Limiting Reagent

In a chemical reaction, the reactant that will "run out" first is called the **limiting reagent**.
The other reactant is called the **excess reagent**.

$$2NH_3 + 3CuO \longrightarrow N_2 + 3Cu + 3H_2O$$

18.1 g 90.4 g

If NH_3 is L.R.:

$$18.1\text{g } NH_3 \times \frac{1\text{ mol } NH_3}{17.04\text{ g } NH_3} \times \frac{1\text{ mol } N_2}{2\text{ mol } NH_3} \times \frac{28.02\text{g } N_2}{1\text{ mol } N_2} = 14.88\text{g } N_2$$

If CuO is L.R.:

$$90.4\text{g CuO} \times \frac{1\text{ mol CuO}}{79.54\text{g CuO}} \times \frac{1\text{ mol } N_2}{3\text{ mol CuO}} \times \frac{28.02\text{g } N_2}{1\text{ mol } N_2} =$$

$10.62\text{g } N_2$

CuO is L.R.

How much NH_3 remains? ← XS

18.1 g (start) − 12.91 g (used) = 5.19 g (remaining)

$$90.4\text{g CuO} \times \frac{1\text{ mol CuO}}{79.54\text{g CuO}} \times \frac{2\text{ mol } NH_3}{3\text{ mol CuO}} \times \frac{17.04\text{g } NH_3}{1\text{ mol } NH_3} =$$

$12.91\text{g } NH_3$ used

Step 1: Moles Known

$$90.4\text{g CuO} \times \frac{1\text{ mol CuO}}{79.54\text{g CuO}} = \text{\_\_\_\_\_}$$

Step 2: Moles Unknown

$$\text{\_\_\_\_\_} \times \frac{2\text{ mol NH}_3}{3\text{ mol CuO}} = \text{\_\_\_\_\_}$$

Step 3: Mass Unknown

$$\text{\_\_\_\_\_} \times \frac{17.04\text{g NH}_3}{1\text{ mol NH}_3} =$$

Percent Reaction

Percent Reaction (percent yield) - is the amount of product measured at equilibrium compared with the maximum possible amount of product.

Equilibrium position
relative concentration of reactants and products at equilibrium
⇒0 % indicates no product formed
⇒100 % indicates the maximum possible product formed

- maximum amount of possible product is found using stoichiometry, assuming a forward reaction with no reverse reaction.

$$\% \text{ reaction} = \frac{\text{Experimental yield}}{\text{Theoretical yield (maximum)}} \times 100\ \%$$

eqm.

not @ eqm.

Classifying Chemical Equilibria

< 50 % - reactants favored
> 50 % - products favored
> 99 % - quantitative

The equilibrium position of the reaction is indicated in the following manner :

$$\text{Ex.} H_{2(g)} + I_{2(g)} \overset{78\%}{<==>} 2HI_{(g)} \qquad t = 448^{o}$$

Indicates that 78 % of the total amount of HI possible is produced at 448°C. Therefore this is a **product** favored reaction.

SAMPLE PROBLEM : % REACTION

Find the % reaction and write the expression if 6.90 g of $H_{2(g)}$ and 32.0 g of $O_{2(g)}$ react to form 25.75 g of ice at - 70 C°.

$$2H_{2(g)} + O_{2(g)} \overset{71.4\%}{\rightleftharpoons} 2H_2O_{(s)}$$

	$2H_{2(g)}$	$+ O_{2(g)}$	$\rightleftharpoons 2H_2O_{(s)}$
init.	6.90g	32.0g	—
eqm.			25.75g

$$\%rxn = \frac{exp.}{theor.} \times 100\%$$

$$\%rxn = \frac{25.75g}{36.04g} \times 100\%$$

$$\%rxn = 71.4\%$$

Find max. product

If H_2 is L.R.:

$$6.90g\ H_2 \times \frac{1\ mol\ H_2}{2.02g\ H_2} \times \frac{2\ mol\ H_2O}{2\ mol\ H_2} \times \frac{18.02g\ H_2O}{1\ mol\ H_2O} = 61.55g\ H_2O$$

If O_2 is L.R.:

$$32.0g\ O_2 \times \frac{1\ mol\ O_2}{32.00g\ O_2} \times \frac{2\ mol\ H_2O}{1\ mol\ O_2} \times \frac{18.02g\ H_2O}{1\ mol\ H_2O} = 36.04g\ H_2O$$

O_2 is L.R.

Find the % reaction and write the expression if 10.0 g of $H_{2(g)}$ and 94.0 g of $Cl_{2(g)}$ react to form 15.4 g of hydrochloric acid.