General Stoichiometry Notes

STOICHIOMETRY: tells relative amts of reactants & products in a chemical reaction

- Given an amount of a substance involved in a chemical reaction, we can figure out the amount of the other substances are needed or produced
- Always compare the number of MOLES
- 4 Fe + 3 O_2 → 2 Fe_2O_3
- If I have 4 moles of Fe, I need 3 moles of O_2 in order to produce 2 moles of Fe_2O_3.
- Comparison of coefficients = MOLE RATIO
- In the above eqn, what is the mole ratio between Fe_2O_3 and O_2?
- Use coefficients… 2 : 3 or 2 to 3

To solve stoichiometry problems… ALWAYS!!!!!!!!!!

**** WRITE BALANCED EQUATION AND GIVEN & UNKNOWN INFORMATION! ****

1.) Find moles of given element or compound.

*** Use molar mass of given substance if problem gives you grams.**

*** Use 6.022×10^{23} if problem gives you molecules.**

2.) Use mole ratio (coefficients) from balanced equation.

$$\frac{\text{\# (from problem or step1) moles given}}{\text{coefficient of given substance}} = \frac{\text{x moles unknown}}{\text{coefficient of unknown}}$$

3.) Find answer.

*** Use molar mass of unknown subst if question asks for grams.**

*** Use 6.022×10^{23} if question asks for molecules.**

Here's an example:

How many moles of ammonia (NH_3) can be produced by the complete reaction of 3.25 moles of hydrogen?

N_2 + 3 H_2 → 2 NH_3

3.25 moles ? moles

1.) DONE!!!

2.) $\frac{3.25 \text{ moles } H_2}{3} = \frac{x \text{ moles } NH_3}{2}$ 3x = 6.5, x = 2.17 moles NH_3

3.) NOT NECESSARY!!! Question asked for moles of NH_3, so answer is 2.17 moles NH_3.

Example 2:

What mass of NaOH is produced when 6.21 moles $Ca(OH)_2$ reacts completely with Na_2CO_3?

Na_2CO_3 + $Ca(OH)_2$ → 2 NaOH + $CaCO_3$

6.21 moles ? g

1.) Step 1 is already done for you! The number of moles is given in the problem! YAY!

2.) $\frac{6.21 \text{ moles } Ca(OH)_2}{1} = \frac{x \text{ moles NaOH}}{2}$ x = 12.42 moles NaOH

3.) $\frac{12.42 \text{ moles NaOH}}{1 \text{ mole}} \left| \frac{40.0 \text{ grams}}{} \right. = 497 \text{ g NaOH}$

Example 3:

If 34.32 grams of acetylene (C_2H_2) are burned in air, how many moles of CO_2 can be formed?

2 C_2H_2 + 5 O_2 → 4 CO_2 + 2 H_2O

34.32 g ? moles

C: 2 x 12.0 = 24.0

H: 2 x 1.0 = 2.0 +

26.0

1.) $\frac{34.32 \text{ g } C_2H_2}{26.0 \text{ grams}} \left| \frac{1 \text{ mole } C_2H_2}{} \right. = 1.32 \text{ moles } C_2H_2$

2.) $\frac{1.32 \text{ moles } C_2H_2}{2} = \frac{x \text{ moles } CO_2}{4}$ $2x = 5.28$
$x = 2.64$ moles CO_2

Problem asked for moles of CO_2, so that is your answer. Be sure to round for significant figures. Answer should be reported as 2.640 moles CO_2

Example 4:
If 27.8 grams of Na_2SO_4 are reacted with excess $Al_2(CO_3)_3$, how many grams of $Al_2(SO_4)_3$ will be formed?

