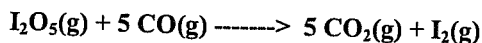


(+19)

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# Limiting Reagents and Percentage Yield Worksheet

1.



- a) 80.0 grams of iodine(V) oxide,  $\text{I}_2\text{O}_5$ , reacts with 28.0 grams of carbon monoxide,  $\text{CO}$ . Determine the mass of iodine  $\text{I}_2$ , which could be produced?

$$\begin{array}{l} 80.0\text{g I}_2\text{O}_5 \left| \frac{1\text{mol I}_2\text{O}_5}{333.8\text{g}} \right| \frac{1\text{I}_2}{1\text{I}_2\text{O}_5} \left| \frac{253.8\text{g I}_2}{1\text{mol I}_2} \right| = 60.8\text{g I}_2 \\ 28\text{g CO} \left| \frac{1\text{mol CO}}{28\text{g CO}} \right| \frac{1\text{I}_2}{5\text{CO}} \left| \frac{253.8\text{g I}_2}{1\text{mol I}_2} \right| = 50.8\text{g I}_2 \end{array}$$

- b) If, in the above situation, only 0.160 moles, of iodine,  $\text{I}_2$  was produced.

- i) What mass(g) of iodine was produced?

$$0.160\text{mol I}_2 \left| \frac{253.8\text{g I}_2}{1\text{mol I}_2} \right| = 40.6\text{g I}_2$$

- ii) What percentage yield of iodine was produced.

$$\frac{40.6}{50.8} \times 100 = 79.9\%$$

2. Zinc and sulfur react to form zinc sulfide according to the equation.



If 25.0 g of zinc and 30.0 g of sulfur are mixed

- a) Which chemical is the limiting reactant?

$$\begin{array}{l} 25.0\text{g Zn} \left| \frac{1\text{mol Zn}}{65.38\text{g Zn}} \right| \frac{1\text{ZnS}}{1\text{Zn}} \left| \frac{97.44\text{g ZnS}}{1\text{mol ZnS}} \right| = 37.26\text{g ZnS} \\ 30\text{g S} \left| \frac{1\text{mol S}}{32.06\text{g S}} \right| \frac{1\text{ZnS}}{1\text{S}} \left| \frac{97.44\text{g ZnS}}{1\text{mol ZnS}} \right| = 91.18\text{g ZnS} \end{array}$$

- b) How many grams of  $\text{ZnS}$  will be formed?

$$37.26\text{g ZnS}$$

- c) How many grams of the excess reactant will remain after the reaction is over?

$$\begin{array}{l} 25\text{g Zn} \left| \frac{1\text{mol Zn}}{65.38\text{g Zn}} \right| \frac{1\text{S}}{1\text{Zn}} \left| \frac{32.06\text{g}}{1\text{mol S}} \right| = 12.26\text{g S} \leftarrow \text{used} \\ 30\text{g S} - 12.26\text{g S} = 17.74\text{g S excess} \end{array}$$

3. Which element is in excess when 3.00 grams of  $\text{Mg}$  is ignited in 2.20 grams of pure oxygen?

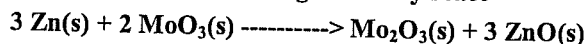
What mass of  $\text{MgO}$  is formed? What mass is in excess?

$$\begin{array}{l} 3\text{g Mg} \left| \frac{1\text{mol Mg}}{24.3\text{g Mg}} \right| \frac{2\text{MgO}}{2\text{Mg}} \left| \frac{40.3\text{g MgO}}{1\text{mol MgO}} \right| = 4.97\text{g MgO} \\ 2.2\text{g O}_2 \left| \frac{1\text{mol O}_2}{32\text{g O}_2} \right| \frac{2\text{MgO}}{1\text{O}_2} \left| \frac{40.3\text{g MgO}}{1\text{mol MgO}} \right| = 5.5\text{g} \end{array}$$

4. How many grams of  $\text{Al}_2\text{S}_3$  are formed when 5.00 grams of  $\text{Al}$  is heated with 10.0 grams  $\text{S}$ ?

$$\begin{array}{l} 2\text{Al} + 3\text{S} \longrightarrow \text{Al}_2\text{S}_3 \\ 5.00\text{g Al} \left| \frac{1\text{mol Al}}{26.98\text{g Al}} \right| \frac{1\text{Al}_2\text{S}_3}{2\text{Al}} \left| \frac{150.14\text{g Al}_2\text{S}_3}{1\text{mol Al}_2\text{S}_3} \right| = 13.9\text{g Al}_2\text{S}_3 \\ 10.0\text{g S} \left| \frac{1\text{mol S}}{32.06\text{g S}} \right| \frac{3\text{Al}_2\text{S}_3}{3\text{S}} \left| \frac{150.14\text{g Al}_2\text{S}_3}{1\text{mol Al}_2\text{S}_3} \right| = 15.6\text{g Al}_2\text{S}_3 \end{array}$$

5. When  $\text{MoO}_3$  and  $\text{Zn}$  are heated together they react



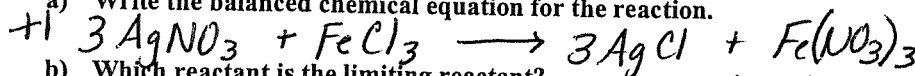
What mass of  $\text{ZnO}$  is formed when 20.0 grams of  $\text{MoO}_3$  is reacted with 10.0 grams of  $\text{Zn}$ ?

