Limiting Reagent - This is the reactant which controls the extent of the reaction. It will be based on the mass of the reactants present, and on the stoichiometry of the reaction.

4. If **6.80 g** of **PH_3** and **6.80 g** of **O_2** are combined according to the (unbalanced) reaction shown below,

$\underline{4}\ PH_3 + \underline{8}\ O_2 \rightarrow \underline{\ }\ P_4O_{10} + \underline{6}\ H_2O$

If you complete a-h below, you will have answered the following three questions.
Which is the limiting reagent? O_2
How many grams of the excess reagent will remain unreacted?
How many grams of P_4O_{10} will be formed?
a. Balance the equation. Use this to answer the following questions.

b. Determine the number of moles of each reactant present.

c. Pick either reactant and, based on the stoichiometry, determine how much of the second reactant would be required to react with it.

d. Decide which reactant is the limiting reagent.

e. How many **moles** of the non-limiting reactant will be consumed?

f. How many **moles** and **grams** of the non-limiting reactant will remain?

g. How many **grams** of **P_4O_{10}** will be formed?

h. When the experiment is carried out, only **6.58 g** of **P_4O_{10}** are formed. What is the **percent yield?** (actual yield / theoretical yield)

h. $\frac{6.58\text{g } P_4O_{10}}{7.55\text{g } P_4O_{10}} \times 100 = \boxed{87.2\%}$

g. $0.213\text{mol } O_2 \times \frac{1\text{ mol } P_4O_{10}}{8\text{ mol } O_2} = 0.0266\text{ mol } P_4O_{10} \times 283.88 = \boxed{7.55\text{g } P_4O_{10}}$

b. $\frac{6.80\text{g } PH_3}{34.00\text{g/mol}} = 0.200\text{mol } PH_3$ $\quad \frac{6.80\text{g } O_2}{32.00\text{g/mol}} = 0.213\text{ mol } O_2$

c. $0.200\text{mol } PH_3 \times \frac{28\text{ mol } O_2}{14\text{ mol } PH_3} = 0.400\text{mol } O_2$ needed to use up all PH_3
Only 0.213 mol O_2 present

d. $\boxed{O_2 \text{ is L.R.}}$

e. $0.213\text{mol } O_2 \times \frac{14\text{ mol } PH_3}{28\text{ mol } O_2} = 0.107\text{mol } PH_3$ will react & be consumed

f. 0.200 mol PH_3 present − 0.107 mol PH_3 consumed =
.093 mol PH_3 in excess × 34.00 g/mol = 3.16 g PH_3 in excess

Balancing Reactions, Stoichiometry and Limiting Reagents

1. Write out the following reactions, and balance them.

a. Sodium sulfate reacts with carbon to form sodium sulfide and carbon dioxide.

$$Na_2SO_4 + 2C \rightarrow Na_2S + 2CO_2$$

b. Nitrogen dioxide reacts with water to form nitric acid and nitrogen monoxide.

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

2. Balance the following reactions:

a. __ Cl_2 (aq) + __ H_2O (l) → __ HCl (aq) + __ HOCl (aq)

b. __ PCl_3 (aq) + 3 H_2O (l) → __ H_3PO_3 (aq) + 3 HCl (aq)

c. 6 P_2H_4 (l) → 8 PH_3 (g) + __ P_4 (g)

3. Balance the reaction for the combustion of propane, C_3H_8 to answer the following questions.

__ C_3H_8 (g) + 5 O_2 (g) → 3 CO_2 (g) + 4 H_2O (l)

a. How many moles of oxygen (g) are required to react with one mole of propane?

$$1\,mol\,C_3H_8 \times \frac{5\,mol\,O_2}{1\,mol\,C_3H_8} = \boxed{5\,mol\,O_2}$$

b. How many moles of propane must be burned in order to produce **0.37 g** CO_2?

$$\frac{0.37\,g\,CO_2}{44.01\,g/mol} = 0.0084\,mol\,CO_2 \times \frac{1\,mol\,C_3H_8}{3\,mol\,CO_2} = \boxed{0.0028\,mol\,C_3H_8}$$

c. How many grams of propane is this?

$$0.0028\,mol\,C_3H_8 \times 44.11\,g/mol$$

$$\boxed{0.12\,g\,C_3H_8}$$