / CO_2 mole ratio? $\frac{2\ mol\ C_4H_{10}}{8\ mol\ CO_2}$

b) If 10 moles of C_4H_{10} were used, how many moles of CO_2 would be produced?

$$10\ mol\ C_4H_{10} \left| \frac{8\ mol\ CO_2}{2\ mol\ C_4H_{10}} \right. = 40\ mol\ CO_2$$

c) What is the O_2 / H_2O mole ratio? $\frac{13\ mol\ O_2}{10\ mol\ H_2O}$

d) If 3.00 moles of O_2 were used, how many moles of H_2O would be produced?

$$3.00\ mol\ O_2 \left| \frac{10\ mol\ H_2O}{13\ mol\ O_2} \right. = 2.31\ mol\ H_2O$$

e) If 6.00 moles of H_2O were produced, how many moles of O_2 were required?

$$6.00\ mol\ H_2O \left| \frac{13\ mol\ O_2}{10\ mol\ H_2O} \right. = 7.80\ mol\ O_2$$