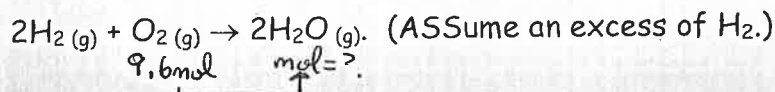


## Chemistry 11

## Stoichiometry Worksheet #1

**Directions:** Answer in the space provided. Be sure to show ALL your work. Please highlight your answer for each question. Watch for sig figs...and enemy fighters ;)

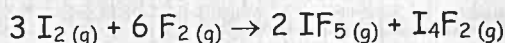
1. How many moles of  $\text{H}_2\text{O}(\text{g})$  are produced when 9.6 mol of  $\text{O}_2(\text{g})$  react according to the equation:



$$9.6 \text{ mol O}_2 \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2} = 19.2 \text{ mol H}_2\text{O}$$

$$\boxed{19 \text{ mol H}_2\text{O}}$$

2. Consider the equation:

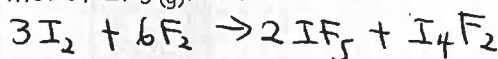


- a. How many moles of  $\text{I}_4\text{F}_2(\text{g})$  are produced by 5.4 mol of  $\text{F}_2(\text{g})$ ? ASSume an excess of  $\text{I}_2$ .

$$5.4 \text{ mol F}_2 \times \frac{1 \text{ mol I}_4\text{F}_2}{6 \text{ mol F}_2} = 0.90 \text{ mol I}_4\text{F}_2$$

- b. How many moles of  $\text{F}_2(\text{g})$  are required to produce 4.5 mol of  $\text{IF}_5(\text{g})$ ? ASSume an excess of  $\text{I}_2$ .

$$4.5 \text{ mol IF}_5 \times \frac{6 \text{ mol F}_2}{2 \text{ mol IF}_5} = 13.5 \text{ mol F}_2$$

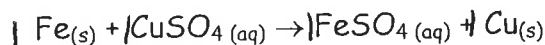


$$\boxed{13 \text{ mol F}_2}$$

- c. How many moles of  $\text{I}_2(\text{g})$  are required to react with exactly 7.6 mol of  $\text{F}_2(\text{g})$ ?

$$7.6 \text{ mol F}_2 \times \frac{3 \text{ mol I}_2}{6 \text{ mol F}_2} = \boxed{3.8 \text{ mol I}_2}$$

3. Consider the equation:



- a. If 14.3 g of Iron (II) sulphate is produced, how many grams of Iron are required?  
ASSume an excess of  $\text{CuSO}_4$ .

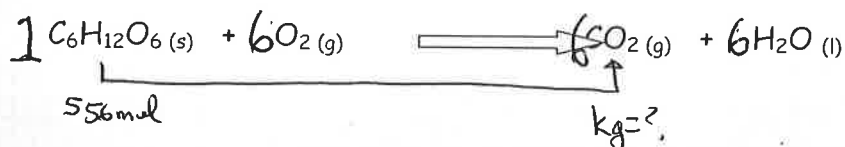
$$14.3 \text{ g FeSO}_4 \times \frac{1 \text{ mol FeSO}_4}{151.9 \text{ g FeSO}_4} \times \frac{1 \text{ mol Fe}}{1 \text{ mol FeSO}_4} \times \frac{55.0 \text{ g Fe}}{1 \text{ mol Fe}} = \boxed{5.18 \text{ g Fe}}$$

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4. What mass (in kg) of  $\text{CO}_2$  is produced by burning 556 moles of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) in air? What mass of oxygen is required?



$$556 \text{ mol C}_6\text{H}_{12}\text{O}_6 \times \frac{3 \text{ mol CO}_2}{1 \text{ mol C}_6\text{H}_{12}\text{O}_6} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} \times \frac{1 \text{ kg}}{1000 \text{ g}} = \boxed{73.4 \text{ kg CO}_2}$$

5. When 66.80 g of benzene,  $\text{C}_6\text{H}_6$ , is added to excess oxygen and ignited, carbon dioxide and water are produced.



- a. What mass of  $\text{CO}_2 (\text{g})$  is produced?