$3\ Na_2SO_4 + Al_2(CO_3)_3 \rightarrow Al_2(SO_4)_3 + 3\ Na_2CO_3$
27.8 g ? g

1.) $27.8 \text{ g } Na_2SO_4 \mid \frac{1 \text{ mole } Na_2SO_4}{142.1 \text{ grams}} = 0.196 \text{ moles } Na_2SO_4$

2.) $\frac{0.196 \text{ moles } Na_2SO_4}{3} = \frac{x \text{ mole } Al_2(SO_4)_3}{1}$ $3x = 0.196$
$x = 0.0653$ moles $Al_2(SO_4)_3$

3.) $0.0653 \text{ mole } Al_2(SO_4)_3 \mid \frac{342.3 \text{ g } Al_2(SO_4)_3}{1 \text{ mole } Al_2(SO_4)_3} = 22.4 \text{ g } Al_2(SO_4)_3$

Na: 2 x 23.0 = 46.0
S: 1 x 32.1 = 32.1
O: 4 x 16.0 = 64.0 +
142.1

Al: 2 x 27.0 = 54.0
S: 3 x 32.1 = 96.3
O: 12 x 16.0 = 192.0 +
342.3

Example 5:
How many molecules of oxygen gas are required to completely react with 85.0 grams of propane (C_3H_8)?

$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
85.0 g ? mcs

1.) $85.0 \text{ g } C_3H_8 \mid \frac{1 \text{ mole}}{44.0 \text{ g}} = 1.93 \text{ moles } C_3H_8$

C: 3 x 12.0 = 36.0
H: 8 x 1.0 = 8.0 +
44.0

2.) $\frac{1.93 \text{ moles } C_3H_8}{1} = \frac{x \text{ moles } O_2}{5}$ $x = 9.65$ moles O_2

3.) $9.65 \text{ moles} \mid \frac{6.022 \times 10^{23} \text{ mcs}}{1 \text{ mole}} = 5.81 \times 10^{24} \text{ mcs } O_2$

Practice Problem:
How many grams of calcium nitrate are formed when 57.9 grams of iron (III) nitrate react with excess calcium hydroxide according to the following equation?

$\_\_ Ca(OH)_2 + \_\_ Fe(NO_3)_3 \rightarrow \_\_ Ca(NO_3)_2 + \_\_ Fe(OH)_3$

Stoichiometry Problems 1 Worksheet

1. When lead (II) sulfide is burned in air, lead (II) oxide and sulfur dioxide are produced. If 0.890 moles of sulfur dioxide were produced, how many moles of oxygen gas were required to react with the lead (II) sulfide? ___ PbS + ___ O_2 → ___ PbO + ___ SO_2

2. In the synthesis reaction of aluminum and oxygen to produce aluminum oxide, how many grams of aluminum are required to react with 0.223 moles of oxygen?
   ___ Al + ___ O_2 → ___ Al_2O_3

3. Calculate the number of grams of oxygen produced if 2.50 grams of potassium chlorate are decomposed completely by heating.
   ___ $KClO_3$ → ___ KCl + ___ O_2

4. How many moles of oxygen are needed for the complete combustion of 3.0 moles of methane (CH_4)? ___ CH_4 + ___ O_2 → ___ CO_2 + ___ H_2O

5. Using the same equation from #4, how many grams of carbon dioxide are formed when 8.0 grams of methane react? ___ CH_4 + ___ O_2 → ___ CO_2 + ___ H_2O

6. When elemental sulfur combines with oxygen gas, sulfur dioxide is formed. What is the total number of grams of oxygen needed to react completely with 2.0 moles of sulfur?
   ___ S + ___ O_2 → ___ SO_2

7. In the synthesis of water from its elements, what is the total number of grams of oxygen gas needed to produce 54 grams of water? ___ H_2 + ___ O_2 → ___ H_2O

8. How many moles of aluminum oxide will be formed when 27 grams of aluminum react completely with excess oxygen gas? ___ Al + ___ O_2 → ___ Al_2O_3

9. What mass (in grams) of sodium oxide is produced by the reaction of 1.44 grams of sodium with excess oxygen? $\_\_ Na + \_\_ O_2 \rightarrow \_\_ Na_2O$

10. What mass (in grams) of water will be given off when 1.92×10^{22} molecules of octane (C_8H_{18}) are burned completely in air? $\_\_ C_8H_{18} + \_\_ O_2 \rightarrow \_\_ CO_2 + \_\_ H_2O$

11. How many grams of $Al_2(SO_4)_3$ are need to react with KCl in order to produce 1.245 moles of K_2SO_4?
$\_\_ Al_2(SO_4)_3 + \_\_ KCl \rightarrow \_\_ AlCl_3 + \_\_ K_2SO_4$

12. Hydrogen gas can be produced through the following unbalanced reaction.
$\_\_ Mg + \_\_ HCl \rightarrow \_\_ MgCl_2 + \_\_ H_2$

(A) What mass of HCl is consumed by the reaction of 2.50 moles of magnesium?

