

AP Stoichiometry Practice

Name Key
 Block _____ Date _____

Write out the balanced chemical equation to answer the following:

- 1) In a single displacement reaction between 43.6g of aluminum and concentrated hydrochloric acid, how many grams of hydrogen gas can be produced?



$$43.6 \text{ g Al} \left(\frac{1 \text{ mol Al}}{26.98 \text{ g}} \right) \left(\frac{3 \text{ mol H}_2}{2 \text{ mol Al}} \right) \left(\frac{2.016 \text{ g}}{1 \text{ mol H}_2} \right) = \boxed{4.89 \text{ g H}_2}$$

- 2) In a decomposition reaction, ammonium nitrate decomposes into nitrogen, oxygen, and water. How many mL of water can be produced if you begin with 1205.7g of ammonium nitrate?



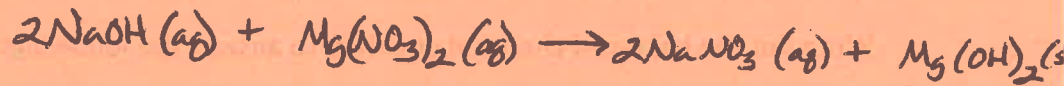
$$1205.7 \text{ g NH}_4\text{NO}_3 \left(\frac{1 \text{ mol NH}_4\text{NO}_3}{80.05 \text{ g}} \right) \left(\frac{4 \text{ mol H}_2\text{O}}{2 \text{ mol NH}_4\text{NO}_3} \right) \left(\frac{18.02 \text{ g}}{1 \text{ mol H}_2\text{O}} \right) \left(\frac{1 \text{ mL}}{1 \text{ g H}_2\text{O}} \right) = \boxed{542.83 \text{ mL H}_2\text{O}}$$

- 3) How many grams of carbon dioxide are produced from the combustion of 43.7g of propane (C₃H₈) in your space heater?



$$43.7 \text{ g C}_3\text{H}_8 \left(\frac{1 \text{ mol C}_3\text{H}_8}{44.09 \text{ g}} \right) \left(\frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8} \right) \left(\frac{44.01 \text{ g}}{1 \text{ mol CO}_2} \right) = \boxed{131 \text{ g CO}_2}$$

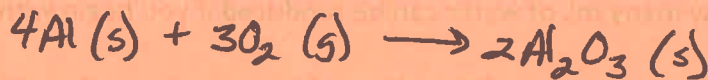
- 4) How many grams of sodium hydroxide would be required to produce 75.0g of precipitate from a double displacement reaction between sodium hydroxide and excess magnesium nitrate?



$$75.0 \text{ g Mg(OH)}_2 \left(\frac{1 \text{ mol Mg(OH)}_2}{58.33 \text{ g}} \right) \left(\frac{2 \text{ mol NaOH}}{1 \text{ mol Mg(OH)}_2} \right) \left(\frac{39.99 \text{ g}}{1 \text{ mol NaOH}} \right) = 102.8 = \boxed{103 \text{ g NaOH}}$$

- 5) If you have 13.5g of aluminum and 46.8g of oxygen, how much aluminum oxide could you theoretically produce in a synthesis reaction?

Limiting reagent



① $13.5 \text{ g Al} \left(\frac{1 \text{ mol Al}}{26.98 \text{ g}} \right) = \boxed{0.500 \text{ mol Al}}$

$46.8 \text{ g O}_2 \left(\frac{1 \text{ mol O}_2}{32.00 \text{ g}} \right) = \boxed{1.46 \text{ mol O}_2}$

How much you HAVE

② $0.500 \text{ mol Al} \left(\frac{3 \text{ mol O}_2}{4 \text{ mol Al}} \right) = \boxed{0.375 \text{ mol O}_2}$

How much O₂ you need to use all of the Al

③ O₂ is in excess (have more than you need)
Al is limiting

④ $0.500 \text{ mol Al} \left(\frac{2 \text{ mol Al}_2\text{O}_3}{4 \text{ mol Al}} \right) \left(\frac{101.96 \text{ g}}{1 \text{ mol Al}_2\text{O}_3} \right) = \boxed{25.5 \text{ g Al}_2\text{O}_3}$

limiting reagent 6)

How many grams of hydrochloric acid could be produced from a reaction between 219.5g of chlorine and 300.9g of hydrobromic acid?



$$219.5 \text{ g Cl}_2 \left(\frac{1 \text{ mol Cl}_2}{70.90 \text{ g}} \right) = 3.096 \text{ mol Cl}_2$$

$$3.096 \text{ mol Cl}_2 \left(\frac{2 \text{ mol HBr}}{1 \text{ mol Cl}_2} \right) = 6.192 \text{ mol HBr}$$

NEED

$$300.9 \text{ g HBr} \left(\frac{1 \text{ mol HBr}}{80.91 \text{ g}} \right) = 3.719 \text{ mol HBr}$$

