SI Worksheet

3/10/22

Agenda:

Kahoot

Worksheet

1. The reaction, $N_2 + 3F_2 \rightarrow 2NF_3$, yields 21.6 g NF_3 when 5.00 g 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 NF3)

$$5.00\text{g } N_2 \times \frac{1\text{mol } N_2}{28.02\text{g}} \times \frac{2\text{NF}_3\text{mol}}{1\text{mol } N_2} \times \frac{71.01\text{g}}{1\text{mol NF}_3} = 25.3\text{g NF}_3$$

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

actual = 21.6g

theoretical = 25.3g

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

2. What is the percent yield of $ZnCl_2$ when 18.0 g of Zn reacts with excess HCl and 29.3 g $ZnCl_2$ is produced?

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

(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_4 reacts with 10.0 g O_2?

$$P_4 + 3O_2 \rightarrow 2P_2O_3$$

The amounts of two reactants are given so this is a limiting reagent problem, determine the amount of P2O3 in grams that would be produced when 12.0 g P4 is consumed, and 10.0 g of O2 is consumed. Determine your limiting reactant, that is your theoretical yield.

$$12.0\text{g } P_4 \times \frac{1\text{mol } P_4}{123.88\text{g } P_4} \times \frac{2\text{mol } P_2O_3}{1\text{mol } P_4} \times \frac{109.94\text{g}}{1\text{mol } P_2O_3} = 21.3\text{g } P_2O_3$$

$$10.0\text{g } O_2 \times \frac{1\text{mol } O_2}{32.00\text{g } O_2} \times \frac{2\text{mol } P_2O_3}{3\text{mol } O_2} \times \frac{109.94\text{g}}{1\text{mol } P_2O_3} = 22.9\text{g } P_2O_3$$

P_4 is limiting therefore the theoretical yield is 21.3g P_2O_3

4. In an experiment, 3.25 g of NH_3 is reacted with 3.50 g of O_2.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

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_2

b. How many grams of NO is formed?

2.63g NO

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

$$3.50\text{g } O_2 \times \frac{1\text{mol } O_2}{32.00\text{g } O_2} \times \frac{4\text{mol } NH_3}{5\text{mol } O_2} \times \frac{17.04\text{g}}{1\text{mol } NH_3} = 1.491\text{g of } NH_3 \text{ is reacted}$$

3.25g - 1.491g = 1.76g excess of NH_3

3 x 8 = 4

5. How much the excess reagent remains if 24.5 grams of CoO is reacted with 2.58 grams of O_2?

$$4CoO + O_2 \rightarrow 2Co_2O_3$$

$$24.5g\ CoO \times \frac{1mol\ CoO}{71.85g} \times \frac{2mol\ Co_2O_3}{4mol\ CoO} \times \frac{165.86g}{1mol\ Co_2O_3} = 27.12g\ Co_2O_3$$

$$2.58g\ O_2 \times \frac{1mol\ O_2}{32.00g} \times \frac{2mol\ Co_2O_3}{1mol\ O_2} \times \frac{165.86g}{1mol\ Co_2O_3} = 26.74g\ O_2$$

↑ limiting

$$26.74g\ O_2 \times \frac{1mol\ O_2}{32.00g} \times \frac{4mol\ CoO}{1mol\ O_2} \times \frac{74.93g}{1mol\ CoO} = 25$$