(B) What mass of each product is produced in part (A)?

13. Acetylene gas, C_2H_2, used in welding, produces an extremely hot flame when it burns in pure oxygen according to the following unbalanced reaction.
$\_\_ C_2H_2 + \_\_ O_2 \rightarrow \_\_ CO_2 + \_\_ H_2O$
How many molecules of CO_2 are produced when 2.50×10^4 grams of C_2H_2 burn completely?

PERCENT YIELD NOTES

~ compares the actual amount of product that you made (in an experiment) to the amount of product you should have made (according to calculations)

~ ACTUAL YIELD: amount of product that you made in an experiment; when given in the problem, the amount (grams, atoms/molecules, moles) given will be associated with a product of the reaction

~ THEORETICAL YIELD: amount of product that you should have made (according to calculations); amount given with a reactant should be used to calculate theoretical yield

~ $\% \text{ YIELD} = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100$

EXAMPLE

(A) What is the theoretical yield of carbon dioxide if 9.5 grams of aluminum bicarbonate are completely decomposed? (B) If a student makes 5.2 grams of CO_2 in an experiment, what is the % yield?

__ $Al(HCO_3)_3$ → __ Al_2O_3 + __ CO_2 + __ H_2O

ANSWER:

2 $Al(HCO_3)_3$ → __ Al_2O_3 + 6 CO_2 + 3 H_2O

9.5 g ? g

1.) $\frac{9.5 \text{ g } Al(HCO_3)_3}{} \left| \frac{1 \text{ mole } Al(HCO_3)_3}{210 \text{ grams}} \right. = 0.0452 \text{ moles } Al(HCO_3)_3$

2.) $\frac{0.0452 \text{ moles } Al(HCO_3)_3}{2} = \frac{x \text{ moles } CO_2}{6}$ $\quad 2x = 0.2712$ $\quad x = 0.1356 \text{ moles } CO_2$

3.) $\frac{0.1356 \text{ moles } CO_2}{} \left| \frac{44.0 \text{ g } CO_2}{1 \text{ mole}} \right. = 6.0 \text{ g } CO_2$ is the theoretical yield.

(B) % yield = $\frac{5.2 \text{ g}}{6.0 \text{ g}} \times 100 = 87\ \%$

PRACTICE PROBLEM

(A) What is the theoretical yield of water if 7.5 grams of oxygen are reacted with excess hydrogen?

(B) If a student produces 7.0 grams of water, what is the student's % yield?

__ H_2 + __ O_2 → __ H_2O

PERCENT YIELD WORKSHEET

1. Use the following information to answer the questions. In the following reaction, 41.0 grams of lead (II) chloride are reacted with excess sodium chromate.

__ $PbCl_2$ + __ Na_2CrO_4 → __ $PbCrO_4$ + __ NaCl

(A) What is the theoretical yield (in grams) of sodium chloride in this reaction?

(B) If a student performed this experiment and recovered 16.5 grams of sodium chloride, what is the student's percent yield?

2. Use the following information to answer the questions. In the following reaction, 1.70 moles of zinc nitrate are reacted with excess chromium (II) phosphide.

$$\_\_\ Zn(NO_3)_2 + \_\_\ Cr_3P_2 \rightarrow \_\_\ Zn_3P_2 + \_\_\ Cr(NO_3)_2$$

(A) What is the theoretical yield (in grams) of zinc phosphide?

(B) If a student performed this experiment and recovered 149 grams of zinc phosphide, what is the student's percent yield?

