Limiting Reagent and Theoretical Yield

*The concept of a limiting reagent is really quite a simple one. As the reaction is being carried out, each reactant is being consumed. The reaction will end as soon as one of the reactant runs out.

*The reactant that runs out is called the limiting reagent.

*The amount of product that is produced is called the theoretical yield.

*Excess Reactant = All reactants which are not the limiting reactant are called excess reactants. They will not be fully consumed during the reaction.

*Actual Yield = The actual amount of a product which is produced.

*Percent Yield = (Actual Yield/Theoretical Yield) ´ 100

*Example
Consider the following reaction:

4NH₃(g) + 5O₂(g) \rightarrow 4NO(g) + 6H₂O

If we react 1.50 g of ammonia with 1.85 g of oxygen, what is the limiting reagent and the theoretical yield of NO? (MW NH₃ = 17.04 g/mol, MW O₂ = 32.00 g/mol, MW NO = 30.01 g/mol)

1.50 g NH₃ x (1 mol NH₃/17.04 g NH₃) x (4 mol NO/4 mol NH₃) x (30.01 g NO/1 mol NO) = 2.64 g NO

1.85 g O₂ x (1 mol O₂/32.00 g O₂) x (4 mol NO/5 mol NH₃) x (30.01 g NO/1 mol NO) = 1.39 g NO

The fact that 1.85 g of O₂ would produce less NO than 1.50 g of NH₃ means that the oxygen will run out first. Therefore, O₂ is the limiting reagent and the theoretical yield is 1.39 g of NO.

*Example
If the actual yield of the above reaction was 1.11 g, what would the percent yield be?

Percent Yield = (1.11 g/1.39 g) x 100 = 79.9%