

Worksheet: Limiting Reactants

1. Nitrogen gas can be prepared by passing ammonia over hot copper (II) oxide according to the equation



How many moles of N_2 are prepared from the following mixtures?

- (a) 3.00 mol of CuO and 3.00 mol of NH_3

$$3 \text{ mol NH}_3 \times \frac{1 \text{ mol N}_2}{2 \text{ mol NH}_3} = 1.5 \text{ mol N}_2$$

$$3 \text{ mol CuO} \times \frac{1 \text{ mol N}_2}{3 \text{ mol CuO}} = 1 \text{ mol N}_2$$

- (b) 3.00 mol of CuO and 2.00 mol of NH_3

$$\begin{array}{l} \text{"} \\ 1 \text{ mol} \end{array} \quad \begin{array}{l} \text{"} \\ 1 \text{ mol} \end{array} \quad 1 \text{ mol N}_2$$

- (c) 3.00 mol of CuO and 1.00 mol of NH_3

$$\begin{array}{l} \text{"} \\ 1 \text{ mol} \end{array} \quad \begin{array}{l} \text{"} \\ 0.5 \text{ mol} \end{array} \quad 0.500 \text{ mol N}_2$$

- (d) 0.628 mol of CuO and 0.430 mol of NH_3

$$0.628 \text{ mol} \times \frac{1 \text{ mol N}_2}{3 \text{ mol CuO}} = 0.210 \text{ mol}$$

$$0.430 \text{ mol} \times \frac{1 \text{ mol N}_2}{2 \text{ mol NH}_3} = 0.215 \text{ mol}$$

- (e) 5.44 mol of CuO and 3.50 mol of NH_3

$$5.44 \text{ mol} \times \frac{1 \text{ mol}}{3 \text{ mol}} = 1.81$$

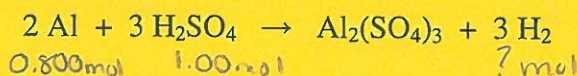
$$3.50 \text{ mol NH}_3 \times \frac{1 \text{ mol}}{2 \text{ mol}} = 1.75 \text{ mol}$$

2. How many moles remain of the reactant in excess in (a) and (c) of problem 1?

a.) $\frac{3 \text{ mol NH}_3}{1.5 \text{ mol N}_2} = \frac{x \text{ NH}_3}{1 \text{ mol N}_2} = 2 \text{ mol NH}_3 \text{ needed}$ $3 \text{ mol} - 2 \text{ mol} = 1 \text{ mol excess}$

c.) $\frac{3 \text{ mol CuO}}{1 \text{ mol N}_2} = \frac{x \text{ CuO}}{0.5 \text{ mol N}_2} = 1.5 \text{ mol}$ $3 \text{ mol} - 1.5 \text{ mol} = 1.5 \text{ mol excess}$

3. Consider the equation



$$\begin{array}{l} 0.800 \text{ mol} \quad 1.00 \text{ mol} \quad ? \text{ mol} \end{array}$$

If 0.800 mole of Al is mixed with 1.00 mol of H_2SO_4 , how many moles of H_2 are produced? How many moles of one of the reactants remain?

$$0.800 \text{ mol Al} \times \frac{3 \text{ mol H}_2}{2 \text{ mol Al}} = 1.2 \text{ mol H}_2$$

$$\frac{0.800 \text{ Al}}{1.2 \text{ H}_2} = \frac{x \text{ Al}}{1.00 \text{ mol H}_2}$$

$$x = 0.667 \text{ mol}$$

$$1.00 \text{ mol H}_2\text{SO}_4 \times \frac{3 \text{ mol}}{3 \text{ mol}} = 1.00 \text{ mol H}_2$$

$$0.8 - 0.667 = 0.133 \text{ mol Al left}$$

$$0.20 \text{ mol H}_2 \times \frac{2 \text{ mol Al}}{3 \text{ mol H}_2} = 0.133 \text{ mol}$$

4. Consider the equation



If 3.44 mol of C_5H_6 is mixed with 20.6 mol of O_2 , what mass of CO_2 is formed?

$$3.44 \text{ mol C}_5\text{H}_6 \times \frac{10 \text{ mol CO}_2}{2 \text{ mol}} = 17.2 \text{ mol CO}_2$$

$$20.6 \text{ mol O}_2 \times \frac{10 \text{ mol}}{13 \text{ mol}} = 15.85 \text{ mol CO}_2 \times \frac{44 \text{ g}}{1 \text{ mol}} = \boxed{697 \text{ g CO}_2}$$

5. Consider the equation



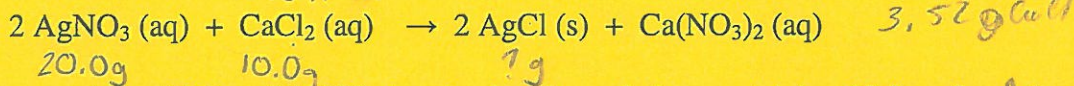
If a 40.0 g sample of O_2 is mixed with 1.50 mol of NH_3 , which is the limiting reactant? How many moles of N_2 form?

$$40.0 \text{ g O}_2 \times \frac{1 \text{ mol}}{32 \text{ g}} \times \frac{2 \text{ mol N}_2}{3 \text{ mol O}_2} = 0.833 \text{ mol}$$

$$1.50 \text{ mol NH}_3 \times \frac{2 \text{ mol N}_2}{4 \text{ mol NH}_3} = \boxed{0.75 \text{ mol N}_2}$$