3. Use the following information to answer the questions. In the following reaction, 10.0 grams of copper (II) sulfate are reacted with excess iron (III) phosphate.

$$\_\_\ CuSO_4 + \_\_\ FePO_4 \rightarrow \_\_\ Cu_3(PO_4)_2 + \_\_\ Fe_2(SO_4)_3$$

(A) How many grams of copper (II) phosphate can be produced?

(B) If a student performed this experiment and recovered 6.70 grams of copper (II) phosphate, what is the student's percent yield?

Limiting Reactant Notes

Limiting Reactant: reactant that will be consumed (used up) first; limits the amount of product that can be made (produced)

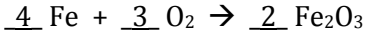
Excess Reactant: reactant that will not be completely consumed by reacting with all of the limiting reactant; there will be some of this reactant left over after the reaction is complete

How is a limiting reactant problem different from a regular stoichiometry problem? There are amounts (grams, atoms/molecules, moles) given with both of the reactants.

How are the calculations different from regular stoichiometry problems? Once you determine the limiting reactant, the calculations are exactly the same.

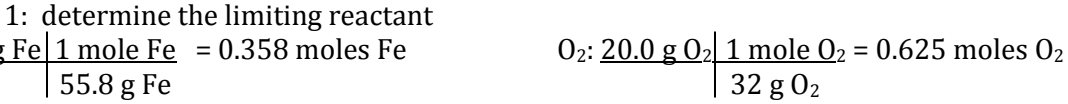
How can I determine which is the limiting reactant? Find the number of moles of each reactant. Divide the number of moles by its coefficient from the balanced equation. The smaller of these two numbers is the limiting reactant. Use the number and unit associated with the limiting reactant to solve the problem.

EX: (A) How many grams of Fe_2O_3 can be produced from the reaction of 20.0 grams of Fe with 20.0 grams of O_2? (B) How many grams of excess reactant remains after reaction is complete?



$$\underline{4}\ Fe + \underline{3}\ O_2 \rightarrow \underline{2}\ Fe_2O_3$$

(A) STEP 1: determine the limiting reactant



Fe: $\frac{20.0\text{ g Fe}}{55.8\text{ g Fe}} \left| \frac{1\text{ mole Fe}}{} \right. = 0.358$ moles Fe

O_2: $\frac{20.0\text{ g } O_2}{32\text{ g } O_2} \left| \frac{1\text{ mole } O_2}{} \right. = 0.625$ moles O_2

Fe: $\frac{0.358}{4} = 0.0895$

O_2: $\frac{0.625}{3} = 0.208$

So, Fe is limiting reactant. **Use the information given for Fe to solve the problem.**

$\frac{0.358 \text{ moles Fe}}{4} = \frac{x \text{ moles } Fe_2O_3}{2}$ $\quad 4x = 0.716$

$x = 0.179$ moles Fe_2O_3

$0.179 \text{ moles } Fe_2O_3 \left| \frac{159.7 \text{ g } Fe_2O_3}{1 \text{ mole } Fe_2O_3} \right. = 28.6 \text{ grams } Fe_2O_3$

(B) STEP 1: Using limiting reactant information, determine the amount of excess reactant used.

$\frac{0.358 \text{ moles Fe}}{4} = \frac{x \text{ moles } O_2}{3}$ $\quad 4x = 1.074$

$x = 0.2685$ moles O_2 used

$0.2685 \text{ moles } O_2 \left| \frac{32 \text{ g } O_2}{1 \text{ mole}} \right. = 8.59 \text{ g } O_2$ used

STEP 2: Subtract number of grams of excess (O_2) used from the original amount given in the problem.

20.0 g – 8.59 g = 11.41 g O_2 remain

On your own… if 25.00 grams of aluminum sulfate reacted with 25.00 grams of zinc chloride, how many grams of aluminum chloride could be produced? How many grams of excess reactant remains after reaction is complete?

$$\_\_ Al_2(SO_4)_3 + \_\_ ZnCl_2 \rightarrow \_\_ AlCl_3 + \_\_ ZnSO_4$$

LIMITING REACTANTS WORKSHEET

1. The coating you see on a corroded iron object that has been left in moist conditions is black iron oxide (Fe_3O_4). This substance can also be made in the laboratory by the reaction between iron and steam, according to the following equation: $Fe + H_2O \rightarrow Fe_3O_4 + H_2$
   (A) When 36.0 grams of H_2O react with 167 grams of Fe, which is the limiting reactant?
   (B) What mass (in grams) of black iron oxide is produced?
   (C) How much of the excess reactant is used when the reaction is completed?

