

Name: KEY Date: \_\_\_\_\_ Mods: \_\_\_\_\_

## Lab # 6 – Mathematics of Chemistry: Molar Mass Calculations

### Introduction

Calculating molar mass, also called gram formula mass, involves using the Periodic Table. You take the number of each element and multiply it by the atomic mass listed for that element. Add up the total mass of each element to get the molar mass.

Example: To get the molar mass of  $C_6H_{12}O_6$ :

$$C = 6 \times 12 \text{ g} = 72 \text{ g/mol}$$

$$H = 12 \times 1 \text{ g} = 12 \text{ g/mol}$$

$$O = 6 \times 16 \text{ g} = 96 \text{ g/mol}$$

Now add the results for each element:

$$72 + 12 + 96 = 180 \text{ g/mol}$$

### Objectives

This activity will review various math skills that you will use throughout the year in chemistry.

Calculate the molar masses of the following chemicals (show work):

$Cl_2$ $C - 1 \cdot 12.01$ $I - 2 \cdot 126.9$  $265.81 \text{ g/mol}$	$UF_6$ $U - 1 \cdot 238.03$ $F - 6 \cdot 19$  $352.03 \text{ g/mol}$
$KOH$ $K - 1 \cdot 39.1$ $O - 1 \cdot 16$ $H - 1 \cdot 1.01$  $56.11 \text{ g/mol}$	$SO_2$ $S - 1 \cdot 32.07$ $O - 2 \cdot 16$  $64.07 \text{ g/mol}$
$BeCl_2$ $Be - 1 \cdot 9.01$ $Cl - 2 \cdot 35.45$  $79.91 \text{ g/mol}$	$H_3PO_4$ $H - 3 \cdot 1.01$ $P - 1 \cdot 30.97$ $O - 4 \cdot 16$  $98 \text{ g/mol}$
$FeCl_3$ $Fe - 1 \cdot 55.85$ $Cl - 3 \cdot 35.45$  $162.2 \text{ g/mol}$	$(NH_4)_2SO_4$ $N - 2 \cdot 14.01$ $H - 8 \cdot 1.01$ $S - 1 \cdot 32.07$ $O - 4 \cdot 16$  $132.17 \text{ g/mol}$
$BF_3$ $B - 1 \cdot 10.81$ $F - 3 \cdot 19$  $67.81 \text{ g/mol}$	$CH_3COOH$ $C - 2 \cdot 12.01$ $H - 4 \cdot 1.01$ $O - 2 \cdot 16$  $60.06 \text{ g/mol}$
$CCl_2F_2$ $C - 1 \cdot 12.01$ $Cl - 2 \cdot 35.45$ $F - 2 \cdot 19$  $120.91 \text{ g/mol}$	$Pb(NO_3)_2$ $Pb - 1 \cdot 207.2$ $N - 2 \cdot 14.01$ $O - 6 \cdot 16$  $331.22 \text{ g/mol}$

Calculations:

1. How many moles are present in 34 grams of  $\text{Cu}(\text{OH})_2$ ?

$$\frac{34 \text{ g}}{97.57 \text{ g/mol}}$$

$$.348 \text{ mol Cu}(\text{OH})_2$$

2. How many moles are present in  $2.45 \times 10^{23}$  molecules of  $\text{CH}_4$ ?

$$\frac{2.45 \times 10^{23}}{6.02 \times 10^{23} \text{ molecules/mol}}$$

$$.407 \text{ mol CH}_4$$

3. How many grams are there in  $3.4 \times 10^{24}$  molecules of  $\text{NH}_3$ ?

$$\frac{3.4 \times 10^{24} \text{ molecules}}{6.02 \times 10^{23} \text{ molecules/mol}} \times 17.04 \text{ g/mol}$$

$$96.24 \text{ g NH}_3$$

4. How many grams are in 0.500 moles of  $\text{CuBr}$ ?

$$.5 \text{ mol} \times 143.45 \text{ g/mol}$$

$$71.73 \text{ g CuBr}$$

5. How many molecules are there in 21.6 grams of  $\text{CH}_4$ ?

$$\frac{21.6 \text{ g}}{16.05 \text{ g/mol}} \times 6.02 \times 10^{23} \text{ molecules/mol}$$

$$3.75 \times 10^{22} \text{ molecules CH}_4$$

6. How many moles are in 25 grams of water?

$$\frac{25 \text{ g}}{18.02 \text{ g/mol}}$$

$$1.39 \text{ mol H}_2\text{O}$$

7. How many grams are in 4.5 moles of  $\text{Li}_2\text{O}$ ?

$$4.5 \text{ mol} \times 29.88 \text{ g/mol}$$

$$134.46 \text{ g Li}_2\text{O}$$

8. How many molecules are in 23 moles of oxygen?

$$23 \text{ mol} \times 6.02 \times 10^{23} \text{ molecules/mol}$$

$$1.38 \times 10^{25} \text{ molecules O}_2$$

9. How many moles are in  $3.4 \times 10^{23}$  molecules of  $\text{H}_2\text{SO}_4$ ?

$$\frac{3.4 \times 10^{23} \text{ molecules}}{6.02 \times 10^{23} \text{ molecules/mol}}$$

