

# SI Worksheet

3/10/22

Agenda:

Kahoot

Worksheet

1. The reaction,  $\text{N}_2 + 3\text{F}_2 \rightarrow 2\text{NF}_3$ , yields 21.6 g  $\text{NF}_3$  when 5.00 g  $\text{N}_2$  reacts with excess fluorine. What is the percent yield?

The actual yield (21.6 g) is given in the problem, but the theoretical, also known as the maximum yield, must be calculated based on the amount of the given reactant. Only one reactant mass is given so this is solved as a stoichiometry problem, not a limiting reagent problem. (25.3 g  $\text{NF}_3$ )

$$5.00 \text{ g N}_2 \times \frac{1 \text{ mol N}_2}{28.02 \text{ g}} \times \frac{2 \text{ NF}_3 \text{ mol}}{1 \text{ mol N}_2} \times \frac{71.01 \text{ g}}{1 \text{ mol NF}_3} = 25.3 \text{ g NF}_3$$

Now that both the actual and theoretical yields are known, the percent yield can be calculated.  
(85.4%)

$$\text{Actual} = 21.6 \text{ g}$$

$$\text{theoretical} = 25.3 \text{ g}$$

$$\begin{aligned} \% \text{ yield} &= \frac{\text{actual}}{\text{theoretical}} \times 100\% \\ &= \frac{21.6}{25.3} \times 100\% \\ &= 85.4\% \end{aligned}$$

2. What is the percent yield of  $\text{ZnCl}_2$  when 18.0 g of  $\text{Zn}$  reacts with excess  $\text{HCl}$  and 29.3 g  $\text{ZnCl}_2$  is produced?



(Hint: Is this chemical reaction balanced?)

Only one reactant mass is given so this is solved as a stoichiometry problem, not a limiting reagent problem. (37.5 g) (78.1%)

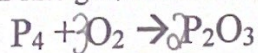
$$18.0 \text{ g Zn} \times \frac{1 \text{ mol Zn}}{65.41 \text{ g}} \times \frac{1 \text{ mol ZnCl}_2}{1 \text{ mol Zn}} \times \frac{136.31 \text{ g}}{1 \text{ mol ZnCl}_2} = 37.5 \text{ g ZnCl}_2$$

↑  
theoretical

$$\% \text{ yield} = \frac{29.3 \text{ g}}{37.5 \text{ g}} \times 100\% = 78.1\%$$



3. What is the theoretical yield when 12.0 g P<sub>4</sub> reacts with 10.0 g O<sub>2</sub>?



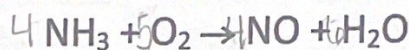
The amounts of two reactants are given so this is a limiting reagent problem, determine the amount of P<sub>2</sub>O<sub>3</sub> in grams that would be produced when 12.0 g P<sub>4</sub> is consumed, and 10.0 g of O<sub>2</sub> is consumed. Determine your limiting reactant, that is your theoretical yield.

$$12.0\text{g P}_4 \times \frac{1\text{mol P}_4}{123.88\text{g P}_4} \times \frac{2\text{mol P}_2\text{O}_3}{1\text{mol P}_4} \times \frac{109.94\text{g}}{1\text{mol P}_2\text{O}_3} = 21.3\text{g P}_2\text{O}_3$$

$$10.0\text{g O}_2 \times \frac{1\text{mol O}_2}{32.00\text{g O}_2} \times \frac{2\text{mol P}_2\text{O}_3}{3\text{mol O}_2} \times \frac{109.94\text{g}}{1\text{mol P}_2\text{O}_3} = 22.9\text{g P}_2\text{O}_3$$

P<sub>4</sub> is limiting therefore the theoretical yield is 21.3g P<sub>2</sub>O<sub>3</sub>

4. In an experiment, 3.25 g of NH<sub>3</sub> is reacted with 3.50 g of O<sub>2</sub>.



- a. What is the limiting reactant? if NO is created?

$$3.25\text{g NH}_3 \times \frac{1\text{mol NH}_3}{17.04\text{g}} \times \frac{4\text{mol NO}}{4\text{mol NH}_3} \times \frac{30.01\text{g}}{1\text{mol NO}} = 5.72\text{g NO}$$

$$3.50\text{g O}_2 \times \frac{1\text{mol O}_2}{32.00\text{g}} \times \frac{4\text{mol NO}}{5\text{mol O}_2} \times \frac{30.01\text{g}}{1\text{mol NO}} = 2.63\text{g NO}$$

O<sub>2</sub>

- b. How many grams of NO is formed?

$$2.63\text{g NO}$$

- c. How much of the excess reactant remains after the reaction?

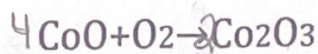
$$3.50\text{g O}_2 \times \frac{1\text{mol O}_2}{32.00\text{g O}_2} \times \frac{4\text{mol NH}_3}{5\text{mol O}_2} \times \frac{17.04\text{g}}{1\text{mol NH}_3} = 1.491\text{g of NH}_3 \text{ is needed}$$

$$3.25\text{g} - 1.491\text{g} = 1.76\text{g excess of NH}_3$$



$$3 \times 8 = 4$$

5. How much the excess reagent remains if 24.5 grams of CoO is reacted with 2.58 grams of O<sub>2</sub>?



$$24.5\text{g CoO} \times \frac{1\text{mol CoO}}{71.85\text{g}} \times \frac{2\text{mol Co}_2\text{O}_3}{4\text{mol CoO}} \times \frac{165.86\text{g}}{1\text{mol Co}_2\text{O}_3} = 27.12\text{g Co}_2\text{O}_3$$

$$2.58\text{g O}_2 \times \frac{1\text{mol O}_2}{32.00\text{g}} \times \frac{2\text{mol Co}_2\text{O}_3}{1\text{mol O}_2} \times \frac{165.86\text{g}}{1\text{mol Co}_2\text{O}_3} = 26.74\text{g O}_2$$

↑  
limiting

$$26.74\text{g O}_2 \times \frac{1\text{mol O}_2}{32.00\text{g}} \times \frac{4\text{mol CoO}}{1\text{mol O}_2} \times \frac{74.93\text{g}}{1\text{mol CoO}} = 25$$