HAVE

HBr is limiting

$$3.719 \text{ mol HBr} \left(\frac{2 \text{ mol HCl}}{2 \text{ mol HBr}} \right) \left(\frac{36.46 \text{ g}}{1 \text{ mol HCl}} \right) = 135.6 \text{ g HCl}$$

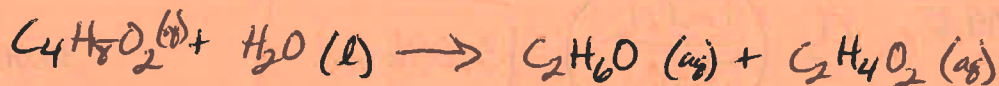
7) If you performed the reaction from #6 and collected 120.1g of HCl, what is your percent yield? Percent error?

$$\% \text{ Yield} = \frac{120.1 \text{ g}}{135.6 \text{ g}} (100) = 88.6 \% \text{ yield}$$

$$\% \text{ Error} = \frac{|120.1 - 135.6|}{135.6} (100) = 11.4 \% \text{ error}$$

- 8) Tying it all together: You perform a reaction between 15.6 g of ethyl ethanoate ($C_4H_8O_2$) and excess water in the presence of heat. After studying ester hydrolysis (yeah, you're smart) you predict two products were created: ethanol (C_2H_6O) and ethanoic acid ($C_2H_4O_2$).

a) Write a chemical equation for the reaction performed.



After performing the reaction, you separate the homogenous mixture via distillation & condensation. The separation yields 3 samples that have unique boiling points.

b) Explain this observation and discuss whether or not it agrees with the reaction prediction from part a.

Yes, it agrees with (a). Although only 2 products are predicted, H_2O is present in excess and will be left over in the reaction vessel along with the 2 products.

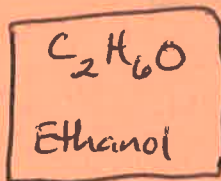
Each individual sample is analyzed for mass and %composition. The results are below.

Sample	Mass (g)	%Composition
1	8.15	52.14% C, 13.13% H, 34.73% O
2	10.63	40.00% C, 6.71% H, 53.29% O
3	45.66	11.19% H, 88.81% O

c) Explain and discuss whether or not both data columns agree with the reaction prediction from part a. Use calculations to support your answer.

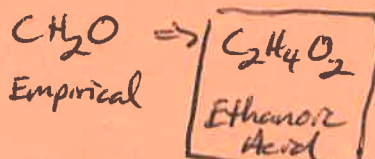
$$(1) \begin{array}{ccc} C & H & O \\ \frac{52.14}{12.01} & \frac{13.13}{1.008} & \frac{34.73}{16} \end{array}$$

$$\begin{array}{ccc} C & H & O \\ \frac{4.34}{2.17} & \frac{13.03}{2.17} & \frac{2.17}{2.17} \end{array}$$



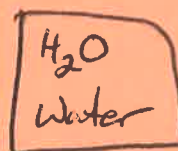
$$(2) \begin{array}{ccc} C & H & O \\ \frac{40.00}{12.01} & \frac{6.71}{1.008} & \frac{53.29}{16} \end{array}$$

$$\begin{array}{ccc} C & H & O \\ \frac{3.33}{3.33} & \frac{6.66}{3.33} & \frac{3.33}{3.33} \end{array}$$



$$(3) \begin{array}{ccc} H & O \\ \frac{11.19}{1.008} & \frac{88.81}{16} \end{array}$$

$$\begin{array}{cc} H & O \\ \frac{11.10}{5.55} & \frac{5.55}{5.55} \end{array}$$



d) Assuming the predicted products were correct, determine the percent yield of ethanol and ethanoic acid.

$$15.6 \text{ g } C_4H_8O_2 \left(\frac{1 \text{ mol } C_4H_8O_2}{88.10 \text{ g}} \right) \left(\frac{1 \text{ mol } C_2H_6O}{1 \text{ mol } C_4H_8O_2} \right) \left(\frac{46.07 \text{ g}}{1 \text{ mol } C_2H_6O} \right) = 8.16 \text{ g Ethanol}$$

$$15.6 \text{ g } C_4H_8O_2 \left(\frac{1 \text{ mol } C_4H_8O_2}{88.10 \text{ g}} \right) \left(\frac{1 \text{ mol } C_2H_4O_2}{1 \text{ mol } C_4H_8O_2} \right) \left(\frac{60.05 \text{ g}}{1 \text{ mol } C_2H_4O_2} \right) = 10.63 \text{ g Ethanoic Acid}$$

$$\% \text{ yield Ethanol} = \frac{8.15 \text{ g}}{8.16 \text{ g}} (100) = 99.9 \%$$

$$\% \text{ yield Ethanoic Acid} = \frac{10.63 \text{ g}}{10.63 \text{ g}} (100) = 100 \%$$