$$.565 \text{ mol H}_2\text{SO}_4$$

10. How many molecules are in 25 grams of  $\text{NH}_3$ ?

$$\frac{25 \text{ g}}{17.04 \text{ g/mol}} \times 6.02 \times 10^{23} \text{ molecules/mol}$$

$$8.83 \times 10^{23} \text{ molecules NH}_3$$

11. How many grams are in  $8.2 \times 10^{22}$  molecules of  $\text{N}_2\text{I}_6$ ?

$$\frac{8.2 \times 10^{22} \text{ molecules}}{6.02 \times 10^{23} \text{ molecules/mol}} \times 789.42 \text{ g/mol}$$

$$1.08 \times 10^{-18} \text{ g N}_2\text{I}_6$$

12. Using your knowledge of mole calculations and unit conversions, determine how many atoms there are in 1 gallon of gasoline. Assume that the molecular formula for gasoline is  $\text{C}_6\text{H}_{14}$  and that the density of gasoline is approximately 0.85 grams/mL.

There are \_\_\_\_\_ atoms in 1 gallon of gasoline.

Name: WORK ON BACK

### Empirical Formula and Molecular Formula

Do your working on separate piece of paper and write you answers below.

Attach you working to the back of this worksheet

Definition:

The empirical formula is simplest formula that you can write for an ionic or covalent compound.

The molecular formula is the actual formula that you should write for a covalent compound

1. Calculate the following empirical formulas

- a. carbon 85.7% and hydrogen 14.3%  $\text{CH}_2$
- b. 2.6 g of chromium combined with 5.3 g of chlorine  $\text{CrCl}_3$
- c. 0.62 g of lead combined with 0.064 g of oxygen  $\text{Pb}_3\text{O}_4$
- d. 20% magnesium, 26.6 % sulfur, 53.3 % oxygen  $\text{MgSO}_4$
- e. 60% carbon, 13.3% hydrogen, 26.7% oxygen  $\text{C}_3\text{H}_4\text{O}$

2. Calculate the Empirical Formulae

- a. 0.62 g of phosphorus combined with 0.48 g of oxygen  $\text{P}_2\text{O}_3$
- b. 1.4 g of nitrogen combined with 0.30g of hydrogen  $\text{NH}_3$
- c. 0.62 g of lead combined with 0.064 g oxygen  $\text{Pb}_3\text{O}_4$
- d. 3.5 g of silicon combined with 4.0 g of oxygen  $\text{SiO}_2$

3. Calculate the following.

- a. A compound has a molecular mass of 28, and contains 85.7% carbon and 14.3% hydrogen. What are the empirical and molecular formulae for this compound?  $\text{E.F} = \text{CH}_2$   $\text{MF} = \text{C}_2\text{H}_4$
- b. A compound has a molecular mass of 58, and contains 82.8% carbon and 17.2% hydrogen. What are the empirical and molecular formulae for this compound?  $\text{EF} = \text{C}_2\text{H}_5$   $\text{MF} = \text{C}_8\text{H}_{10}$

3a

		EF	
C	85.7/12.01	= 7.14/7.14	= 1
H	14.3/1.01	= 14.16/7.14	= 2

1st: find formula wt  
 $12.01 + 2.02 = 14.03$

2nd: divide given by formula wt

$$\frac{28}{14.03} = 2$$

3b

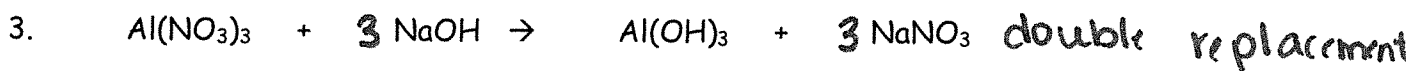
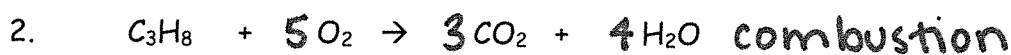
C	82.8/12.01	= 6.89/6.89	= 1.2 = 2
H	17.2/1.01	= 17.03/6.89	= 2.5 * 2 = 5

