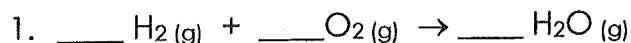
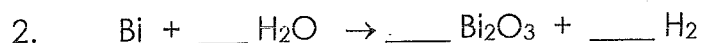


Balance the equations and then determine the number of moles of each chemical.



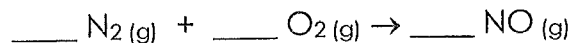
# moles of H ₂	# moles of O ₂	# moles of H ₂ O
5.0 mol		
	13.0 mol	
		1.10 mol



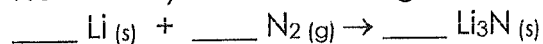
# moles Bi	# moles H ₂ O	# moles Bi ₂ O ₃	# moles H ₂
		6.00 mol	
	0.50 mol		
4.0 mol			

3. Nitrogen in the cylinder of a car reacts with oxygen to produce the pollutant, nitrogen monoxide.

How many moles of nitrogen monoxide are produced from the combustion of 1.52 moles of nitrogen.



4. Lithium metal reacts with nitrogen gas in the air to produce a black solid. How many moles of nitrogen are required to react with 1.83 moles of lithium?



5. Ammonium hydroxide and iron (III) nitrate go through a double replacement reaction. Determine the number of moles of ammonium hydroxide required to produce 0.13 moles of iron (III) hydroxide (product).

STEPS: A. WRITE AND BALANCE THE EQUATION IF IT IS NOT DONE FOR YOU
B. USE THE MOLAR RATIO TO ANSWER THE QUESTION.

- 1) How many moles of hydrogen are needed to completely react with 2.0 moles of nitrogen?
$$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$$
- 2) How many moles of oxygen are produced by the decomposition of 6.0 moles of potassium chlorate?
$$2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$$
- 3) How many moles of hydrogen are produced from the reaction of 3.0 moles of zinc with an excess of hydrochloric acid? (hint: single replacement reaction)
- 4) How many moles of oxygen are necessary to react completely with 4.2 moles of propane (C_3H_8)? (hint: combustion reaction)
- 5) How many moles of potassium nitrate are produced when 2.4 moles of potassium phosphate react with aluminum nitrate? (hint: double replacement)
- 6) How many moles of hydrogen gas are required to react with excess nitrogen to prepare 0.602 moles of ammonia?
- 7) How many moles of ammonium chloride are required for an exact reaction with 420 mol of calcium hydroxide? (hint: double replacement)

4.12 Mass To Moles Or Moles To Mass Calculations

Remember to:

- Write and balance the chemical equation
- Use the molar ratio to determine quantities
- Calculate mass from moles (if necessary)

- In the production of water, hydrogen gas is united with oxygen gas.
 - Calculate the mass of water that could be produced if 14.2 moles of oxygen were used?
 - Calculate the mass of hydrogen that would be needed if 0.4555 mol of oxygen were used?
- Magnesium and oxygen produce magnesium oxide. What mass of magnesium is needed to react with 7.89 moles of oxygen?
- What mass of water is produced when 2.55 moles of aluminum hydroxide and sufficient hydrochloric acid are mixed? (acid-base neutralization)
- How many moles of carbon dioxide are produced if 122.4 g of pentane (C_5H_{12}) undergoes combustion?
- In the double replacement reaction 123.4 g of $Pb(NO_3)_2$ are mixed with potassium iodide. How many moles of potassium iodide would be needed?
- Aluminum and chlorine react to produce aluminum chloride. What mass of aluminum chloride is produced when 256.9 g of aluminum are reacted with a sufficient amount of chlorine?

4.13 Mass to Mole Calculations

Fill in the missing boxes. Show all work!

Steps: 1. Determine the formula or the name of the substance (whichever is missing)

2. Calculate the molar mass.

3. Calculate the mass or the number of moles. Show work.

formula	Name of substance	Molar mass	Mass (show work)	# of Moles (show work)
$C_{12}H_{22}O_{11}$	Sucrose	342.2 g/mol	1000.0 g (given)	answer 2.921 mol
NaOH	_____ (Lye)			0.641 mol
_____	Ammonium phosphate (Fertilizer)		10.0 kg	
$CO_2 (s)$	_____ (Dry ice)			5.00 mol
KCl	_____ (Potash)		149.2 g	
_____	Aluminum oxide (used to make bricks)			1.20 mol
_____	Sodium bisulfate (Sani-flush)		60.10 g	
$Mg(OH)_2$	_____ (Milk of magnesia)			0.42 mol

