Welcome to 2nd Semester Chemistry!!! Now let's review Stoichiometry!!!

Hudecek, 2010.

Directions: All problems require a balanced chemical equation. As always, you must show all calculations with proper units in order to earn credit for your assignment.

A. *Basic Stoichiometry and Percent Yield*

1. Iron metal reacts with an aqueous solution of copper(II) sulfate by single replacement to produce iron(III) sulfate.
   a. What mass of copper is produced from 4.50 moles of iron?
   b. How many moles of iron(III) sulfate are formed from 3.75 grams of iron?
   c. What is the percent yield if 9.10 grams of copper metal are recovered from 25.0 grams of copper(II) sulfate?

2. a. Write the chemical equation for the combustion of butane (C_4H_{10}).
   b. How many moles of oxygen would be needed to react with 3.50 kilograms of butane?
   c. How many grams of oxygen would be needed to produce 350.0 milligrams of carbon dioxide gas?
   d. What volume of carbon dioxide gas, in liters at STP, would be produced from the complete combustion of 85.0 grams of butane? (density of CO_2 at STP = 1.997 g/L)

3. Iron is generally produced from iron ore through a reaction in a blast furnace where iron(III) oxide reacts with carbon monoxide to produce iron metal and carbon dioxide.
   a. What mass of carbon monoxide is needed to completely react with 5.875 kilograms of iron(III) oxide?
   b. What mass of iron can be produced from 78.85 grams of iron(III) oxide if a 92.0% yield is expected?
   c. What is the percent yield if 27.2 grams of iron are collected from 42.0 grams of the oxide?

4. Aqueous solutions of aluminum chloride and ammonium carbonate react by double replacement to produce a precipitate of aluminum carbonate.
   a. How many moles of aluminum chloride are needed to react with 6.50 moles of ammonium carbonate?
   b. How many moles of ammonium chloride are produced from the reaction of a solution containing 73.25 grams of ammonium carbonate?
   c. What mass of precipitate can be collected from a solution that contains 23.55 grams of aluminum chloride if the percent yield is expected to be 95.2%?

5. In the commercial production of the element arsenic, arsenic(III) oxide is heated with carbon, producing carbon dioxide and arsenic.
   a. What is the percent yield if 5.33 grams of arsenic are produced from 8.87 grams of arsenic(III) oxide?
   b. What mass of arsenic is recovered from 125.0 kilograms of arsenic(III) oxide if the percent yield is 92.50%?

6. A solution with 0.250 kg of aqueous potassium carbonate reacts with a solution containing an excess quantity of iron(III) chloride to produce a precipitate of iron(III) carbonate.
   a. How many moles of iron(III) chloride are theoretically used up in this reaction?
   b. What is the percent yield if 158.2 grams of precipitate are collected?

B. Limiting Reactants

7. 4.50 moles of aluminum hydroxide are allowed to react with 7.00 moles of sulfuric acid.
   a. Determine the limiting reactant showing a calculation of proof.
   b. How many moles of aluminum sulfate should theoretically form?
   c. How many moles of the excess reactant remain after the reaction is complete?

8. 45.0 grams of hexane (C_6H_{14}) react by combustion in the presence of 115.0 grams of oxygen gas.
   a. Determine the limiting reactant showing a calculation of proof.
   b. Calculate the mass of excess reactant.
   c. How many moles of carbon dioxide are theoretically produced?
   d. How many grams of water vapor are theoretically produced?

9. How many grams of aluminum oxide would theoretically be produced when 15.0 grams of aluminum metal is allowed to react with 10.0 grams of oxygen gas?

10. One of the steps in the commercial production of nitric acid involves reacting ammonia gas with oxygen gas to produce nitrogen monoxide and water.
   a. Which reactant is limiting if 1.50 grams of ammonia are allowed to react with 2.75 grams of oxygen gas?
   b. How many grams of nitrogen monoxide and water form?
   c. How many grams of the excess reactant remains?

11. A mixture of 50.0 grams of acetylene (C_2H_2) and 175.0 grams of oxygen is ignited in a welding torch.
   a. Identify the limiting reactant and show a calculation of proof.
   b. How many grams of acetylene, oxygen, carbon dioxide, and water are present after the reaction is complete?

12. 45.0 grams of magnesium metal reacts with a solution containing 150.0 grams of aluminum nitrate through single replacement.
   a. Write out the balanced chemical equation for this reaction and determine the limiting reactant, showing a calculation of proof.
   b. What mass of excess reactant is left over?
   c. Calculate the mass of aluminum metal expected if the percent yield is 89.5%.

13. A reaction between hydrazine, N_2H_4, and dinitrogen tetroxide, has been used to launch rockets into space. The reaction produces nitrogen gas and water vapor.
   a. Identify the excess reactant and calculate the mass of it that remains from the reaction of 500. grams of both hydrazine and dinitrogen tetroxide.
   b. If 6.25×10^6 kg hydrazine and 9.75×10^6 kg dinitrogen tetroxide are allowed to react, what volume of nitrogen gas at STP would form (density N_2 @ STP = 1.25 g/L)

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1.	a.	429 g Cu		7.	a.	$Al(OH)_3$ is limiting
	b.	0.0336 mol $Fe_2(SO_4)_3$			b.	2.25 mol $Al_2(SO_4)_3$
	c.	91.5%			c.	0.25 mol H_2SO_4 excess
2.	b.	391 mol O_2		8.	a.	O_2 is limiting
	c.	0.414 g O_2			b.	12.4 g C_6H_{14} excess
	d.	129 L CO_2			c.	2.270 mol CO_2
					d.	47.72 g H_2O (g)
3.	a.	3091 g CO				
	b.	50.74 g Fe		9.		21.2 g Al_2O_3
	c.	92.5%				
				10.	a.	O_2 is limiting
4.	a.	4.33 mol $AlCl_3$			b.	2.06 g NO, 1.86 g H_2O
	b.	1.524 mol NH_4Cl			c.	0.33 g NH_3 excess
	c.	19.7 g $Al_2(CO_3)_3$				
				11.	a.	C_2H_2 is limiting
5.	a.	79.3%			b.	no C_2H_2 left, 21 g O_2
	b.	87.57 kg As				169 g CO_2, 34.6 g H_2O
				12.	a.	$Al(NO_3)_3$ is limiting
6.	a.	1.21 mol $FeCl_3$			b.	19.3 g Mg excess
	b.	90.4%			c.	17.0 g Al
				13.	a.	152 g N_2H_4 excess
					b.	6.55×10^9 L N_2 @ STP