Definitions:

- Amounts of products calculated from the complete reaction of the limiting reagent is called **theoretical yields.**
- The amount actually produced of a product is the **actual yield**.

$$Percent\ yield\ = \frac{Actual\ yield}{Theoretical\ yield} \times 100$$

- The reactant runs out first in a chemical reaction is called the *limiting reactant* or *limiting reagent*. The reaction stops after the limiting reagent runs out.

Example: Aluminum oxide was prepared by heating 225.0 g of chromium (II) oxide with 125.0 g of Al. If 100.0 g of aluminum oxide were obtained, calculate percent of yield.

1) Balance the chemical reaction:

$$2Al + 3CrO \xrightarrow{\Delta} Al_2O_3 + 3Cr$$

2) Determine the limiting reactants:

First for the Al reactant:

$$mol(Al) = \frac{125\ g}{27\ {}^{g}/_{mol}} = 4.63\ \text{mole}$$

$$4.63\ mol\ Al\ \times \frac{1\ mol\ of\ Al_2O_3}{2\ mol\ of\ Al} = 2.32\ \ mol\ \ of\ Al_2O_3$$

Second for the CrO reactant:

$$mol(CrO) = \frac{225\ g}{68\ {}^{g}/_{mol}} = 3.31\ \text{mole}$$

$$3.31\ mol\ CrO\ \times \frac{1\ mol\ of\ Al_2O_3}{3\ mol\ of\ CrO} = 1.10\ \ mol\ \ of\ Al_2O_3$$

3) Limiting reactants: Because CrO gives the less moles of product (1.10 mole of aluminum oxide), it is limiting reactant.

4) Convert the moles of the product by the limiting reactant to gram.

$$mole = \frac{mass}{molar\ mass}$$

$$mass = 1.10\ mol\ Al_2O_3 \times 102\ {}^{g}/_{mol} = 112.2\ g$$

5) Calculate percent of yield:

$$Percent\ yield\ = \frac{Actual\ yield}{Theoretical\ yield} \times 100$$

$$Percent\ yield\ of\ Al_2O_3 = \frac{100.0\ g}{112.2\ g} \times 100 = 89.1\%$$