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 × 12 g = 72 g/mol
H = 12 × 1 g = 12 g/mol
O = 6 × 16 g = 96 g/mol

Now add the results for each element:
72 + 12 + 96 = 180 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·1·12.01 I·2·126.9 265.81 g/mol	UF_6 U·1·238.03 F·6·19 352.03 g/mol
KOH K·1·39.1 O·1·16 H·1·1.01 56.11 g/mol	SO_2 S·1·32.07 O·2·16 64.07 g/mol
$BeCl_2$ Be·1·9.01 Cl·2·35.45 79.91 g/mol	H_3PO_4 H·3·1.01 P·1·30.97 O·4·16 98 g/mol
$FeCl_3$ Fe·1·55.85 Cl·3·35.45 162.2 g/mol	$(NH_4)_2SO_4$ O·4·16 N·2·14.01 H·8·1.01 S·1·32.07 132.17 g/mol
BF_3 B·1·10.81 F·3·19 67.81 g/mol	CH_3COOH C·2·12.01 H·4·1.01 O·2·16 60.06 g/mol
CCl_2F_2 C·1·12.01 Cl 2·35.45 F 2·19 120.91 g/mol	$Pb(NO_3)_2$ Pb·1·207.2 N·2·14.01 O·6·16 331.22 g/mol

Calculations:

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

$\frac{34\text{ g}}{97.57\text{ g}} \left|\frac{1\text{ mol}}{}\right.$ .348 mol $Cu(OH)_2$

2. How many moles are present in 2.45×10^{23} molecules of CH_4?

$\frac{2.45\times10^{23}}{6.02\times10^{23}} \left|\frac{1\text{ mol}}{}\right.$ .407 mol CH_4

3. How many grams are there in 3.4×10^{24} molecules of NH_3?

$\frac{3.4\times10^{24}}{6.02\times10^{23}} \left|\frac{1\text{ mol}}{1\text{ mol}}\right| \frac{17.04\text{ g}}{}$ 96.24 g NH_3

4. How many grams are in 0.500 moles of CuBr?

$\frac{.5\text{ mol}}{1\text{ mol}} \left|\frac{143.45\text{ g}}{}\right.$ 71.73 g CuBr

5. How many molecules are there in 21.6 grams of CH_4?

$\frac{21.6\text{ g}}{16.05\text{ g}} \left|\frac{1\text{ mol}}{1\text{ mol}}\right| \frac{6.02E^{23}}{}$ 3.75×10^{22} molecules CH_4

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

$\frac{25\text{ g}}{18.02\text{ g}} \left|\frac{1\text{ mol}}{}\right.$ 1.39 mol H_2O

7. How many grams are in 4.5 moles of Li_2O?

$\frac{4.5\text{ mol}}{1\text{ mol}} \left|\frac{29.88\text{ g}}{}\right.$ 134.46 g Li_2O

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

$\frac{23\text{ mol}}{1\text{ mol}} \left|\frac{6.02\times10^{23}}{}\right.$ 1.38×10^{25} molecules O_2

9. How many moles are in 3.4×10^{23} molecules of H_2SO_4?

$\frac{3.4\times10^{23}}{6.02\times10^{23}} \left|\frac{1\text{ mol}}{}\right.$ .565 mol H_2SO_4

10. How many molecules are in 25 grams of NH_3?

$\frac{25\text{ g}}{17.04\text{ g}} \left|\frac{1\text{ mol}}{1\text{ mol}}\right| \frac{6.02\times10^{23}}{}$ 8.83×10^{23} molecules NH_3

11. How many grams are in 8.2×10^{22} molecules of N_2I_6?

$\frac{8.2\times10^{22}}{6.02\times10^{23}} \left|\frac{1\text{ mol}}{1\text{ mol}}\right| \frac{789.42\text{ g}}{}$ 1.08×10^{-18} g N_2I_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 C_6H_{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% CH_2
   b. 2.6 g of chromium combined with 5.3 g of chlorine $CrCl_3$
   c. 0.62 g of lead combined with 0.064 g of oxygen Pb_3O_4
   d. 20% magnesium, 26.6 % sulfur, 53.3 % oxygen $MgSO_4$
   e. 60% carbon, 13.3% hydrogen, 26.7% oxygen C_3H_8O

