Chemistry Lecture #61: Percent Yield

The mass-mass stoichiometric calculations we've done have all been *theoretical yields*. This is the amount of product you're supposed to get under perfect conditions. In real life, you never get the exact amount of product you expect; your actual yield always fall a little bit short. And if conditions are poor or you have bad lab technique, your actual yield of product can be well below the expected amount.

Percent yield is the percentage of the theoretical yield that actually occurs.

$$\text{Percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

Percent yield problems are just like stoichiometric problems with an extra step at the end. You find the grams of the unknown, which will be the theoretical yield. You then use this value in the percent yield formula to see if you got close to the ideal yield of product.

$N_2 + 3H_2 \rightarrow 2NH_3$

What is the percent yield if 5.50 g of H_2 react to form 20.4 g of NH_3?

In this problem, 5.50 g is the mass of known. The 20.4 g of NH_3 is the actual yield. We'll set this number aside and use it later. We first need to convert the 5.50 g of H_2 into grams of NH_3, and this will be the theoretical yield.

5.50 g known ? g unknown

$N_2 + 3H_2 \rightarrow 2NH_3$

Actual yield = 20.4 g NH_3

H_2 = 2.02 g/mole NH_3 = 17.0 g/mole

$$\frac{5.50 \text{ g } H_2}{1} \times \frac{\text{mole } H_2}{2.02 \text{ g } H_2} \times \frac{2 \text{ moles } NH_3}{3 \text{ moles } H_2} \times \frac{17.0 \text{ g } NH_3}{\text{mole } NH_3}$$

= 30.9 g NH_3 theoretical yield

$$\text{Percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

$$= \frac{20.4}{30.9} \times 100\% = 66.0\% \text{ yield}$$

This means that we only got 66.0 percent of what we should have gotten.

We can also use the formula introduced in lecture #59 to find the theoretical yield.

5.50 g known ? g unknown

$N_2 + 3H_2 \rightarrow 2NH_3$

Actual yield = 20.4 g NH_3

H_2 = 2.02 g/mole NH_3 = 17.0 g/mole

U_g = ? K_g = 5.50 g C_u = 2

M_u = 17.0 g/mole M_k = 2.02 g/mole C_k = 3

$$U_g = \frac{K_g C_u M_u}{M_k C_k} = \frac{(5.50)(2)(17.0)}{(2.02)(3)} = 30.9 \text{ g } NH_3 \text{ theoretical yield}$$

$$\text{Percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

$$= \frac{20.4}{30.9} \times 100\% = 66.0\% \text{ yield}$$

This means that we only got 66.0 percent of what we should have gotten.