(given (do the rxn)) $\frac{AY}{TY} \times 100 = \%Y$ (stoich)

# Stoichiometry Problems 4 (Percent Yield)

1. Nitrogen gas ($N_2$) can be prepared by passing gaseous ammonia ($NH_3$) over solid copper oxide at high temperatures. The other products of the reaction are solid copper and water vapor. When a chemist reacts 18.1 grams of $NH_3$ is reacted with an excess CuO, 12.5 grams of nitrogen gas are produced. What is the percent yield of $N_2$ in this reaction? (Write a balanced equation.) (AY)

$$2NH_{3(g)} + 3CuO_{(s)} \rightarrow N_{2(g)} + 3Cu_{(s)} + 3H_2O_{(g)}$$

AY 12.5g; 18.1g → ? g

$$\frac{18.1\,g\,NH_3}{1} \left| \frac{1\,mol\,NH_3}{17.04\,g\,NH_3} \right| \frac{1\,mol\,N_2}{2\,mol\,NH_3} \left| \frac{28.02\,g\,N_2}{1\,mol\,N_2} \right| = \boxed{14.9\,g\,N_2}$$ TY

$$\%Y = \frac{12.5}{14.9} \times 100 = 83.9\%$$

2. Sulfur ($S_8$) reacts with oxygen to produce sulfur dioxide. A chemist completely reacts 31.5 grams of sulfur and produces 58.1 grams of sulfur dioxide. What was the percent yield of the reaction? (Write a balanced equation.)

$$S_8 + 8O_2 \rightarrow 8SO_2$$

AY = 58.1g; 31.5g → TY ? g

$$\frac{31.5\,g\,S_8}{1} \left| \frac{1\,mol\,S_8}{256.48\,g\,S_8} \right| \frac{8\,mol\,SO_2}{1\,mol\,S_8} \left| \frac{64.06\,g\,SO_2}{1\,mol\,SO_2} \right| = \boxed{62.9\,g\,SO_2}$$ TY

$$\%Y = \frac{AY}{TY} \times 100$$

$$\%Y = \frac{58.1}{62.9} \times 100 = 92.4\%$$

3. A. The reaction of solid aluminum with aqueous copper(II) sulfate is known to have a 56.6% yield. If 1.85 g of Al reacts with excess copper (II) sulfate, what mass of copper is produced? (Write a balanced equation.) B. If one wishes to produce 100.00 g of copper, what mass of aluminum should be reacted with excess copper(II) sulfate? (AY)

A) $$2Al + 3CuSO_4 \rightarrow 3Cu + Al_2(SO_4)_3$$

1.85g → ? g

$$\frac{1.85\,g\,Al}{1} \left| \frac{1\,mol\,Al}{26.98\,g\,Al} \right| \frac{3\,mol\,Cu}{2\,mol\,Al} \left| \frac{63.55\,g\,Cu}{1\,mol\,Cu} \right| = \boxed{6.54\,g\,Cu}$$ TY

$$56.6\% = \frac{AY}{6.54g} \times 100$$

$$.566 = \frac{AY}{6.54g} \rightarrow AY = \boxed{3.70\,g\,Cu}$$ AY

B) $$56.6\% = \frac{100.0\,g}{TY} \times 100$$

$$.566 = \frac{100.0}{TY}$$

$$TY = \boxed{177\,g}$$

$$\frac{177\,g\,Cu}{1} \left| \frac{1\,mol\,Cu}{63.55\,g\,Cu} \right| \frac{2\,mol\,Al}{3\,mol\,Cu} \left| \frac{26.98\,g\,Al}{1\,mol\,Al} \right| = \boxed{50.1\,g\,Al}$$ needed

4. Methanol ($CH_3OH$) can be produced through the reaction of CO and $H_2$ in the presence of a catalyst. If 75.0 g of CO reacts with an excess of hydrogen gas to produce 68.4 g of $CH_3OH$, what is the percent yield of $CH_3OH$? (Write a balanced equation.) AY = 68.4g

$$CO + 2H_2 \rightarrow CH_3OH$$

75.0g → TY ? g

$$\frac{75.0\,g\,CO}{1} \left| \frac{1\,mol\,CO}{28.01\,g\,CO} \right| \frac{1\,mol\,CH_3OH}{1\,mol\,CO} \left| \frac{32.05\,g\,CH_3OH}{1\,mol\,CH_3OH} \right| = \boxed{85.8\,g\,CH_3OH}$$ (TY)

$$\%Y = \frac{68.4\,g}{85.8\,g} \times 100 = 79.7\%$$

nope

5. Solid lithium hydroxide is used in space vehicles to remove exhaled carbon dioxide from the living environment to form solid lithium carbonate and liquid water. The balanced equation for the reaction is shown below. If two astronauts are going to be aboard a space craft for exactly 5 days, what mass of lithium hydroxide must be carried on the space craft to absorb all the carbon dioxide exhaled by the astronauts? Each astronaut exhales 2.3 pounds of $CO_2$ per day. The reaction is known to have an 88.5% yield.

$$2\,LiOH(s) + CO_2(g) \rightarrow Li_2CO_3(s) + H_2O(l)$$

$$\frac{5\ \text{days}}{1}\left|\frac{2.3\ \text{lb}\ CO_2}{1\ \text{day}}\right|\frac{454\ \text{g}\ CO_2}{1\ \text{lb}\ CO_2} = 5221\ \text{g}\ CO_2 \times 2\ \text{astronauts} = \boxed{10{,}442\ \text{g}\ CO_2}$$

$5200\ \text{g}\ CO_2$ $\qquad$ $10{,}400\ \text{g}\ CO_2$

$$\%Y = \frac{AY}{TY} \times 100$$

$$88.5 = \frac{10{,}442}{TY} \times 100$$

$$.885 = \frac{10{,}442}{TY}$$

$$TY = 11{,}799\ \text{g}\ CO_2$$

} using a REACTANT!

$$\frac{11{,}799\ \text{g}\ CO_2}{1}\left|\frac{1\ \text{mol}\ CO_2}{44.01\ \text{g}\ CO_2}\right|\frac{2\ \text{mol}\ LiOH}{1\ \text{mol}\ CO_2}\left|\frac{23.95\ \text{g}\ LiOH}{1\ \text{mol}\ LiOH}\right| = 12841.90\ \text{g}\ LiOH$$

— OR —

$$\frac{10{,}442\ \text{g}\ CO_2}{1}\left|\frac{1\ \text{mol}\ CO_2}{44.01\ \text{g}\ CO_2}\right|\frac{1\ \text{mol}\ Li_2CO_3}{1\ \text{mol}\ CO_2}\left|\frac{73.89\ \text{g}\ Li_2CO_3}{1\ \text{mol}\ Li_2CO_3}\right| = 17531.46\ \text{g}\ Li_2CO_3$$

$$\%Y = \frac{AY}{TY} \times 100$$

$$.885 = \frac{17531.46}{TY}$$

$$TY = 19809.55\ \text{g}\ Li_2CO_3$$

this needs to be AY if all the $CO_2$ is used!

$$\frac{19809.55\ \text{g}\ Li_2CO_3}{1}\left|\frac{1\ \text{mole}\ Li_2CO_3}{73.89\ \text{g}\ Li_2CO_3}\right|\frac{2\ \text{mol}\ LiOH}{1\ \text{mol}\ Li_2CO_3}\left|\frac{23.95\ \text{g}\ LiOH}{1\ \text{mol}\ LiOH}\right| = 12841.76\ \text{g}\ LiOH$$