2. Zinc and sulfur react to form zinc sulfide according to the following equation:

$Zn + S_8 \rightarrow ZnS$

(A) If 23.0 grams of Zn are heated with 19.3 grams of S_8, which is the limiting reactant?
(B) How many grams of product are formed?
(C) How many grams of excess reactant remain after the reaction is completed?

3. Carbon reacts with steam under certain conditions to produce hydrogen and carbon monoxide.

$C + H_2O \rightarrow H_2 + CO$

(A) If 2.40 grams of carbon react with 3.10 grams of steam, which is the limiting reactant?
(B) How many moles of each product are formed?
(C) How many grams of each product are formed?

4. Aluminum reacts with hydrochloric acid according to the following equation:

$Al + HCl \rightarrow AlCl_3 + H_2$

(A) If 18 grams of aluminum are combined with 75 grams of HCl, which is the limiting reactant?
(B) What mass of each product is formed?

MORE PRACTICE PROBLEMS IF YOU NEED THEM…

1.) A reaction between methane and sulfur produces carbon disulfide (CS_2), a liquid often used in the production of cellophane.

$\_\_\_ CH_4 + \_\_\_ S_8 \rightarrow \_\_\_ CS_2 + \_\_\_ H_2S$

If 1.50 moles of S_8 are used, (A) how many moles of CS_2 are produced?
(B) How many moles of H_2S are produced?

2.) Lead (II) oxide is obtained by roasting galena, lead (II) sulfide, in air.

$\_\_\_ PbS + \_\_\_ O_2 \rightarrow \_\_\_ PbO + \_\_\_ SO_2$

(A) Determine the theoretical yield (in grams) of PbO if 200.0 grams of PbS are heated.
(B) What is the percent yield if 170.0 grams of PbO are obtained?

3.) Some rockets are fueled by the reaction of hydrazine (N_2H_2) and hydrogen peroxide (H_2O_2). How many moles of nitrogen gas can be produced by reacting 255 grams of hydrazine with excess hydrogen peroxide?

$\_\_ N_2H_2 + \_\_ H_2O_2 \rightarrow \_\_ N_2 + \_\_ H_2O$

4.) One in a series of reactions that inflate automobile air bags is the decomposition of sodium azide (NaN_3).

$\_\_ NaN_3 \rightarrow \_\_ Na + \_\_ N_2$

Determine the mass of N_2 produced if 100.0 grams of NaN_3 are decomposed.

5.) Titanium is a transition metal used in many alloys because it is extremely strong and lightweight. Titanium tetrachloride ($TiCl_4$) is extracted from titanium oxide using chlorine and carbon.

$\_\_\_ TiO_2 + \_\_\_ C + \_\_ Cl_2 \rightarrow \_\_\_ TiCl_4 + \_\_\_ CO_2$

If you begin with 1.25 moles of TiO_2, what mass of Cl_2 gas is needed?

6.) How many molecules of iodine can be produced by the complete reaction of 43.97 grams of KI?

$\_\_ CuCl_2 + \_\_ KI \rightarrow \_\_ CuI + \_\_ KCl + \_\_ I_2$

7.) What mass of ammonia (NH_3) is needed to react completely with oxygen to produce 3.54×10^{24} molecules of water?

$\_\_ NH_3 + \_\_ O_2 \rightarrow \_\_ NO + \_\_ H_2O$

UNITS 8 & 9 REVIEW WORKSHEET

1.) ___ $CaCl_2$ + ___ $AgNO_3$ → ___ $Ca(NO_3)_2$ + ___AgCl

(A) Type of reaction?