4.14 Solution Stoichiometry

Chemistry 11 – Mrs. Dildy

1. How many moles of calcium nitrate are needed to react with 50.0 mL of 2.25 M potassium hydroxide to produce calcium hydroxide and potassium nitrate.
2. Iron is reacted with 25.0 ml of 2.25 M hydrochloric acid to produce aqueous iron (III) chloride and hydrogen gas. How many moles of hydrogen gas are produced in this reaction?
3. 125.0 ml of 0.755 M nitric acid is reacted with solid copper to produce copper (II) nitrate, nitrogen dioxide and water. How many moles of nitrogen dioxide are produced in this reaction?
4. An excess of chlorine gas and 250.0 mL of 3.25 M sodium bromide react to form liquid bromine and aqueous sodium chloride. How many moles of bromine would be produced in this reaction?
5. How many moles of carbon dioxide gas would be produced in the reaction between 35.5 mL of 5.75 M sulfuric acid and excess solid sodium hydrogen carbonate to produce aqueous sodium sulfate, carbon dioxide gas and water.

6. 85.0 mL of 4.25 M hydrochloric acid is neutralized with sufficient calcium hydroxide. How many moles of calcium chloride would be produced in this reaction?

7. How many grams of lead (II) carbonate are produced in the reaction between 200.0 mL of 1.25 M sodium carbonate and sufficient lead (II) nitrate.

8. 45.0 mL of 0.125 M silver nitrate is reacted with sufficient sodium sulfide to produce silver sulfide and sodium nitrate. How many grams of silver sulfide are produced in this reaction?

9. In a chemical analysis, a 10.0 mL sample of hydrochloric acid was neutralized with 18.2 mL of 0.259 M NaOH. Calculate the concentration of the hydrochloric acid.

10. What is the concentration of a potassium hydroxide solution if 12.8 mL of this solution is required to react with 25.0 mL of 0.110 M sulfuric acid to produce water and potassium sulfate?

A. Percent Yield

1. 1.00 mole of Ca and 1.00 mole of Cl_2 were present as reactants. Only 106 g of CaCl_2 is produced. What is the percent yield?

Equation: _____

2. 0.60 mole of N_2 and 1.80 mole of H_2 were present as reactants. Only 14.5 g of NH_3 are produced. What is the percent yield?

Equation: _____

B. Limiting Reactants

Limiting Reactant:

Excess Reactant:

3. 8.51 g hydrogen gas and 9.25 grams of oxygen gas produce water.

Equation: _____

Find: The limiting reactant _____
Amount by which the other is in excess _____

H_2	O_2

4. 0.143 g of K and 0.235 g Cl_2 produce KCl.

Equation: _____

Find: The limiting reactant _____

Amount by which the other is in excess _____

K	Cl_2

5. 7.45 g of N_2 and 4.20 g O_2 produce dinitrogen monoxide.

Equation: _____

Find: The limiting reactant _____

Amount by which the other is in excess _____

N_2	O_2

6. 2.00 moles KI are mixed with 3.00 moles $\text{Pb}(\text{NO}_3)_2$ in a double replacement reaction.

Equation: _____

Find: The limiting reactant _____

Amount by which the other is in excess _____

KI	$\text{Pb}(\text{NO}_3)_2$

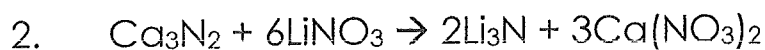
4.16 Limiting Reagent Stoichiometry Problems

Chemistry 11 – Mrs. Dildy



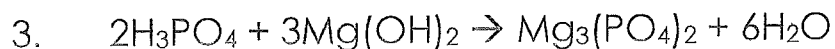
a) If 5.39 moles of BaCl_2 is reacted with 1.89 moles of $\text{Al}_2(\text{CO}_3)_3$, which one is the limiting reagent and which compound is in excess?

b) How many moles of AlCl_3 are expected from the reaction?



a) When 1.89 moles of LiNO_3 are reacted with 0.444 mole Ca_3N_2 , which compound is in excess?

b) How many moles of Li_3N are expected when 7.9 moles LiNO_3 and 1.45 moles Ca_3N_2 are reacted?



a) Which compound is the limiting reagent if 4.11 moles of phosphoric acid are reacted with 7.58 moles magnesium hydroxide?

b) What is the theoretical yield of water? (i.e. how many grams water are produced?)

