PERCENTAGE COMPOSITION:

$$\text{MASS PERCENT} = \frac{\text{Mass of element in 1 mole compound}}{\text{mass of 1 mole compound}} \times 100$$

ex. Calculate the mass percent of carbon in ethanol, C_2H_5OH

ex. When aluminum metal is heated with an element from group 6A, an ionic compound forms. When the experiment is performed, the product is 18.56% Al by mass. What is the identity of the element and the formula of the compound?

EMPIRICAL FORMULA DETERMINATION:

1) Since mass percentage gives the number of grams of a particular element per 100 grams of compound, base the calculation on 100 grams of compound. Each percent will then represent the mass in grams of that element.

2) Determine the number of moles of each element present in 100 grams of compound by dividing the grams by the atomic masses of the elements present.

3) Divide each value of the number of moles by the smallest of the values. If each resulting subscripts is a whole number (± .05), these numbers represent the subscripts of the elements in the empirical formula.

4) If the numbers obtained in the previous step are not whole numbers, multiply EACH number by an integer so that the results are all whole numbers (decimal part is usually .16, .25, .33, .50, .67, or .75 (± .01)).

GIVE THE EMPIRICAL FORMULA OF EACH:

1) 0.0130 mol C, 0.0390 mol H, 0.0065 mol O

2) 11.66-g Fe, 5.01-g O

3) 40.0% C, 6.70% H, and 53.3% O by mass

EX.) Epsom salts is a hydrate. The formula for Epsom salts can be written as $MgSO_4 * XH_2O$, where X represents the the number of moles of water per mole of $MgSO_4$. When 5.061-g of this hydrate is heated to 250^oC, all the water of hydration is lost, leaving 2.472-g of anhydrous magnesium sulfate. What is the value of X?

MOLECULAR FORMULA DETERMINATION:
Method One:
1) Obtain the empirical formula
2) Compute the molar mass corresponding to the empirical formula.
3) Divide the given molar mass by the empirical molar mass.
4) the integer from the previous step represents the number of empirical formula units in one molecule. When the empirical formula subscripts are multiplied by this integer, the molecular formula results.

Example:
1) Caffeine contains 49.5% C, 5.15% H, 28.9% N and 16.5% O by mass and has a molar mass of about 195 g/mol. Determine its molecular formula.

2) Ibuprofen contains 75.69% C, 8.80% H, and 15.51% O by mass and has a molar mass of about 206 g/mol. Determine its molecular formula.

Method Two:
1) Using the mass percentages and the molar mass, determine the mass of each element present in one mole of the compound.
2) Determine the number of moles of each element present in one mole of compound.
3) The integers from the previous step represent the subscripts in the molecular formula.

Example:
1) Caffeine contains 49.5% C, 5.15% H, 28.9% N and 16.5% O by mass and has a molar mass of about 195 g/mol. Determine its molecular formula.

2) Ibuprofen contains 75.69% C, 8.80% H, and 15.51% O by mass and has a molar mass of about 206 g/mol. Determine its molecular formula.

ELEMENT IDENTITY:

1) 95.49-g of M_2S reacts with an excess of oxygen to yield 76.26-g of M. Identify M.

2) 0.5000-g XI_3 reacts with excess chlorine gas. If 0.2360-g XCl_3 is produced, determine the identity of X.

COMBUSTION ANALYSIS:

EX 1: A compound containing carbon and hydrogen (a hydrocarbon) is burned. Combustion of 47.6 - g of the compound produces 42.8-g of water and 156.8-g of carbon dioxide. Determine its empirical formula.

EX. 2:A compound contains only carbon, hydrogen, and oxygen. Combustion of 10.68-g of the compound yields 16.01-g CO_2 and 4.37-g H_2O. If the molar mass of the compound is 176.1-g/mol, determine its molecular formula.

3) Combustion of 5.878-g of a primary alcohol(contains C,H,O) produced 14.667-g of CO_2 and 7.208-g of H_2O.

