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General Chemistry I – CHM1045

(Chapter 4) Chemical Stoichiometry

Definitions:

Chemical Stoichiometry is the numerical relationships between the amounts of reactant and products in a chemical reaction.

Problem Solving Guide:

Step 1: Identify the given information.

Step 2: Identify what the problem wants you to find.

Step 3: Set up your stoichiometry formula.

Step 4: Input the given mass. If the mass is given in moles skip step 5.

Step 5: Convert the mass from grams (g) to moles (mol) by using the atomic mass (s).

Step 6: This is the bridge that uses the given information to find out the answer. This step combines the reactant coefficient and the product coefficient (mole to mole ratio).

Step 7: Convert the mass from moles (mol) to grams (g) by using the atomic mass (s).

Stoichiometry Formula

Given (g or mol) → Conversion to moles using the atom mass (s) (g/mol) → Mole relationship between what is given and what you are trying to find. This is based on the coefficients of the molecules in the chemical formula. (mol/mol) → Conversion to grams using the atom mass(s) (g/mol) → **ANSWER** What you are trying to find (g)

At the end of your stoichiometry formula you should be left in the units that you are trying to find (grams or moles).

Mole Relationships (Ratios)

1. ***What is it?*** We can use these ratios to determine what amount of a molecule, in **moles**, will react with or produce a given number of **moles** of a different molecule.
2. ***How do you find it?*** The mole ratios can be found by looking at the coefficients associated with each molecule. Coefficients are the large numbers that are in the front of each molecule. If there is no number in front of the molecule it means that there is only one (1) mole of the molecule in the reaction.

Chemical Formula	$2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$			
Molecule	$NaOH$	H_2SO_4	H_2O	Na_2SO_4
Mole Ratio	2	1	2	1

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Example:

How many grams of sodium sulfate will be formed if 89.3 grams of sodium hydroxide was used in the reaction? There will be an excess of sulfuric acid.

$2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$

Molecular Mass:
Na_2SO_4 = 142.1 grams/mol
NaOH = 40 grams/mol

89.3 g NaOH	1 mol NaOH	1 mol Na_2SO_4	142.1 g Na_2SO_4	158.6 g Na_2SO_4
	40 g NaOH	2 mol NaOH	1 mol Na_2SO_4	

⇨ 159 g Na_2SO_4 *(3 sig. fig)*

Practice:

1. Oxygen gas can be produced by decomposing potassium chlorate using the reaction below. If 138.6 g of $KClO_3$ is heated and decomposes completely, what mass of oxygen gas is produced?
   $2KClO_3$ (s) --> 2KCl (s) + $3O_2$
2. Calculate how how many grams of HF will be made if you start with 5.33 mol F_2.
   $5F_2$ (g) + $2NH_3$ (g) --> N_2F_4 (g) + 6HF (g)
3. How many grams of aluminum sulfate are produced if you react 74.44 g $CuSO_4$?
   2Al (s) + $3CuSO_4$ (aq) --> $Al_2(SO_4)_3$ (aq) + 3Cu (s)
4. How many grams of O_2 will be produced by 12.00 moles of $NaClO_3$?
   $2NaClO_3$ (s) --> 2NaCl (s) + $3O_2$ (g)
5. How many grams of NaCl are produced when 80.0 grams of O_2 are produced?
   $2NaClO_3$ (s) --> 2NaCl (s) + $3O_2$ (g)
6. The average human requires 120.0 grams of glucose ($C_6H_{12}O_6$) per day. How many grams of CO_2 (in the photosynthesis reaction) are required for this amount of glucose?
   6 CO_2 + 6 H_2O ---> $C_6H_{12}O_6$ + 6 O_2
7. Molten iron and carbon monoxide are produced in a blast furnace by the reaction of iron(III) oxide and coke (pure carbon). If 25.0 kilograms of pure Fe_2O_3 is used, how many kilograms of iron can be produced? Fe_2O_3 + 3 C ---> 2 Fe + 3 CO
8. How many moles of Cu are needed to react with 3.50 moles of $AgNO_3$?
   Cu + 2 $AgNO_3$ ---> $Cu(NO_3)_2$ + 2 Ag
9. What mass of iron is needed to react with 16.0 grams of sulfur? 8 Fe + S_8 ---> 8 FeS
10. How many grams of Na_2O are required to produce 1.60 x 10^2 grams of NaOH?
    Na_2O + H_2O ---> 2 NaOH

Answers: 1) 54.286 g O_2 2) 127.92 g HF 3) 53.23 g $Al_2(SO_4)_3$ 4) 576.00 g O_2 5) 97.417 g NaCl 6) 175.9 g CO_2
7) 17.5 kg Fe 8) 1.75 mol Cu 9) 27.9 g Fe 10) 43.9 g FeS