4. 3.54 mole phosphorus and 6.91 mole oxygen are reacted to give diphosphorus hexaoxide.

a) Write the balanced equation

b) How many moles of diphosphorus hexaoxide will be produced? (hint: find limiting reagent)

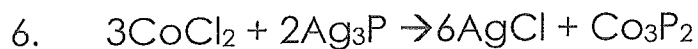


15.44 g of Cr and 80.5 g O_2 are reacted to produce CrO_3 .

a) Which compound is the limiting reagent and which one is in excess?

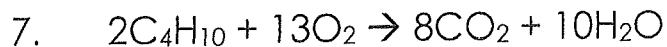
b) How many moles of CrO_3 are expected? How many grams?

c) What is the percent yield if only 14.6 g of CrO_3 is recovered?



a) 9.45 g of CoCl_2 is present with 13.45 g of Ag_3P . Which is the limiting reagent?

b) How many grams of silver chloride are expected from this reaction?



How many moles of water will be produced when 40.0 g of C_4H_{10} are combusted with 2000.0 g of oxygen?

Chemical Reactions, Energy, and Stoichiometry Unit Review

1. Classifying Chemical Equations

Complete and Balance the following equations

Classify the reactions as: synthesis, decomposition, single replacement, double replacement, acid-base neutralization, or combustion

- _____ $\text{KClO}_3 \rightarrow$ _____ $\text{KCl} +$ _____ O_2 _____
- _____ $(\text{NH}_4)_2\text{SO}_4 +$ _____ $\text{Ba}(\text{NO}_3)_2 \rightarrow$ _____ $\text{BaSO}_4 +$ _____ NH_4NO_3 _____
- _____ $\text{Mg} +$ _____ $\text{HCl} \rightarrow$ _____ $\text{MgCl}_2 +$ _____ H_2 _____
- _____ $\text{H}_2 +$ _____ $\text{O}_2 \rightarrow$ _____ H_2O _____
- _____ $\text{Al} +$ _____ $\text{NiBr}_2 \rightarrow$ _____ $\text{AlBr}_3 +$ _____ Ni _____
- _____ $\text{Al} +$ _____ $\text{O}_2 \rightarrow$ _____ Al_2O_3 _____
- _____ $\text{NaCl} \rightarrow$ _____ $\text{Na} +$ _____ Cl_2 _____
- _____ $\text{N}_2 +$ _____ $\text{H}_2 \rightarrow$ _____ NH_3 _____
- _____ $\text{AgNO}_3 +$ _____ $\text{KCl} \rightarrow$ _____
- _____ $\text{C}_2\text{H}_6 +$ _____ $\text{O}_2 \rightarrow$ _____
- _____ $\text{CaCl}_2 +$ _____ $\text{F}_2 \rightarrow$ _____
- _____ $\text{Al}_2\text{O}_3 \rightarrow$ _____
- _____ $\text{HCl} +$ _____ $\text{NaOH} \rightarrow$ _____
- _____ $\text{KCl} +$ _____ $\text{Zn}_3(\text{PO}_4)_2 \rightarrow$ _____
- _____ $\text{Na} +$ _____ $\text{I}_2 \rightarrow$ _____

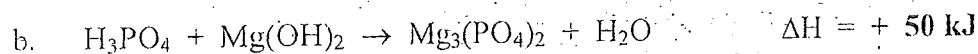
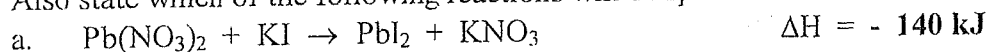
2. Writing Chemical Equations

Complete and Balance the following equations, including showing states.

1. An aqueous solution of copper(II) sulphate reacts with aluminum metal to produce an aqueous solution of aluminum sulphate and copper metal.
2. Aqueous ammonium chloride solution reacts with aqueous lead(II) nitrate solution to produce solid lead(II) chloride and one other aqueous product.
3. Liquid gasoline (C_6H_{14}) undergoes combustion in air, releasing 100 kJ of heat and producing two gaseous products. Include an energy term in the reaction.

3. Energy

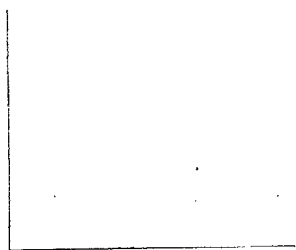
1. Rewrite and balance the following equations with the energy term in the equation. Also state which of the following reactions will be spontaneous.