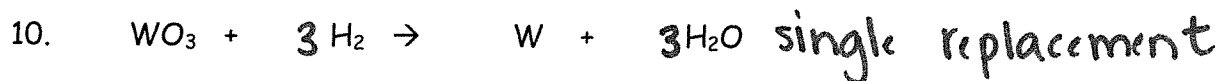
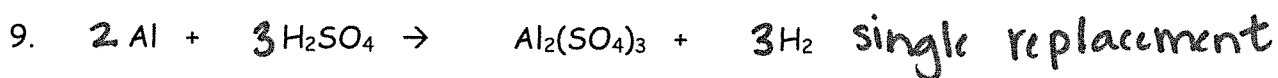
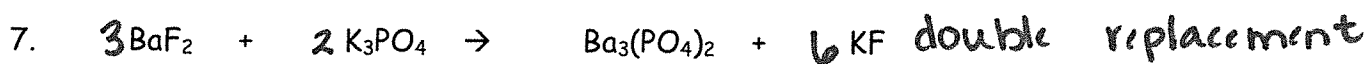
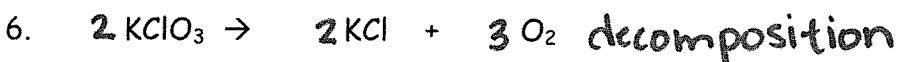
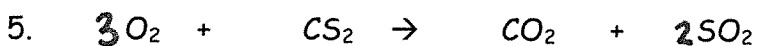
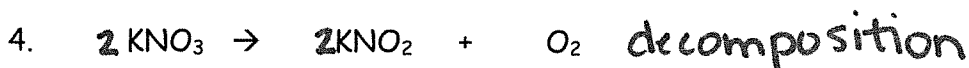
$$\frac{58}{14.03} = 4$$

## I. Fill in the blanks with the most appropriate term:

A chemical equation tells the story of a chemical reaction. Reactants are the starting substances in the reaction while products are the new substances that are formed. The large numbers in front of some of the formulas are called coefficients. These numbers are used to balance the equation because chemical reactions must obey the Law of conservation of Matter. The number of atoms of each element on both sides of the equation must be equal because matter cannot be created or destroyed. When balancing equations, the only numbers that can be changed are coefficients; remember that subscripts must never be changed in order to balance an equation.

## II. Balance the following equations:





Honors Physical Science  
Chemical Equations

Name: \_\_\_\_\_

Write the balanced chemical equation for the following reactions. Be sure to list the reaction type.

1. A solution of lithium bromide is mixed with gaseous chlorine to make lithium chloride and ~~chlorine~~ <sup>Bromine</sup> SR



2. Powdered copper is slowly stirred into an aqueous solution of lead(II) nitrate resulting in a copper(II) nitrate solution and lead. SR



3. Solid calcium carbonate is heated to release carbon dioxide gas and solid calcium oxide. D



4. Solid diphosphorus pentoxide is mixed with water to form an acid, (H<sub>3</sub>PO<sub>4</sub>). S



5. A solution of magnesium hydroxide is mixed with a solution of phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) to form magnesium phosphate solution and water. DR



6. Washing soda, sodium carbonate decahydrate, is a hydrate compound used for washing, water softening, and bleaching. When heated what will the reaction be?

decomposition

7. Mercury(II) sulfate reacts with ammonium nitrate to yield mercury(II) nitrate and ammonium sulfate. DR



8. Calcium oxide will react with diphosphorus pentoxide to form calcium phosphate. S



9. Lithium metal reacts with water to make lithium hydroxide and hydrogen gas. SR



10. When copper(II) hydroxide is heated, copper(II) oxide and water are formed. D



## Reaction Type Worksheet

Name: \_\_\_\_\_

Name the type of the reaction given.

1. synthesis  $2 \text{Al} + \text{N}_2 \rightarrow 2 \text{AlN}$
2. decomposition  $\text{NH}_4 \rightarrow \text{N}_2\text{O} + 2 \text{H}_2\text{O}$
3. single replace  $3 \text{Zn} + 2 \text{H}_3\text{PO}_4 \rightarrow \text{Zn}_3(\text{PO}_4)_2 + 3 \text{H}_2$
4. decomp.  $2 \text{KNO}_3 \rightarrow 2 \text{KNO}_2 + \text{O}_2$
5. synthesis  $4 \text{P} + 5 \text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$
6. single replace  $2 \text{Al} + 3 \text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3 \text{H}_2$
7. single replace  $\text{Zn} + 2 \text{AgNO}_3 \rightarrow \text{Zn}(\text{NO}_3)_2 + 2 \text{Ag}$
8. double replace  $2 \text{NaNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{HNO}_3$
9. synthesis  $4 \text{Al} + 3 \text{O}_2 \rightarrow 2 \text{Al}_2\text{O}_3$
10. double replace  $2 \text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{HCl}$
11. double replace  $\text{FeCl}_3 + \text{H}_3\text{PO}_4 \rightarrow \text{FePO}_4 + 3 \text{HCl}$
12. synthesis  $2 \text{SO}_2 + \text{O}_2 \rightarrow 2 \text{SO}_3$
13. decomp  $2 \text{HgO} \rightarrow 2 \text{Hg} + \text{O}_2$
14. decomp  $2 \text{H}_2\text{O}_2 \rightarrow 2 \text{H}_2\text{O} + \text{O}_2$
15. decomp  $2 \text{NH}_3 \rightarrow \text{N}_2 + 3 \text{H}_2$