Practice Problems:

Fe^{+3} O^{-2}

1. Carbon monoxide reacts with iron (III) oxide to produce solid iron and carbon dioxide.

   a. Write and balance the chemical equation describing the reaction.

$$3CO + Fe_2O_3 \rightarrow 2Fe + 3CO_2$$

   b. How many grams of iron will be produced from 343.1 g of iron (III) oxide?

$$343.1\text{ g } Fe_2O_3 \times \frac{1\text{ mol } Fe_2O_3}{160\text{ g } Fe_2O_3} \times \frac{2\text{ mol Fe}}{1\text{ mol } Fe_2O_3} \times \frac{56\text{ g Fe}}{1\text{ mol Fe}} = 240.2\text{ g Fe}$$

   c. How many liters of carbon dioxide will be formed (at STP) when 286.9 g of iron (III) oxide reacts with an excess amount of carbon monoxide?

$$286.9\text{ g } Fe_2O_3 \times \frac{1\text{ mol } Fe_2O_3}{160\text{ g } Fe_2O_3} \times \frac{3\text{ mol } CO_2}{1\text{ mol } Fe_2O_3} \times \frac{22.4\text{ L } CO_2}{1\text{ mol } CO_2} = 120.5\text{ L}$$

   d. If only 115 L of CO_2 are collected from the reaction above (c), what is the percent yield?

$$\frac{115\text{ L}}{120.7\text{ L}} \times 100 = 95.28\%$$

   e. How much iron will be produced from the reaction of 15.0 g of iron (III) oxide and 10.0 L of carbon monoxide (at STP)?

$$15.0\text{ g } Fe_2O_3 \times \frac{1\text{ mol } Fe_2O_3}{159.7\text{ g}} \times \frac{2\text{ mol Fe}}{1\text{ mol } Fe_2O_3} \times \frac{55\text{ g Fe}}{1\text{ mol Fe}} = 10.3\text{ g Fe}$$

$$10.0\text{ L CO} \times \frac{1\text{ mol CO}}{22.4\text{ L}} \times \frac{2\text{ mol Fe}}{3\text{ mol CO}} \times \frac{55\text{ g Fe}}{1\text{ mol Fe}} = 16.4\text{ g Fe}$$

   f. Based on (e) above, what is the limiting reactant? What reactant is present in excess?

Fe_2O_3 LR CO - excess

2. 1 $CaO(s)$ + 1 $H_2O(l)$ → 1 $Ca(OH)_2(aq)$

How many grams of calcium hydroxide will be formed in this reaction when 4.44 g of calcium oxide and 7.77 g of water are available to react? Also identify the limiting and excess reactants.

$$4.44\text{ g CaO} \times \frac{1\text{ mol CaO}}{56.08\text{ g CaO}} \times \frac{1\text{ mol Ca(OH)}_2}{1\text{ mol CaO}} \times \frac{74.08\text{ g Ca(OH)}_2}{1\text{ mol Ca(OH)}_2} = \boxed{5.87\text{ g Ca(OH)}_2}$$

$$7.77\text{ g H}_2\text{O} \times \frac{1\text{ mol H}_2\text{O}}{18\text{ g H}_2\text{O}} \times \frac{1\text{ mol Ca(OH)}_2}{1\text{ mol H}_2\text{O}} \times \frac{74.08\text{ g Ca(OH)}_2}{1\text{ mol Ca(OH)}_2} = 31.9\text{ g Ca(OH)}_2$$

LR = CaO EXC = H_2O

7. Aspirin (acetalylsalicylic acid) and acetic acid byproduct ($C_2H_4O_2$) are prepared by heating salicylic acid, $C_7H_6O_3$, with acetic anhydride, $C_4H_6O_3$.

$$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + C_2H_4O_2$$

a) What is the limiting reagent when 2.00 g of salicylic acid is heated with 4.00 g of acetic anhydride?

$$2.00\text{g } C_7H_6O_3 \times \frac{1\text{mol } C_7H_6O_3}{138.07\text{g } C_7H_6O_3} \times \frac{1\text{mol } C_9H_8O_4}{1\text{mol } C_7H_6O_3} \times \frac{180.09\text{g}}{1\text{mol } C_9H_8O_4} = 2.60\text{g } C_9H_8O_4$$

$$4.00\text{g } C_4H_6O_3 \times \frac{1\text{mol } C_4H_6O_3}{102.04\text{g } C_4H_6O_3} \times \frac{1\text{mol } C_9H_8O_4}{1\text{mol } C_4H_6O_3} \times \frac{180.09\text{g}}{1\text{mol } C_9H_8O_4} = 7.06\text{g } C_9H_8O_4$$

LR = $C_7H_6O_3$

b) What is the theoretical yield (in grams) of aspirin, $C_9H_8O_4$?

2.60g $C_9H_8O_4$

c) If the actual yield of aspirin is 2.10 g, what is the percentage yield?

$$\frac{2.10\text{g}}{2.60\text{g}} \times 100 = 80.8\%$$

4) Balance this equation and state which type of reaction is taking place:

$$1\ Mg + 2\ HNO_3 \rightarrow 1\ Mg(NO_3)_2 + 1\ H_2$$

Type of reaction: SR

5) If I start this reaction with 40 grams of magnesium and an excess of nitric acid, how many grams of hydrogen gas will I produce?

$$40\text{g Mg} \times \frac{1\text{ mol Mg}}{24.3\text{g}} \times \frac{1\text{ mol } H_2}{1\text{ mol Mg}} \times \frac{2\text{ g } H_2}{1\text{ mol } H_2} = 3.3 \rightarrow \boxed{3\text{g } H_2}$$

6) If 1.7 grams of hydrogen is actually produced, what was my percent yield of hydrogen?

$$\frac{1.7}{3.3} \times 100 = \boxed{51.25\%}$$