2. Calculate the Empirical Formulae
   a. 0.62 g of phosphorus combined with 0.48 g of oxygen P_2O_3
   b. 1.4 g of nitrogen combined with 0.30g of hydrogen NH_3
   c. 0.62 g of lead combined with 0.064 g oxygen Pb_3O_4
   d. 3.5 g of silicon combined with 4.0 g of oxygen $Si:O_2$

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? E.F = CH_2 MF = C_2H_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? EF = C_2H_5 MF = C_8H_{20}

E F

3a 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

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

Worksheet: Balancing Equations **Name** _____

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:

1. $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$ synthesis

2. $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$ combustion

3. $Al(NO_3)_3 + 3\ NaOH \rightarrow Al(OH)_3 + 3\ NaNO_3$ double replacement

4. $2KNO_3 \rightarrow 2KNO_2 + O_2$ decomposition

5. $3O_2 + CS_2 \rightarrow CO_2 + 2SO_2$

6. $2KClO_3 \rightarrow 2KCl + 3O_2$ decomposition

7. $3BaF_2 + 2K_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6KF$ double replacement

8. $H_2SO_4 + Mg(NO_3)_2 \rightarrow MgSO_4 + 2HNO_3$ double replacement

9. $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$ single replacement

10. $WO_3 + 3H_2 \rightarrow W + 3H_2O$ single replacement

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 chloride to make lithium chloride and ~~chlorine~~ Bromine [SR]

$2LiBr + Cl_2 \rightarrow 2LiCl + Br_2$

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

$Cu + Pb(NO_3)_2 \rightarrow Cu(NO_3)_2 + Pb$

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

$CaCO_3 \rightarrow CO_2 + CaO$

4. Solid diphosphorus pentoxide is mixed with water to form an acid, (H_3PO_4). [S]

$P_2O_5 + 3H_2O \rightarrow 2H_3PO_4$

5. A solution of magnesium hydroxide is mixed with a solution of phosphoric acid (H_3PO_4) to form magnesium phosphate solution and water. [DR]

$3Mg(OH)_2 + 2H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6H_2O$

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]

$HgSO_4 + 2NH_4NO_3 \rightarrow Hg(NO_3)_2 + (NH_4)_2SO_4$

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

$3CaO + P_2O_5 \rightarrow Ca_3(PO_4)_2$

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

$2Li + 2H_2O \rightarrow 2LiOH + H_2$

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

$Cu(OH)_2 \rightarrow CuO + H_2O$

Reaction Type Worksheet

Name:_____

Name the type of the reaction given.

1. synthesis _____ $2\ Al + N_2 \rightarrow 2\ AlN$

2. decomposition $NH_4 \rightarrow N_2O + 2\ H_2O$

3. single replace. $3\ Zn + 2\ H_3PO_4 \rightarrow Zn_3(PO_4)_2 + 3\ H_2$

4. decomp. _____ $2\ KNO_3 \rightarrow 2\ KNO_2 + O_2$

5. synthesis _____ $4\ P + 5\ O_2 \rightarrow P_4O_{10}$

6. single replace _____ $2\ Al + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\ H_2$

7. single replace _____ $Zn + 2\ AgNO_3 \rightarrow Zn(NO_3)_2 + 2\ Ag$

8. double replac _____ $2\ NaNO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2\ HNO_3$

9. synthesis _____ $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$

10. double replac $2\ NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2\ HCl$

11. double replace $FeCl_3 + H_3PO_4 \rightarrow FePO_4 + 3\ HCl$

12. synthesis _____ $2\ SO_2 + O_2 \rightarrow 2\ SO_3$

13. decomp _____ $2\ HgO \rightarrow 2\ Hg + O_2$

14. decomp _____ $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

15. decomp _____ $2\ NH_3 \rightarrow N_2 + 3\ H_2$