Worksheet 6

Mass % Composition, Empirical Formulas, and Molecular Formulas

Mass % Composition: The percent, by mass, of each element in a compound. If the formula of a compound is $A_xB_yC_z$, then the percent composition is given by:

$$\%A = \frac{x(\text{molar mass of A})}{\text{molar mass of } A_xB_yC_z} \times 100\%$$

$$\%B = \frac{y(\text{molar mass of B})}{\text{molar mass of } A_xB_yC_z} \times 100\%$$

$$\%C = \frac{z(\text{molar mass of C})}{\text{molar mass of } A_xB_yC_z} \times 100\%$$

Empirical Formula: The smallest whole number ratio of the elements in a compound.

To calculate the empirical formula when given a mass % composition:

1.) Write each percent as grams.

2.) Convert grams of each element to moles by dividing by that element's molar mass.

3.) Divide the moles of the element with the least number of moles into the moles of the other elements.

4.) If all resulting numbers are closer than 0.1 to a whole number, round them to those whole numbers. These numbers are the subscripts in the empirical formula.

       a.) If any of the resulting numbers are 0.1 or farther away from a whole number, find a whole number such that when multiplied by that number will make it closer than 0.1 to a whole number.

       b.) Multiply all resulting ratios by that number over itself. The resulting ratios will give you the empirical formula.

Molecular Formulas: The actual ratio of elements in a compound.

If given the percent composition and the molar mass of the compound, multiply the molar mass of each element by it's percent (divided by 100). The resulting numbers, as whole numbers, are the subscripts for the elements in the molecular formula.

If given the empirical formula and the molecular mass, divide the molecular mass by the empirical mass. Multiply the subscripts in the empirical formula by the resulting whole number to get the subscripts for the molecular formula.

Problems

1.) Calculate the mass percent composition of lysergic acid diethylamide, $C_{20}H_{25}N_3O$.

% C: _____

% H: _____

% N: _____

% O: _____

2.) Calculate the mass percent composition of iron (III) sulfate monohydrate.

% Fe: _____

% S: _____

% O: _____

% H: _____

3.) Calculate the number of grams of fluorine in 7.228 g of xenon tetrafluoride.

Grams Fluorine:_____

4.) Calculate the mass percent of magnesium in the mineral $MgF_2 \cdot (MgSiO_3)_2$.

% Mg: _____

% F: _____

% Si: _____

% O: _____

5.) Krels have 7.22 times the mass of gleps. Gleps have 0.314 the mass of scens. The lightest of these has a mass of 2.171 g. How much total does a collection of 14 krels, 11 gleps, and 9 scens weigh?

Total mass:_____

6.) 65.32 g of a compound, that is composed of sodium, oxygen, and sulfur, contains 21.14 g of sodium and 14.75 g of sulfur. What is the empirical formula of this compound?

Empirical Formula:_____

7.) A compound is 46.01 % Fe and 53.99 % Si, by mass. Calculate the empirical formula of this compound.

Empirical Formula:_____

8.) A compound that contains only carbon, hydrogen, and oxygen is 45.27% C, 9.499% H, and 45.23% O by mass. Calculate the empirical formula of this compound.

Empirical Formula:_____

9.) A compound has the empirical formula PO_2, and a molecular mass of 314.86 g/mol. What is the molecular formula of this compound?

Molecular Formula:_____

10.) A compound has the empirical formula C_3H_6O and a molecular mass of 174.240 g/mol. What is the molecular formula of this compound?

Molecular Formula:_____

11.) A compound is 92.257 % carbon and 7.743 % hydrogen, by mass. The molar mass of this compound is 78.114 g/mol. What are the empirical and molecular formulas of this compound?

Empirical Formula:_____

Molecular Formula:_____

12.) A certain sulfur containing amino acid is 33.059% C, 5.551 % H, 11.011 % N, 25.159 % O, and 25.220 % S, by mass. Each molecule of this compound contains two atoms of sulfur. What is the molecular formula of this compound?

Molecular Formula:_____

13.) A 3.1151 gram sample of a compound containing only cesium and potassium completely decomposes to yield 2.346 g of cesium. What is the empirical formula of this compound?

Empirical Formula:_____

14.) Oxygen forms a binary compound (compound A) with a certain metal that is 13.38 % oxygen by mass. When this compound is heated gently some of the oxygen is driven off and the new compound (compound B) is 9.334 % oxygen by mass. When this new compound is heated up very strongly more oxygen is driven off and the new compound (compound C) is 7.168 % oxygen by mass. Given that the empirical formula of compound A is MO_2, where "M" stands for the metal, calculate the molar mass of the metal, the identity of the metal, and the empirical formulas of compounds B and C.

Molar Mass of Metal:_____

Identity of Metal:_____

Empirical Formula Compound B:_____