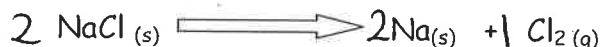
$$66.80 \text{ g C}_6\text{H}_6 \times \frac{1 \text{ mol C}_6\text{H}_6}{78.0 \text{ g C}_6\text{H}_6} \times \frac{12 \text{ mol CO}_2}{2 \text{ mol C}_6\text{H}_6} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} = \boxed{226 \text{ g CO}_2}$$

- b. What mass of  $\text{H}_2\text{O} (\text{l})$  is produced?



$$66.80 \text{ g C}_6\text{H}_6 \times \frac{1 \text{ mol C}_6\text{H}_6}{78.0 \text{ g C}_6\text{H}_6} \times \frac{6 \text{ mol H}_2\text{O}}{2 \text{ mol C}_6\text{H}_6} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \boxed{46.2 \text{ g H}_2\text{O}}$$

6. What is the mass of  $\text{NaCl}$  that will decompose to yield 355 g of  $\text{Cl}_2$ ?



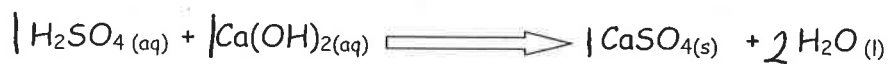
$$355 \text{ g Cl}_2 \times \frac{1 \text{ mol Cl}_2}{70.0 \text{ g Cl}_2} \times \frac{2 \text{ mol NaCl}}{1 \text{ mol Cl}_2} \times \frac{58.2 \text{ g NaCl}}{1 \text{ mol NaCl}} = \boxed{585 \text{ g NaCl}}$$

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7. For the neutralization of calcium hydroxide and sulphuric acid,



1. How many grams of calcium hydroxide will react with 29.4 g of sulphuric acid?

$$29.4 \text{ g H}_2\text{SO}_4 \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.1 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol Ca}(\text{OH})_2}{1 \text{ mol H}_2\text{SO}_4} \times \frac{74.1 \text{ g Ca}(\text{OH})_2}{1 \text{ mol Ca}(\text{OH})_2} = \boxed{22.2 \text{ g Ca}(\text{OH})_2}$$

2. What mass of  $\text{CaSO}_4$  will be produced?

$$29.4 \text{ g H}_2\text{SO}_4 \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.1 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol CaSO}_4}{1 \text{ mol H}_2\text{SO}_4} \times \frac{136.2 \text{ g CaSO}_4}{1 \text{ mol CaSO}_4} = \boxed{40.8 \text{ g CaSO}_4}$$

8. How is chemistry 11 going so far? What do you like? What's not so good?

9. Pick three (3) students in the class, and write something POSITIVE about them:

1.

2.

3.

KEY

## Chemistry 11

## Stoichiometry Worksheet #2

**Directions:** Answer in the space provided. Be sure to show ALL your work. Please highlight your answer for each question. Watch for sig figs...and Darth Vader ;)

1. Consider the reaction:



- a. What mass of  $\text{NO} (\text{g})$  is produced when 2.00 mol of  $\text{NH}_3 (\text{g})$  are reacted with an excess of  $\text{O}_2 (\text{g})$ ?

$$2.00 \text{ mol NH}_3 \times \frac{4 \text{ mol NO}}{4 \text{ mol NH}_3} \times \frac{30.0 \text{ g NO}}{1 \text{ mol NO}} = \boxed{60.0 \text{ g NO}}$$

- b. What mass of  $\text{H}_2\text{O} (\text{g})$  is produced when 4.00 mol of  $\text{O}_2 (\text{g})$  are reacted with an excess of  $\text{NH}_3 (\text{g})$ ?

$$4.00 \text{ mol O}_2 \times \frac{6 \text{ mol H}_2\text{O}}{5 \text{ mol O}_2} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \boxed{86.4 \text{ g H}_2\text{O}}$$

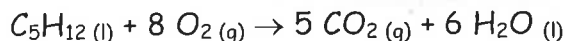
- c. What volume of  $\text{NH}_3 (\text{g})$  at STP is required to react with 3.00 mol of  $\text{O}_2 (\text{g})$ ?

$$3.00 \text{ mol O}_2 \times \frac{4 \text{ mol NH}_3}{5 \text{ mol O}_2} \times \frac{22.4 \text{ L NH}_3}{1 \text{ mol NH}_3} = \boxed{53.8 \text{ L of NH}_3}$$

- d. What volume of  $\text{NH}_3 (\text{g})$  at STP is required to produce 0.750 mol of  $\text{H}_2\text{O} (\text{g})$ ?

$$0.750 \text{ mol H}_2\text{O} \times \frac{4 \text{ mol NH}_3}{6 \text{ mol H}_2\text{O}} \times \frac{22.4 \text{ L NH}_3}{1 \text{ mol NH}_3} = \boxed{11.2 \text{ L of NH}_3}$$

2. Pentane,  $\text{C}_5\text{H}_{12} (\text{l})$ , burns according to the reaction:



- a. What mass of  $\text{H}_2\text{O}$  is produced when 100.0 g of  $\text{C}_5\text{H}_{12}$  is burned? Assume an excess of  $\text{O}_2$ .

$$100.0 \text{ g C}_5\text{H}_{12} \times \frac{1 \text{ mol C}_5\text{H}_{12}}{72.0 \text{ g C}_5\text{H}_{12}} \times \frac{6 \text{ mol H}_2\text{O}}{1 \text{ mol C}_5\text{H}_{12}} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \boxed{150. \text{ g H}_2\text{O}}$$

