Honors Chemistry PS.29

Name: Key Date: ______________ Mods: __________

Unit 7: Percent Yield

1) Use the balanced equation below to find out how many grams of sulfur dioxide are actually produced if 1.5×10^{23} molecules of zinc sulfide are reacted with excess oxygen and the percent yield is 75%.

→ don't worry about this reactant if the problem tells you there is excess of it

$$2\,ZnS\,(s) + 3\,O_2\,(g) \rightarrow 2\,ZnO\,(s) + 2\,SO_2\,(g)$$

$$\frac{1.5\times10^{23}\text{ molec. ZnS}}{} \left|\ \frac{1\text{ mol ZnS}}{6.022\times10^{23}\text{ molec. ZnS}}\ \right|\ \frac{2\text{ mol SO}_2}{2\text{ mol ZnS}}\ \left|\ \frac{64.1\text{ g SO}_2}{1\text{ mol SO}_2}\right.$$

$= 15.97\text{ g SO}_2$ (theoretical yield)

$$\%\text{ yield} = \left(\frac{\text{act}}{\text{theor}}\right)\times100$$

$$75\% = \left(\frac{x}{15.97\text{ g SO}_2}\right)\times100$$

$$0.75 = \frac{x}{15.97\text{ g}}$$

$$x = (0.75)(15.97\text{ g})$$

$$x = 11.98\text{ g SO}_2$$ actually produced

2) Some underwater welding is done via the thermite reaction, in which rust (iron (III) oxide) reacts with aluminum to produce iron and solid aluminum oxide. In one such reaction, you combine 258 g of aluminum and excess rust to produce 464 g of iron. What was the percent yield of iron for your experiment?

→ actual yield

$$\underline{1}\ Fe_2O_3\,(s) + \underline{2}\ Al\,(s) \rightarrow \underline{1}\ Al_2O_3\,(s) + \underline{2}\ Fe\,(s)$$

$$\frac{258\text{ g Al}}{} \left|\ \frac{1\text{ mol Al}}{27\text{ g Al}}\ \right|\ \frac{2\text{ mol Fe}}{2\text{ mol Al}}\ \left|\ \frac{55.9\text{ g Fe}}{1\text{ mol Fe}}\right. = 534.2\text{ g Fe}$$ (theoretical yield)

$$\%\text{ yield} = \left(\frac{464\text{ g Fe}}{534.2\text{ g Fe}}\right)\times100$$

$$= 86.86\%$$

3) Solid "slaked lime," $Ca(OH)_2$, is produced when water reacts with solid "quick lime," CaO. While performing a laboratory experiment, you begin with 2400 g of quick lime, add excess water, and produce 2060 g of slaked lime. What is the percent yield of slaked lime in your reaction?

↳ actual yield.

$\underline{1}\ H_2O(l) + \underline{1}\ CaO(s) \rightarrow \underline{1}\ Ca(OH)_2$

$$\frac{2400\ \text{g CaO}}{} \Big| \frac{1\ \text{mol CaO}}{56\ \text{g CaO}} \Big| \frac{1\ \text{mol } Ca(OH)_2}{1\ \text{mol CaO}} \Big| \frac{74\ \text{g } Ca(OH)_2}{1\ \text{mol } Ca(OH)_2} = 3171.43\ \text{g } Ca(OH)_2$$

(theoretical yield)

$$\%\ \text{yield} = \left(\frac{2060\ \text{g } Ca(OH)_2}{3171.43\ \text{g } Ca(OH)_2}\right) \times 100 = 64.95\%$$

4) The Haber process is the conversion of nitrogen and hydrogen at high pressure into ammonia, as follows:

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$$

a) How many grams of ammonia are actually produced if 375 g of nitrogen reacts with excess hydrogen and the percent yield is 70%?

$$\frac{375\ \text{g } N_2}{} \Big| \frac{1\ \text{mol } N_2}{28\ \text{g } N_2} \Big| \frac{2\ \text{mol } NH_3}{1\ \text{mol } N_2} \Big| \frac{17\ \text{g } NH_3}{1\ \text{mol } NH_3} = 455.36\ \text{g } NH_3$$

(theoretical yield)

$$70\% = \left(\frac{x}{455.36\ \text{g } NH_3}\right) \times 100$$

$$0.70 = \frac{x}{455.36\ \text{g}}$$

$$x = (0.70)(455.36\ \text{g}) = 318.75\ \text{g } NH_3$$

actually produced

b) You produce 700 g of ammonia during an experiment, what mass of nitrogen did you use to begin your reaction, assuming that the percent yield of your experiment is 80%?

actual yield

$$80\% = \left(\frac{700\ \text{g } NH_3}{x}\right) \times 100$$

$$0.80 = \frac{700\ \text{g } NH_3}{x}$$

$$x = (0.80)(700\ \text{g } NH_3)$$

$= 875\ \text{g } NH_3$ (theoretical yield)

$$\frac{875\ \text{g } NH_3}{} \Big| \frac{1\ \text{mol } NH_3}{17\ \text{g } NH_3} \Big| \frac{1\ \text{mol } N_2}{2\ \text{mol } NH_3} \Big| \frac{28\ \text{g } N_2}{1\ \text{mol } N_2} = 720.59\ \text{g } N_2$$