NH_3 is limiting

6. Consider the equation



If a solution containing 20.0 g of AgNO_3 is mixed with a solution containing 10.0 g of CaCl_2 , which compound is the limiting reactant? What mass of AgCl forms? What mass of one of the reactants remains?

$$10.0 \text{ g CaCl}_2 \times \frac{1 \text{ mol}}{110 \text{ g}} \times \frac{2 \text{ mol AgCl}}{1 \text{ mol CaCl}_2} = 0.182 \text{ mol}$$

$$20.0 \text{ g AgNO}_3 \times \frac{1 \text{ mol}}{170 \text{ g}} \times \frac{2 \text{ mol AgCl}}{2 \text{ mol}} = 0.118 \text{ mol} \times \frac{143 \text{ g AgCl}}{1 \text{ mol}} = \boxed{16.9 \text{ g AgCl}}$$

$$\frac{0.091 \text{ mol CaCl}_2}{0.182 \text{ mol AgCl}} = \frac{x}{0.118 \text{ mol AgCl}}$$

$$2 \times \boxed{3.52 \text{ g CaCl}_2} \times x = 0.059 \text{ mol CaCl}_2 \text{ needed}$$

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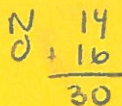
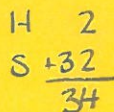
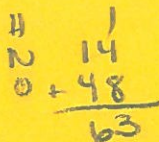
$$0.091 - 0.059 = 0.032 \text{ mol} \times \frac{110 \text{ g}}{1 \text{ mol}} =$$

AgNO_3 is limiting

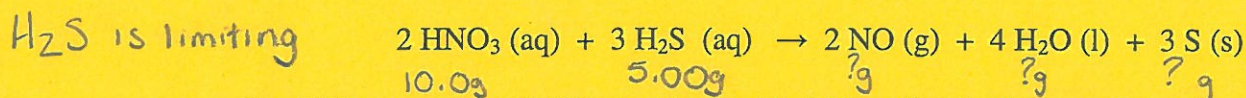
Ca 40
Cl 70
110

Ag 108
Cl 35
143

Ag 108
N 14
O 48
170



7. Consider the balanced equation



If a 10.0 g quantity of HNO_3 is mixed with 5.00 g of H_2S , what are the masses of each product and of the reactant present in excess after the reaction occurs?

$$10.0\text{g HNO}_3 \times \frac{1\text{mol}}{63\text{g}} \times \frac{2\text{mol}}{2\text{mol}} = 0.159\text{mol NO}$$

$$5.00\text{g H}_2\text{S} \times \frac{1\text{mol}}{34\text{g}} \times \frac{2\text{mol}}{3\text{mol}} = 0.0980\text{mol NO} \times \frac{30\text{g}}{1\text{mol}} = \boxed{2.94\text{g NO}}$$

$$= 0.147\text{mol H}_2\text{S} \times \frac{4\text{mol}}{3\text{mol}} \times \frac{18\text{g}}{1\text{mol}} = \boxed{3.53\text{g H}_2\text{O}}$$

$$0.147\text{mol H}_2\text{S} \times \frac{2\text{mol}}{3\text{mol}} \times \frac{63\text{g HNO}_3}{1\text{mol}}$$

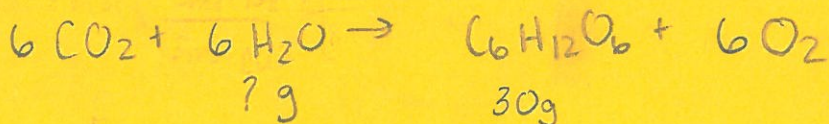
$$0.147\text{mol H}_2\text{S} \times \frac{3\text{mol}}{3\text{mol}} \times \frac{32\text{g}}{1\text{mol}} = \boxed{4.70\text{g S}}$$

$$6.17\text{g HNO}_3$$

$$10.0\text{g} - 6.17\text{g} = \boxed{3.83\text{g HNO}_3 \text{ left}}$$

8. Photosynthesis is a complex process composed of many steps. The initial reactants are carbon dioxide and water, and the final products are glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) and oxygen. If a plant needs to make 30.0 g of glucose through photosynthesis, how many grams of water are needed? (Hint: How many mLs of water?)

$$\begin{array}{r} \text{C } 6(12) = 72 \\ \text{H } 12(1) = 12 \\ \text{O } 6(16) = 96 \\ \hline 180 \end{array}$$



$$30\text{g C}_6\text{H}_{12}\text{O}_6 \times \frac{1\text{mol}}{180\text{g}} \times \frac{6\text{mol H}_2\text{O}}{1\text{mol}} \times \frac{18\text{g}}{1\text{mol}} = \boxed{18.0\text{g H}_2\text{O}}$$

see below for other method

$$\begin{array}{r} 0.159 \\ -0.0980 \\ \hline \end{array}$$

$$0.061\text{mol NO} \times \frac{2\text{mol NO}}{2\text{mol HNO}_3} \times \frac{63\text{g}}{1\text{mol}} = \boxed{3.84\text{g HNO}_3 \text{ left}}$$