(B) If 50.0 grams of calcium chloride are reacted with excess silver nitrate, how many grams of silver chloride can be produced?

(C) What is the percent yield if a student makes 118 grams of silver chloride in this experiment?

2.) ___ $Fe(HCO_3)_3$ → ___ Fe_2O_3 + ___ H_2O + ___CO_2

(A) Type of reaction?

(B) A lab group decomposed 15.0 grams of $Fe(HCO_3)_3$. What is the theoretical yield of iron (III) oxide?

(C) If the lab group produced 4.63 grams of iron (III) oxide, what is their percent yield?

3.) ___ Au + ___HNO_3 + ___HCl → ___ $AuCl_3$ + ___NO + ___ H_2O

(A) How many grams of hydrochloric acid (HCl) are needed to completely react 1.25 moles of gold metal?

4.) ___ Fe + ___ $CuNO_3$ → ___ $Fe(NO_3)_2$ + ___ Cu

(A) How do we know that this reaction actually happens?

(B) When 3.7 moles of iron are reacted with excess copper (I) nitrate, how many moles of copper are produced?

5.) ___ $Ca_3(PO_4)_2$ + ___ SiO_2 + ___ C → ___ P + ___ $CaSiO_3$ + ___ CO

(A) How many moles of $CaSiO_3$ would be produced by the complete reaction of 225.5 grams of calcium phosphate?

6.) ___ Ca + ___ H_2O → ___ $Ca(OH)_2$ + ___ H_2

(A) How many molecules of water would be needed to react completely with 34.2 grams of calcium?

7.) ___ K_3PO_4 + ___ $MgCl_2$ → ___ $Mg_3(PO_4)_2$ + ___ KCl

(A) What is the theoretical yield of potassium chloride if 21.7 grams of magnesium chloride are reacted with 25.4 grams of potassium phosphate?

(B) How many grams of excess reactant remain after the reaction is complete?

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8.) Al + $NiCl_2$ →

9.) $Zn(NO_3)_2$ + Mg →

10.) Cu + K_2SO_4 →

11.) CsF + I_2 →

12.) Cl_2 + NaBr →

13.) $Pb(ClO_3)_2$ + K →

14.) Mn + LiOH →

Stoichiometry Problems 1 wksht.
1.) 1.34 moles O_2 2.) 8.02 g Al 3.) 0.980 g O_2 4.) 6.0 moles O_2 5.) 22 g 6.) 64 g O_2 7.) 48 g O_2 8.) 0.50 moles Al_2O_3 9.) 1.94 g Na_2O 10.) 5.16 g H_2O 11.) 142.1 g $Al_2(SO_4)_3$ 12.) a) 183 g HCl b) 238 g $MgCl_2$; 5.00 g H_2 13.) 1.16 x 10^{27} mcs CO_2

Percent Yield wksht.
1.) (A) 17.2 g (B) 95.9 % 2.) (A) 146 g (B) 102 % 3.) (A) 7.95 g (B) 84.3 %

Limiting Reactants wksht.
1. (A) H_2O, (B) 116 g, (C) 83.7 g; 2. (A) Zn, (B) 34.3 g, (C) 8.0 g;
3. (A) H_2O, (B) 0.172 moles of each, (C) 4.82 g CO, 0.347 g H_2; 4. (A) Al, (B) 88.9 g $AlCl_3$, 2.02 g H_2

More Practice Problems.
1.) (A) 3.00 moles CS_2 (B) 6.00 moles H_2S 2.) (A) 186.6 g PbO (B) 91.10 % 3.) 8.50 moles N_2
4.) 64.60 g N_2 5.) 178 g Cl_2 6.) 3.988 x 10^{22} mcs I_2 7.) 66.6 g NH_3

UNITS 8 & 9 REVIEW WORKSHEET
1. (A) double replacement (B) 129 g (C) 91.5% 2. (A) decomposition (B) 5.01 g (C) 92.4%
3. (A) 137 g 4. (A) Fe is higher than Cu on Activity Series. (B) 7.4 moles 5. (A) 2.180 moles
6. (A) 1.03 x 10^{24} molecules 7. (A) 26.8 g (B) 4.6 g remain

8.) $2\ Al + 3\ NiCl_2 \rightarrow 3\ Ni + 2\ AlCl_3$

9.) $Zn(NO_3)_2 + Mg \rightarrow Zn + Mg(NO_3)_2$

10.) $Cu + K_2SO_4 \rightarrow$ no rxn.

