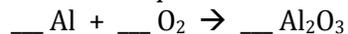


Stoichiometry Problems 1 Worksheet

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? $__ \text{PbS} + __ \text{O}_2 \rightarrow __ \text{PbO} + __ \text{SO}_2$

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?



3. Calculate the number of grams of oxygen produced if 2.50 grams of potassium chlorate are decomposed completely by heating.



4. How many moles of oxygen are needed for the complete combustion of 3.0 moles of methane (CH₄)? $__ \text{CH}_4 + __ \text{O}_2 \rightarrow __ \text{CO}_2 + __ \text{H}_2\text{O}$

5. Using the same equation from #4, how many grams of carbon dioxide are formed when 8.0 grams of methane react? $__ \text{CH}_4 + __ \text{O}_2 \rightarrow __ \text{CO}_2 + __ \text{H}_2\text{O}$

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?

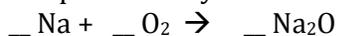


7. In the synthesis of water from its elements, what is the total number of grams of oxygen gas needed to produce 54 grams of water? $__ \text{H}_2 + __ \text{O}_2 \rightarrow __ \text{H}_2\text{O}$

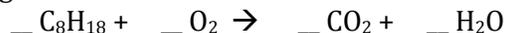
8. How many moles of aluminum oxide will be formed when 27 grams of aluminum react completely with excess oxygen gas? $__ \text{Al} + __ \text{O}_2 \rightarrow __ \text{Al}_2\text{O}_3$

UNIT 9 - STOICHIOMETRY

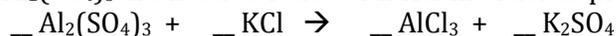
9. What mass (in grams) of sodium oxide is produced by the reaction of 1.44 grams of sodium with excess oxygen?



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?



11. How many grams of $\text{Al}_2(\text{SO}_4)_3$ are need to react with KCl in order to produce 1.245 moles of K_2SO_4 ?



12. Hydrogen gas can be produced through the following unbalanced reaction.



(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)?

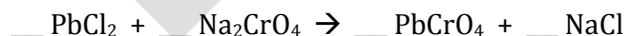
13. Acetylene gas, C_2H_2 , used in welding, produces an extremely hot flame when it burns in pure oxygen according to the following unbalanced reaction.



How many molecules of CO_2 are produced when 2.50×10^4 grams of C_2H_2 burn completely?

PERCENT YIELD WORKSHEET

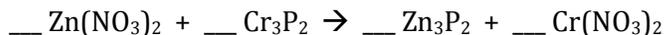
1. Use the following information to answer the questions. In the following reaction, 41.0 grams of lead (II) chloride are reacted with excess sodium chromate.



(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.



(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.

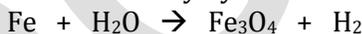


(A) How many grams of copper (II) phosphate can be produced?

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

LIMITING 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:



- (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:



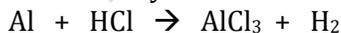
- (A) If 23.0 grams of Zn are heated with 19.3 grams of S_8 , which is the limiting reactant?
 (B) How many grams of product are formed?
 (C) How many grams of excess reactant remain after the reaction is completed?

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



- (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:



- (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.

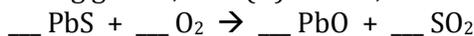


UNIT 9 - STOICHIOMETRY

If 1.50 moles of S₈ are used, (A) how many moles of CS₂ are produced?

(B) How many moles of H₂S are produced?

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

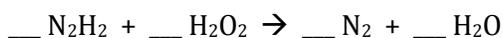


(A) Determine the theoretical yield (in grams) of PbO if 200.0 grams of PbS are heated.

(B) What is the percent yield if 170.0 grams of PbO are obtained?

3.) Some rockets are fueled by the reaction of hydrazine (N₂H₂) and hydrogen peroxide (H₂O₂).

How many moles of nitrogen gas can be produced by reacting 255 grams of hydrazine with excess hydrogen peroxide?



4.) One in a series of reactions that inflate automobile air bags is the decomposition of sodium azide (NaN₃).



Determine the mass of N₂ produced if 100.0 grams of NaN₃ are decomposed.

5.) Titanium is a transition metal used in many alloys because it is extremely strong and lightweight.

Titanium tetrachloride (TiCl₄) is extracted from titanium oxide using chlorine and carbon.



If you begin with 1.25 moles of TiO₂, what mass of Cl₂ gas is needed?

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



7.) What mass of ammonia (NH₃) is needed to react completely with oxygen to produce 3.54 x 10²⁴ molecules of water?



UNITS 8 & 9 REVIEW WORKSHEET

1.) $\underline{\quad} \text{CaCl}_2 + \underline{\quad} \text{AgNO}_3 \rightarrow \underline{\quad} \text{Ca(NO}_3)_2 + \underline{\quad} \text{AgCl}$

(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.) $\underline{\quad} \text{Fe(HCO}_3)_3 \rightarrow \underline{\quad} \text{Fe}_2\text{O}_3 + \underline{\quad} \text{H}_2\text{O} + \underline{\quad} \text{CO}_2$

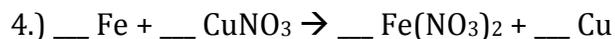
(A) Type of reaction?