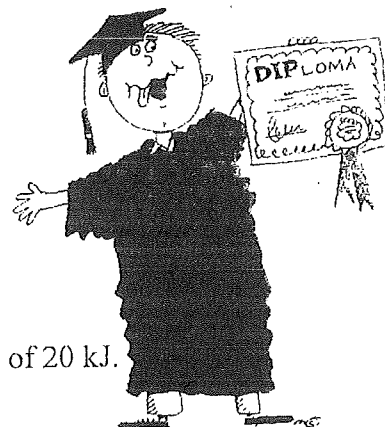
2. Consider the following reaction: $\text{A} \rightarrow \text{B}$ $\Delta H = - 50 \text{ kJ}$

a. Re-write this equation to show the 50 kJ on the appropriate side.

b. Draw a PE graph of this reaction labeling the ΔH and activation energy of 20 kJ.

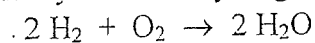


c. Will the surroundings feel warmer or cooler as the reaction occurs?



4. Stoichiometry

1. How many moles of hydrogen are required to react with 2.5 moles of oxygen to produce water?



2. How many moles of hydrochloric acid, HCl, will be required to produce 0.40 moles of hydrogen gas by reaction with zinc? The equation is: $\text{Zn} + 2 \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$

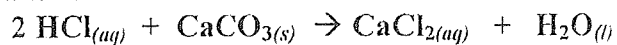
3. Hydrogen and nitrogen react to form ammonia (NH_3). How many moles of hydrogen will be required to produce 1.70 moles of ammonia, NH_3 ?
4. Consider the acid-base neutralization reaction between HCl and NaOH . How many moles of HCl are required to completely neutralize 30.0 mL of 0.318 M NaOH ?
5. Carbon and oxygen react to produce carbon dioxide. How many grams of carbon will react with 0.25 moles of oxygen in this reaction?
6. How many liters of oxygen can be produced at STP when 15.6 g of sulphur trioxide, SO_3 are decomposed into sulphur (S) and oxygen gas?



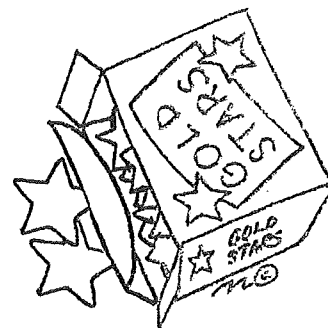
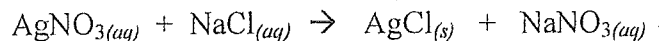
7. Chlorine gas and solid carbon react to form carbon tetra chloride. How many grams of chlorine are required to produce 355 g of carbon tetrachloride by reaction with carbon?

8. A tablet of Tums ($\text{CaCO}_3(s)$) has a mass of 0.750 g. The concentration of $\text{HCl}_{(aq)}$ in the stomach is about 0.25 M. What volume of stomach acid can a Tums tablet neutralize?

The equation for the reaction is:

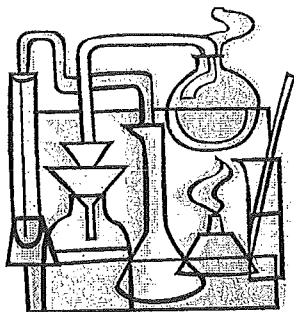


9. A solution containing 0.128 mol AgNO_3 is mixed with a solution containing an excess of aqueous sodium chloride. It is found that 17.8 g of $\text{AgCl}_{(s)}$ is formed. Calculate the **percent yield** of silver chloride. The chemical reaction is as follows:



10. When 5.44 g of copper are reacted with an excess of oxygen, 5.10 g of copper (II) oxide (CuO) are formed. Calculate the **percent yield** of copper (II) oxide.

11. Assume that 12.0 g of oxygen are reacted with 20.0 g of magnesium to produce magnesium oxide, MgO . Determine which **reactant is in excess** and **by what amount**, and **calculate the number of grams of product** formed.



12. If 13.1 g of potassium are reacted with 18.0 g of oxygen to produce potassium oxide, K_2O , determine **which reactant is in excess** and **by what amount** (in moles), and **calculate the number of grams of products** formed.

13. A solution of silver nitrate reacts with aluminum to produce silver and one other product. The 0.400 mol/L silver nitrate solution has a volume of 8.0 L. The mass of aluminum placed in the solution is 50.0 g.

- Calculate the theoretical yield of silver.
- If 305 g of silver is actually produced, calculate the % yield of silver.