11.) $CsF + I_2 \rightarrow$ no rxn.

12.) $Cl_2 + 2\ NaBr \rightarrow Br_2 + 2\ NaI$

13.) $Pb(ClO_3)_2 + 2\ K \rightarrow Pb + 2\ KClO_3$

14.) $Mn + LiOH \rightarrow$ no rxn.

MOLE RELATIONSHIP IN A CHEMICAL REACTION LAB

The Law of Conservation of Matter states that "matter is neither created nor destroyed in a chemical reaction." In other words, the total mass of the reactants must equal the total mass of the products in a chemical reaction. Chemical equations are balanced so that they do not contradict the law of conservation of matter. The coefficients used to balance an equation also give the relative number of moles of reactants and products.

In this activity, you will test the Law of Conservation of Matter by causing a chemical reaction to occur with a given amount of reactant. You will then carefully determine the mass of one of the products. With these measurements, you will be able to calculate the moles of one reactant and one product and compare the number of moles. From the balanced equation, you should be able to see the relationship between the number of moles of a reactant and the number of moles of a product.

OBJECTIVES
- predict a balanced equation for the reaction taking place
- react a known mass of Na_2CO_3 with excess HCl
- calculate the mole ratio between Na_2CO_3 and NaCl
- determine whether your results support the Law of Conservation of Matter

EQUIPMENT

- goggles & apron	- balance	- dropper pipet
- Erlenmeyer flask	- lab burner/oven/hot plate	* ring stand & iron ring

PROCEDURE
* SAFETY GOGGLES AND LAB APRON MUST BE WORN AT ALL TIMES DURING THIS EXPERIMENT! *

1. Clean & dry an Erlenmeyer flask. Determine the mass of the empty, **dry** flask to the nearest 0.01 g.
2. With a spatula, add about 0.75 grams of sodium carbonate to the Erlenmeyer flask, and read the mass to the nearest 0.01 g. (NOTE: You should not attempt to measure *exactly* 0.75 g.)
3. Using the dropper pipet, carefully add hydrochloric acid to the flask (that already has the Na_2CO_3 in it). CAUTION: HCl causes burns; avoid skin and eye contact. Rinse spills with plenty of water.
4. Continue adding the acid slowly until the reaction has stopped and there is no more sodium carbonate at the bottom of the flask. Do not add more acid than is needed to complete the reaction. (If you add more than is needed, the rest of the lab will take longer.)
5. Swirl the flask to make sure the HCl has reacted all of the Na_2CO_3. If any unreacted Na_2CO_3 remains, add a few more drops of HCl to complete the reaction. (The reaction is complete when there is no white powder left in the evaporating dish and HCl can be added without any fizzing occurring.)
6. Heat the liquid in the Erlenmeyer flask until it boils GENTLY. Take care to avoid loss of liquid from boiling over. Continue to dry the solid slowly until all moisture appears to have evaporated.
7. Remove the dish from the heat and allow it to cool. Then measure and record the mass to the nearest 0.01 g.
8. After massing, the contents of the dish may be rinsed down the drain using plenty of water. Clean all lab equipment and return it to where the instructor says.

DATA TABLE

Mass of empty Erlenmeyer flask	_____g
Mass of flask & Na_2CO_3	_____g
Mass of Na_2CO_3	_____g
Mass of flask & NaCl	_____g
Mass of NaCl	_____g

QUESTIONS AND CALCULATIONS

1. There are three products in the chemical reaction you performed in this lab. One of the products is NaCl. The other two products in this reaction are also the products made in a combustion reaction. Write the balanced equation for the reaction in this experiment.