(B) A lab group decomposed 15.0 grams of Fe(HCO₃)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.) $\underline{\quad} \text{Au} + \underline{\quad} \text{HNO}_3 + \underline{\quad} \text{HCl} \rightarrow \underline{\quad} \text{AuCl}_3 + \underline{\quad} \text{NO} + \underline{\quad} \text{H}_2\text{O}$

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

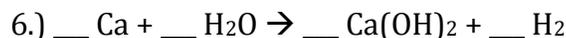


(A) How do we know that this reaction actually happens?

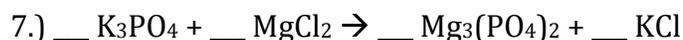
(B) When 3.7 moles of iron are reacted with excess copper (I) nitrate, how many moles of copper are produced?



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

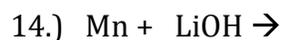
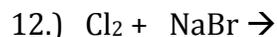
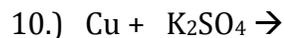
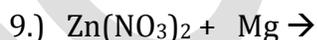
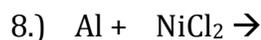


(A) How many molecules of water would be needed to react completely with 34.2 grams of calcium?



(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?



UNIT 9 - STOICHIOMETRY

Stoichiometry Problems 1 wksht.

- 1.) 1.34 moles O₂ 2.) 8.02 g Al 3.) 0.980 g O₂ 4.) 6.0 moles O₂ 5.) 22 g 6.) 64 g O₂ 7.) 48 g O₂ 8.)
0.50 moles Al₂O₃ 9.) 1.94 g Na₂O 10.) 5.16 g H₂O 11.) 142.1 g Al₂(SO₄)₃ 12.) a) 183 g HCl b) 238 g MgCl₂;
5.00 g H₂ 13.) 1.16 x 10²⁷ mcs CO₂

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.

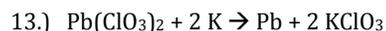
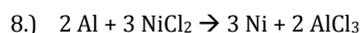
1. (A) H₂O, (B) 116 g, (C) 83.7 g; 2. (A) Zn, (B) 34.3 g, (C) 8.0 g;
3. (A) H₂O, (B) 0.172 moles of each, (C) 4.82 g CO, 0.347 g H₂; 4. (A) Al, (B) 88.9 g AlCl₃, 2.02 g H₂

More Practice Problems.

- 1.) (A) 3.00 moles CS₂ (B) 6.00 moles H₂S 2.) (A) 186.6 g PbO (B) 91.10 % 3.) 8.50 moles N₂
4.) 64.60 g N₂ 5.) 178 g Cl₂ 6.) 3.988 x 10²² mcs I₂ 7.) 66.6 g NH₃

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 10²⁴ molecules 7. (A) 26.8 g (B) 4.6 g remain



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 ₂ CO ₃	_____g
Mass of Na ₂ CO 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.



2. From your balanced equation, what is the mole ratio between Na₂CO₃ 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 Na₂CO₃ 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 Na₂CO₃ and NaCl?
Show your work here:
answer = 1 : _____

7. Starting with the mass of Na₂CO₃ 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?

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100 \quad \text{answer} = \underline{\hspace{2cm}} \times 100 =$$

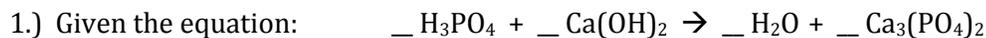
(Note: Theoretical yield is answer from #7. Actual yield is the last line of your data table.)

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



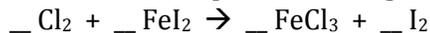
If 1.67 moles of $\text{Ca}(\text{OH})_2$ completely react with excess H_3PO_4

(A) How many moles of H_3PO_4 are needed to react with the $\text{Ca}(\text{OH})_2$?

(B) How many moles of H_2O can be produced?

(C) How many moles of $\text{Ca}_3(\text{PO}_4)_2$ can be produced?

2.) How many moles of chlorine are needed to produce 35.2 grams of FeCl_3 according to this equation?



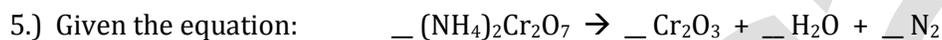
3.) How many grams of calcium carbide are needed to completely react with 2.942 moles of water?



4.) How many grams of CuI can be produced from the complete reaction of 4.397 moles of KI ?



(Balancing hint: get an even number of Is on the product side first)



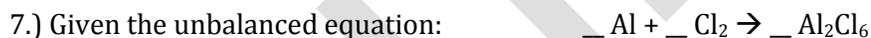
Answer these questions using the equation above:

(A) What type of reaction is represented?

(B) How many moles of water are produced by the complete decomposition of 28 grams of $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$?

(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?



(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?



(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?