Worksheet #14

Limiting Reagents

1. Potassium superoxide, KO_2, is used in rebreathing masks to generate oxygen according to the reaction below. If the mask contains 0.150 mol KO_2 and 0.100 mol water, how many moles of oxygen can be produced? What is the limiting reagent?

$$4KO_2(s) + 2H_2O(\ell) \rightarrow 4KOH(s) + 3O_2(g)$$

2. Suppose 13.7 g of C_2H_2 reacts with 18.5 g O_2 according to the reaction below. What is the mass of CO_2 produced? What is the limiting reagent?

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(\ell)$$

3. Nitrogen gas can react with hydrogen gas to form gaseous ammonia. If 4.7 g of nitrogen reacts with 9.8 g of hydrogen, how much ammonia is formed? What is the limiting reagent?

4. One of the most common acids found in acid rain is sulfuric acid. Sulfuric acid is formed when gaseous sulfur dioxide reacts with ozone (O_3) in the atmosphere to form gaseous sulfur trioxide and oxygen. The sulfur trioxide forms sulfuric acid when it comes in contact with water. If 5.13 g of sulfur dioxide reacts with 6.18 g of ozone, how much sulfur trioxide is formed? What is the limiting reagent?

5. Another way that sulfuric acid is formed in the atmosphere is when sulfur dioxide reacts with oxygen in a reaction catalyzed by dust in the atmosphere to form sulfur trioxide. If 7.99 g of sulfur dioxide reacts with 2.18 g of oxygen, how much sulfur trioxide can form? What is the limiting reagent?

Determining Excess Reactants

6. In the reaction in problem #5 above, how much of the excess reactant remains after all of the limiting reactant has reacted?

7. Heating together the solids NH_4Cl and $Ca(OH)_2$ can generate ammonia. Aqueous $CaCl_2$ and liquid H_2O are also formed. If a mixture of 33.0 g each of NH_4Cl and $Ca(OH)_2$ is heated, how many grams of NH_3 will form? What is the limiting reagent? Which reactant remains in excess, and in what mass?

8. Nitrogen monoxide is formed primarily in car engines, and it can react with oxygen to form gaseous nitrogen dioxide. Nitrogen dioxide forms nitric acid when it comes in contact with water, another component of acid rain. If 3.13 g of nitrogen monoxide reacts with 4.16 g of oxygen, how much nitrogen dioxide will form? What is the limiting reagent? Which reactant remains in excess, and in what mass?

Percent Yield

9. Liquid nitroglycerine ($C_3H_5(NO_3)_3$) is a powerful explosive. When it detonates, it produces a gaseous mixture of nitrogen, water, carbon dioxide, and oxygen. What is the theoretical yield of nitrogen 5.55 g of nitroglycerine explodes? If the actual amount of nitrogen obtained is 0.991 g, what is the percent yield of nitrogen?

10. Solid copper(I) oxide reacts with oxygen to form copper(II) oxide. If 4.18 g of copper(I) oxide reacts with 5.77 g of oxygen, what is the theoretical yield of copper(II) oxide? If the actual amount of copper(II) oxide obtained is 4.28 g, what is the percent yield?

11. What is the percent yield of a reaction in which 41.5 g of solid tungsten(VI) oxide reacts with excess hydrogen to produce metallic tungsten and 9.50 mL of water? The density of water is 1.00 g/mL

12. What is the percent yield of a reaction in which 201 g of solid phosphorous trichloride reacts with excess water to form 128 g of aqueous hydrogen chloride and aqueous phosphorous acid, H_3PO_3?

13. When 18.5 g of gaseous methane and 43.0 g of chlorine gas undergo a reaction that has an 80.0% yield, what mass of liquid chloromethane, CH_3Cl, forms? Gaseous hydrogen chloride also forms.

14. When 56.6 g of calcium and 30.5 g of nitrogen undergo a reaction that has a 93.0% yield, what mass of solid calcium nitride forms?

15. How many moles of MnCl can be produced by the reaction of 5.0 mol $KMnO_4$, 3.0 mol $H_2C_2O_4$, and 22 mol HCl?

$$2KMnO_4 + 5H_2C_2O_4 + 6HCl = 2MnCl_2 + 10\ CO_2 + 2KCl + 8H_2O$$

16. How many grams of Fe are produced by reacting 2.00 kg Al with 300 g Fe_2O_3?

$$Fe_2O_3 + 2Al = Al_2O_3 + 2Fe$$

17. How many grams of which reactant are left over in Problem 16?

18. Gaseous H_2S dissociates into H_2 and S gases at very high temperatures: $H_2S = H_2 + S$. When 0.620 g of H_2S was held at 2000° C, it was found that 13 mg of H_2 were produced. What is the percent yield?

19. The first step in the Ostwald process for manufacturing nitric acid is the reaction of ammonia, NH_3, with oxygen, O_2, to produce nitric oxide, NO, and water. The reaction consumes 595 g of ammonia. How many grams of water are produced? Write the balanced equation.

20. Sodium reacts violently with water to produce hydrogen and sodium hydroxide. How many grams of hydrogen are produced by the reaction of 400 mg of sodium with water?