   _____ + _____ → NaCl + _____ + _____

2. From your balanced equation, what is the mole ratio between Na_2CO_3 and NaCl? _____ : _____

3. Suppose you had started with 3.25 moles of sodium carbonate. (A) How many moles of sodium chloride would you expect to be formed? (B) Explain.

   (A) _____

   (B) _____

4. Calculate the number of moles of Na_2CO_3 used in this reaction. answer = _____
   Show your work here:

5. Calculate the number of moles of NaCl produced in this reaction. answer = _____
   Show your work here:

6. From the data you collected in the lab, what is the mole ratio between Na_2CO_3 and NaCl?
   Show your work here:
   answer = 1 : _____

7. Starting with the mass of Na_2CO_3 that you actually used in the experiment, determine the theoretical yield (in grams) of NaCl in this experiment. (Stoichiometry problem!)
   Show your work here:

8. Compare the theoretical yield with your actual yield. What is your percent yield?

   % yield = $\frac{\text{actual yield}}{\text{theoretical yield}}$ x 100 answer = _____ x 100 =

   (Note: Theoretical yield is answer from #7. Actual yield is the last line of your data table.)

9. Was your percent yield more or less than 100%? Explain what your percent yield means in terms of the lab procedure. If your percent yield was less than 100%, what could have happened in the lab that would cause that result? If your percent yield was more than 100%, what could have happened in the lab that would cause that result?

10. Write a paragraph describing the observations of this chemical reaction. Also include in this paragraph:
    - How did you know that a chemical reaction occurred?
    - What were two (2) sources of error in this experiment (in terms of procedure - not faulty equipment or miscalculations)?
    - What could be done to prevent these errors if you did the experiment again?

Stoichiometry Assignment

1.) Given the equation: $\_\ H_3PO_4 + \_\ Ca(OH)_2 \rightarrow \_\ H_2O + \_\ Ca_3(PO_4)_2$
If 1.67 moles of $Ca(OH)_2$ completely react with excess H_3PO_4
(A) How many moles of H_3PO_4 are needed to react with the $Ca(OH)_2$?
(B) How many moles of H_2O can be produced?
(C) How many moles of $Ca_3(PO_4)_2$ can be produced?

2.) How many moles of chlorine are needed to produce 35.2 grams of $FeCl_3$ according to this equation? $\_\ Cl_2 + \_\ FeI_2 \rightarrow \_\ FeCl_3 + \_\ I_2$

3.) How many grams of calcium carbide are needed to completely react with 2.942 moles of water?
$\_\ CaC_2 + \_\ H_2O \rightarrow \_\ Ca(OH)_2 + \_\ C_2H_2$

4.) How many grams of CuI can be produced from the complete reaction of 4.397 moles of KI?
$\_\ CuCl_2 + \_\ KI \rightarrow \_\ CuI + \_\ KCl + \_\ I_2$
(Balancing hint: get an even number of Is on the product side first)

5.) Given the equation: $\_\ (NH_4)_2Cr_2O_7 \rightarrow \_\ Cr_2O_3 + \_\ H_2O + \_\ N_2$
Answer these questions using the equation above:
(A) What type of reaction is represented?

(B) How many moles of water are produced by the complete decomposition of 28 grams of $(NH_4)_2Cr_2O_7$?

(C) What is the name of the reactant compound?

6.) How many grams of ammonia (NH_3) are needed to react completely with oxygen to produce 35.4 grams of water?
$\_\ NH_3 + \_\ O_2 \rightarrow \_\ NO + \_\ H_2O$

7.) Given the unbalanced equation: $\_\ Al + \_\ Cl_2 \rightarrow \_\ Al_2Cl_6$
(A) If 40.5 grams of aluminum react with 213 grams of chlorine, how many grams of Al_2Cl_6 can be produced?
(B) How many grams of excess reactant remain?

8.) Given the unbalanced equation: $\_\ C_3H_6 + \_\ O_2 \rightarrow \_\ CO_2 + \_\ H_2O$
(A) What is the theoretical yield (in grams) of carbon dioxide if 45.0 grams of oxygen are reacted with excess C_3H_6?
(B) If 34.7 grams of carbon dioxide are produced in an experiment, what is the percent yield?