A) Determine its empirical formula.

B) Give a proposed formula for the alcohol

C) Draw as many isomers as you can.

Ex 1: A compound containing carbon and hydrogen (a hydrocarbon) is burned. Combustion of 47.6-g of the compound produces 42.8-g of water and 156.8-g of carbon dioxide. Determine the empirical formula.

2) Combustion of 5.878-g of a primary alcohol(contains C,H,O) produced 14.667-g of CO_2 and 7.208-g of H_2O.

A) Determine its empirical formula.

EX. 3:A compound contains only carbon, hydrogen, and oxygen. Combustion of 10.68-g of the compound yields 16.01-g CO_2 and 4.37-g H_2O. If 0.255-mol of the compound contains 44.91-g, determine its molecular formula.

Stoichiometry as a Proportion:

ex: If 100.-g of aluminum reacts with an excess amount of oxygen, what mass of aluminum oxide could be produced?

STOICHIOMETRY:

1) Suppose a solution containing 3.50-g sodium phosphate is mixed with a solution containing 6.40-g of barium nitrate. If 4.70-g barium phosphate is obtained, calculate the percentage yield.

2) 8.50-g of iron(II) sulfate reacts with excess potassium permanganate and sulfuric acid to produce iron(III) sulfate and other products. Calculate the amount that could be produced.

3) If 30.0-g of aluminum is reacted with 90.0-g of hydrogen chloride, calculate the amount of excess reactant that remains.

ICE BOX USE IN STOICHIOMETRY

1) 6.00-mol of propane, C_3H_8, is burned in air to produce carbon dioxide and water. Determine the moles of oxygen needed and the moles of water and carbon dioxide that could be produced.

ICE BOX USE IN STOICHIOMETRY

2) Aluminum reacts with oxygen gas to give aluminum oxide. What amount of oxygen gas is needed for complete reaction with 6.0-mol aluminum? What amount of aluminum oxide, in moles, can be produced?

ICE BOX USE IN STOICHIOMETRY

3) If 3.80-mol of silver nitrate reacts with 5.70-mol of sodium chloride:

a) What is the limiting reactant?

b) How much excess reactant remains?

ICE BOX USE IN STOICHIOMETRY

4) If 5.00-mol of chlorine gas react with 7.50-mol of sodium,
   a) What is the limiting reactant?
   b) How much excess reactant remains?
   c) What amount of product is produced?

ICE BOX USE IN STOICHIOMETRY

5) Iron(III) oxide can be converted to iron and carbon dioxide by treatment with carbon monoxide. If 25.0-mol of iron(III) oxide is combined with 66.0-mol of carbon monoxide,
(A) Which is the limiting reactant?
(B) What amount, in moles, of the excess reactant remains?
(C) What amount of iron, in moles, is expected?

ICE BOX USE IN STOICHIOMETRY

6) If 9.00-mol of sodium carbonate reacts with 10.00-mol of aluminum chloride:
    a) What is the limiting reactant?
    b) What amount of excess reactant remains?
    c) What amount of precipitate forms?

ICE BOX USE IN STOICHIOMETRY

7) Ethanol, CH_3CH_2OH, burns in oxygen to produce carbon dioxide and water. If 8.00-mol of ethanol and 21.0-mol of oxygen are reacted,

A) What is the limiting reactant?

B) What amount, in moles, of the excess reactant remains?

C) What amount, in moles, of carbon dioxide could be produced?

D) What amount, in moles, of water could be produced?

ICE BOX USE IN STOICHIOMETRY

8) Using the ICEBOX method, determine the mass of water that could be produced by reacting 45.0-g of butane, C_4H_{10}, with 150.-g of oxygen. What mass of excess reactant remains assuming the reaction gives a 100% yield of the products.

ICE BOX USE IN STOICHIOMETRY

9) 30.0-moles of aluminum sulfate is needed. Determine the number of moles of aluminum and sulfuric acid needed. Calculate the moles of hydrogen gas that could also be produced.