

LIMITING REAGENTS, THEORETICAL , ACTUAL AND PERCENT YIELDS

A limiting reagent is a chemical *reactant* that limits the amount of product that is formed. The limiting reagent gives the smallest yield of product calculated from the reagents (reactants) available. This smallest yield of product is called the theoretical yield.

To find the limiting reagent and theoretical yield, carry out the following procedure:

1. Find the moles of each reactant present.
2. Calculate the moles of a product formed from each mole of reactant.
3. Identify the reactant giving the smaller number of moles of product. This reactant is the Limiting Reagent:
4. Calculate the grams of product produced by the Limiting Reagent. This is the theoretical yield.

THEORETICAL YIELD

The theoretical yield is the amount of the product in g formed from the limiting reagent. From the moles of limiting reagent available, calculate the grams of product that is theoretically possible (same as Step 4 above).

ACTUAL YIELD

The actual yield is the amount of the product in g actually formed in the laboratory.

PERCENT YIELD

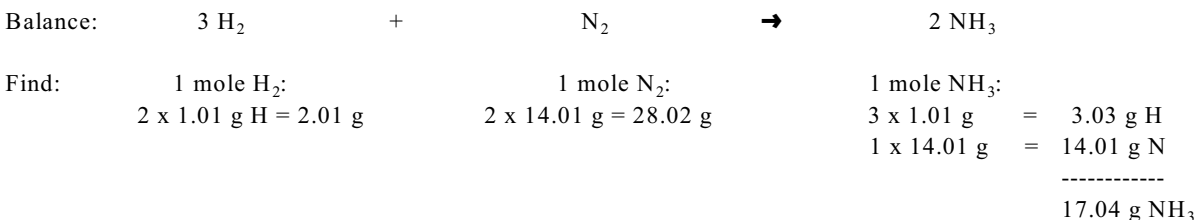
The percent yield is the percent of the product formed based upon the theoretical yield.

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

LIMITING REAGENTS, THEORETICAL , ACTUAL AND PERCENT YIELDS

EXAMPLE OF A LIMITING REAGENT PROBLEM

How many grams of NH₃ can be produced (theoretically) from the reaction of 5.0 g of N₂ and 5.0 g H₂? What is the limiting reagent? If 8.52 g are actually formed, what is the percent yield of NH₃?



To answer this type of question, carry out EACH step of the following procedure:

1. Find the g of product produced from each of the given amounts of reactants.

For H ₂ :	5.0 g H ₂	x	$\frac{1 \text{ mole H}_2}{2.02 \text{ g H}_2}$	x	$\frac{2 \text{ mole NH}_3}{3 \text{ mol H}_2}$	x	$\frac{17.04 \text{ g NH}_3}{1 \text{ mol NH}_3}$	=	28.12 g NH ₃
For N ₂ :	5.0 g N ₂	x	$\frac{1 \text{ mole N}_2}{140.01 \text{ g N}_2}$	x	$\frac{2 \text{ mole NH}_3}{1 \text{ mol N}_2}$	x	$\frac{17.04 \text{ g NH}_3}{1 \text{ mol NH}_3}$	=	12.16 g NH ₃ (carry 1 or 2 additional significant figures here)

2. Identify the smaller amount of calculated product:

This is the maximum amount of product that can be formed. The larger amount cannot be formed because there is not enough of the limiting reagent present.

12.16 g is the smaller amount calculated.

3. Identify the reactant that gives the smallest amount of product.
The limiting reagent determines the amount of product formed.

The limiting reagent is N₂.

4. Identify the **THEORETICAL YIELD**:

The theoretical yield is the amount of the product (in g) formed from the limiting reagent.

12 g is the theoretical yield

5. Identify the **ACTUAL YIELD**:

The actual yield is the amount of the product (in g or mol) actually formed in the laboratory.

8.25 g is the actual yield.

6. Calculate the **PERCENT YIELD**: The percent yield is based upon the theoretical yield.

actual yield (g)									
-----	x 100 %	=	Percent Yield	=	-----	x 100 %	=	68%	
theoretical yield (g					12.16 g				
calculation)					(For theoretical yield, carry more sig. figs. in this				

Final sig. figs. limited by the given amounts of reactants.