$$20.0\text{g MoO}_3 \left| \frac{1\text{mol MoO}_3}{143.94\text{g MoO}_3} \right| \frac{3\text{ZnO}}{2\text{MoO}_3} \left| \frac{81.38\text{g ZnO}}{1\text{mol ZnO}} \right| = 16.96\text{g ZnO}$$

$$10.0\text{g Zn} \left| \frac{1\text{mol Zn}}{65.38\text{g Zn}} \right| \frac{3\text{ZnO}}{3\text{Zn}} \left| \frac{81.38\text{g ZnO}}{1\text{mol ZnO}} \right| = 12.48\text{g ZnO}$$

6. Silver nitrate,  $\text{AgNO}_3$ , reacts with ferric chloride,  $\text{FeCl}_3$ , to give silver chloride,  $\text{AgCl}$ , and ferric nitrate,  $\text{Fe}(\text{NO}_3)_3$ . In a particular experiment, it was planned to mix a solution containing 25.0 g of  $\text{AgNO}_3$  with another solution containing 45.0 grams of  $\text{FeCl}_3$ .

a) Write the balanced chemical equation for the reaction.



b) Which reactant is the limiting reactant?

$$\frac{25.0\text{g AgNO}_3}{169.87\text{g AgNO}_3} \times \frac{1\text{mol AgNO}_3}{3\text{AgNO}_3} = .147\text{mol AgCl}$$

$$\frac{45.0\text{g FeCl}_3}{162.2\text{g FeCl}_3} \times \frac{1\text{mol FeCl}_3}{3\text{FeCl}_3} = .832\text{mol AgCl}$$

c) What is the maximum number of moles of  $\text{AgCl}$  that could be obtained from this mixture?

$$\boxed{.147\text{mol AgCl} +1}$$

d) What is the maximum number of grams of  $\text{AgCl}$  that could be obtained?

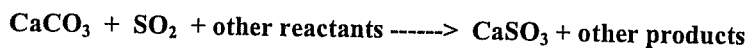
$$\frac{.147\text{mol AgCl}}{1\text{mol AgCl}} \times 143.32\text{g AgCl} = \boxed{21.1\text{g AgCl} +1}$$

e) How many grams of the reactant in excess will remain after the reaction is over?

$$\frac{25\text{g AgNO}_3}{169.87\text{g AgNO}_3} \times \frac{1\text{mol AgNO}_3}{3\text{AgNO}_3} \times \frac{1\text{FeCl}_3}{162.2\text{g FeCl}_3} = 7.96\text{g FeCl}_3 \text{ used}$$

$$45.0 - 7.96\text{g} = 37.04\text{g FeCl}_3 \text{ excess}$$

7. Solid calcium carbonate,  $\text{CaCO}_3$ , is able to remove sulphur dioxide from waste gases by the reaction:



In a particular experiment, 255 g of  $\text{CaCO}_3$  was exposed to 135 g of  $\text{SO}_2$  in the presence of an excess amount of the other chemicals required for the reaction.

a) What is the theoretical yield of  $\text{CaSO}_3$ ?

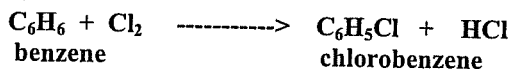
$$\frac{255\text{g CaCO}_3}{100\text{g CaCO}_3} \times \frac{1\text{mol CaCO}_3}{1\text{CaCO}_3} \times \frac{1\text{CaSO}_3}{120.14\text{g CaSO}_3} = 306.15\text{g CaSO}_3$$

$$\frac{135\text{g SO}_2}{64\text{g SO}_2} \times \frac{1\text{mol SO}_2}{1\text{SO}_2} \times \frac{1\text{CaSO}_3}{120.14\text{g CaSO}_3} = 253.4\text{g CaSO}_3$$

b) If only 198 g of  $\text{CaSO}_3$  was isolated from the products, what was the percentage yield of  $\text{CaSO}_3$  in this experiment?

$$\frac{198}{253.4} \times 100 = \boxed{78.26\% +1}$$

8. A research supervisor told a chemist to make 100 g of chlorobenzene from the reaction of benzene with chlorine and to expect a yield no higher than 65%. What is the minimum quantity of benzene that can give 100 g of chlorobenzene if the yield is 65%? The equation for the reaction is:



$$.65 = \frac{100}{X} \quad X = 153.35\text{g C}_6\text{H}_5\text{Cl}$$

$$\frac{153.35\text{g C}_6\text{H}_5\text{Cl}}{112.61\text{g C}_6\text{H}_5\text{Cl}} \times \frac{1\text{mol C}_6\text{H}_5\text{Cl}}{1\text{C}_6\text{H}_5\text{Cl}} \times \frac{78.12\text{g C}_6\text{H}_6}{1\text{mol C}_6\text{H}_6} = \boxed{106.38\text{g C}_6\text{H}_6 +1}$$

$$.65X = 100$$

$$\frac{100}{.65} = X =$$