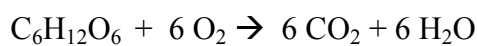


# Honors Chemistry 2:

## Unit 1 Review



# Stoichiometry

### Students should be able to:

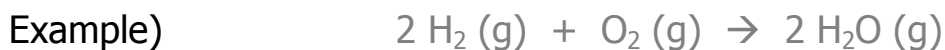
- ✓ Calculate the atomic weight (average atomic mass) of an element from the relative abundances and masses of its naturally occurring isotopes.
- ✓ Calculate the percentage composition of a compound from its formula.
- ✓ Calculate the molar mass of a substance from its chemical formula.
- ✓ Be able to interconvert between moles, mass, and number of particles of a substance.
- ✓ Calculate the empirical formula of a compound from either elemental percent composition or quantity of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  produced from its combustion.
- ✓ Calculate the molecular formula of a compound from the empirical formula and molecular weight.
- ✓ Find the mass of any substance in a chemical reaction from the mass of one substance.
- ✓ Determine the limiting reactant (limiting reagent) in a reaction and then calculate the amount of each product and the mass of the excess reactant left over.
- ✓ Calculate theoretical yield.

### Keywords:

- atomic mass
- formula weight
- Avogadro's number
- molecular formula
- atomic mass unit
- molecular weight
- molar mass
- limiting reactant (limiting reagent)
- atomic weight (average atomic mass)
- mole
- empirical formula
- percent yield

# **I. Chemical Equations**

## A. Chemical Equations –



## B. Balancing Chemical Equations – “The Law of Conservation of Matter”

## C. Sample Exercise 3.1 – Balance the following equation:



# **II. Patterns of Chemical Reactivity**

## A. How can you use the Periodic Table to predict Chemical Reactions?

1. What happens when an alkali metal reacts with water?

2. Predict what would happen if an alkaline earth metal reacts with water:

## B. What is a **Combustion Reaction?**

C. Sample Exercise 3.2 – Write the balanced chemical equation for the reaction that occurs when menthanol,  $\text{CH}_3\text{OH}$  (l), is burned in air.

D. What is a **Combination Reaction**?

1. Example –

E. What is a **Decomposition Reaction**?

1. Example –

### **III. Atomic and Molecular Weights**

A. The Atomic Mass Scale –

1. **Atomic Mass Unit** –

2. What is the Atomic Mass Unit based on?

B. **Average Atomic Masses**

1. What is the difference between mass number and average atomic mass / atomic weight?

- C. Sample Exercise 3.3 – Naturally occurring chlorine is 75.33% Cl-35, which has an atomic mass of 34.969 amu, and 24.47% Cl-37, which has an atomic mass of 36.966. Calculate the average atomic mass (atomic weight) of chlorine.

D. **Formula and Molecular Weights**

**Aka - Formula mass / molecular mass / gram formula mass**

- E. Sample Exercise 3.4 – Calculate the formula weight of (a) sucrose,  $C_{12}H_{22}O_{11}$  ; (b) calcium nitrate,  $Ca(NO_3)_2$  .

F. What is a **Mass Spectrometer**?

1. How does one work?

G. % Composition from formulas –

1. Sample Exercise 3.5 – Calculate the % composition of  $C_{12}H_{22}O_{11}$ .

## **IV. The MOLE**

A. The Definition –

B. Avogadro's Number –

1. Sample Exercise 3.6 – How many C atoms are in 0.350 mol of  $C_6H_{12}O_6$ ?

C. Molar Mass –

1. Sample Exercise 3.7 – What is the mass of 1 mol of glucose,  $C_6H_{12}O_6$ ?

D. Converting between masses, moles, and # of particles:

1. Sample Exercise 3.8 – How many moles of glucose,  $C_6H_{12}O_6$ , are in (a) 538g and (b) 1.00g of this substance?
2. Sample Exercise 3.9 - What is the mass, in grams, of 0.433 mol of  $Ca(NO_3)_2$ ?
3. Sample Exercise 3.10 – How many glucose molecules are in 5.23 g of  $C_6H_{12}O_6$ ?

## V. Empirical Formulas from Analyses

A. Definition –

B. Sample Exercise 3.11 – Ascorbic Acid (Vitamin C) contains 40.92% C, 4.58% H, and 54.50% O by mass. What is the empirical formula of ascorbic acid?

C. Finding the Molecular Formula from the Empirical Formula –

D. Sample Exercise 3.12 – Mesitylene, a hydrocarbon that occurs in small amounts in crude oil, has an empirical formula of  $C_3H_4$ . The experimentally determined molecular weight of this substance is 121 amu. What is the molecular formula of mesitylene?

## E. Combustion Analysis –

1. Example Problem – An unknown substance is known to contain only C, H, and O. Combustion of 0.255 g of the substance produces 0.561 g CO<sub>2</sub> and 0.306 g H<sub>2</sub>O. Calculate the empirical formula of the substance.

## VI. Quantitative Info from Balanced Equations (Stoichiometry)

A. What do the coefficients in a balanced chemical equation tell us?

B. How do we solve mass – mass problems?



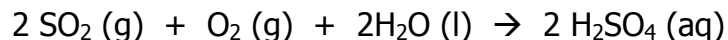
C. Sample Exercise 3.13 – How many grams of water are produced in the combustion of 1.00 g of glucose,  $C_6H_{12}O_6$ ?

D. Sample Exercise 3.14 – Solid lithium hydroxide is used in space vehicles to remove exhaled  $CO_2$ . The lithium hydroxide reacts with the gaseous  $CO_2$  to form solid lithium carbonate and liquid water. How many grams of  $CO_2$  can be absorbed by each 1.00 g of lithium hydroxide?

## VII. Limiting Reactants

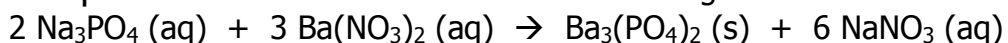
A. What is a Limiting Reactant (Limiting Reagent)?

B. Sample Exercise 3.15 – Part of the  $\text{SO}_2$  that is introduced into the atmosphere ends up being converted to sulfuric acid. The net reaction is :



How much sulfuric acid can be formed from 5.0 mol of  $\text{SO}_2$ , 1.0 mol of  $\text{O}_2$ , and an unlimited quantity of  $\text{H}_2\text{O}$ ?

C. Sample Exercise 3.16 – Consider the following reaction:

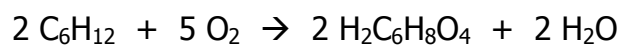


Suppose that a solution containing 3.50 g of  $\text{Na}_3\text{PO}_4$  is mixed with a solution containing 6.40 g of  $\text{Ba}(\text{NO}_3)_2$ . How many grams of  $\text{Ba}_3(\text{PO}_4)_2$  can be formed?

D. What is a **theoretical yield**?

1. What is the **percent yield**?

E. Sample Exercise 3.17 – Adipic acid,  $\text{H}_2\text{C}_6\text{H}_8\text{O}_4$ , is a raw material used for the production of nylon. It is made commercially by a controlled reaction between cyclohexane,  $\text{C}_6\text{H}_{12}$ , and  $\text{O}_2$ :



- (a) Assume that you carry out this reaction starting with 25.0 g of cyclohexane, and the cyclohexane is the limiting reactant. What is the theoretical yield of adipic acid?
- (b) If you obtain 33.5 g of adipic acid for your reaction, what is the percent yield of adipic acid?