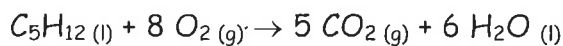
- b. What mass of  $\text{C}_5\text{H}_{12}$  is required to produce 90.0 L of  $\text{CO}_2$  at STP? Assume an excess of  $\text{O}_2$ .

$$90.0 \text{ L of CO}_2 \times \frac{1 \text{ mol CO}_2}{22.4 \text{ L CO}_2} \times \frac{1 \text{ mol C}_5\text{H}_{12}}{5 \text{ mol CO}_2} \times \frac{72.0 \text{ g C}_5\text{H}_{12}}{1 \text{ mol C}_5\text{H}_{12}} = \boxed{57.9 \text{ g C}_5\text{H}_{12}}$$

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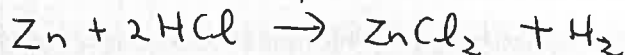
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- c. What volume of  $\text{O}_2$  at STP is required to produce 70.0 g of  $\text{CO}_2$ ? Assume an excess of  $\text{C}_5\text{H}_{12}$ .

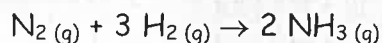
$$70.0 \text{g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.0 \text{g CO}_2} \times \frac{8 \text{ mol O}_2}{5 \text{ mol CO}_2} \times \frac{22.4 \text{ L of O}_2}{1 \text{ mol O}_2} = \boxed{57.0 \text{ L of O}_2}$$

3. How many litres of hydrogen gas will be produced by 5.72 g of zinc in the single replacement reaction of zinc and hydrochloric acid at STP?



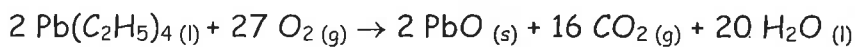
$$5.72 \text{g Zn} \times \frac{1 \text{ mol Zn}}{65.4 \text{g Zn}} \times \frac{1 \text{ mol H}_2}{1 \text{ mol Zn}} \times \frac{22.4 \text{ L of H}_2}{1 \text{ mol H}_2} = \boxed{1.96 \text{ L of H}_2}$$

4. Calculate the number of grams of nitrogen gas required to make 1.22 L of ammonia at STP. Assume an excess of  $\text{H}_2$ .



$$1.22 \text{ L of NH}_3 \times \frac{1 \text{ mol NH}_3}{22.4 \text{ L of NH}_3} \times \frac{1 \text{ mol N}_2}{2 \text{ mol NH}_3} \times \frac{28.0 \text{ g N}_2}{1 \text{ mol N}_2} = \boxed{0.762 \text{ g N}_2}$$

5. Tetraethyl lead,  $\text{Pb}(\text{C}_2\text{H}_5)_4 (\text{l})$ , is an "anti-knock" ingredient, which was added to some gasoline's. Tetraethyl lead burns according to the equation:



- a. What volume of  $\text{O}_2 (\text{g})$  at STP is consumed when 100.0 g of  $\text{PbO} (\text{s})$  are formed?

$$100.0 \text{g PbO} \times \frac{1 \text{ mol PbO}}{223.2 \text{g PbO}} \times \frac{27 \text{ mol O}_2}{2 \text{ mol PbO}} \times \frac{22.4 \text{ L of O}_2}{1 \text{ mol O}_2} = \boxed{135 \text{ L of O}_2}$$

- b. How many molecules of  $\text{CO}_2$  are formed when  $1.00 \times 10^{-6}$  g of tetraethyl lead is burned? Assume an excess of  $\text{O}_2$ .

$$1.00 \times 10^{-6} \text{g Pb}(\text{C}_2\text{H}_5)_4 \times \frac{1 \text{ mol}}{323.2 \text{g}} \times \frac{16 \text{ mol CO}_2}{2 \text{ mol Pb}(\text{C}_2\text{H}_5)_4} \times \frac{6.02 \times 10^{23} \text{ molecules CO}_2}{1 \text{ mol CO}_2}$$

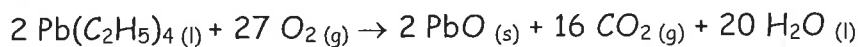
$$\boxed{1.49 \times 10^{16} \text{ molecules CO}_2}$$

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- c. What volume of  $\text{O}_2(\text{g})$  at STP, in milliliters, is required to react with  $1.00 \times 10^{15}$  molecules of tetraethyl lead?

$$1.00 \times 10^{15} \text{ molecules Pb}(\text{C}_2\text{H}_5)_4 \times \frac{1 \text{ mol Pb}(\text{C}_2\text{H}_5)_4}{6.02 \times 10^{23} \text{ Pb}(\text{C}_2\text{H}_5)_4} \times \frac{27 \text{ mol O}_2}{2 \text{ mol Pb}(\text{C}_2\text{H}_5)_4} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = \boxed{5.02 \times 10^{-7} \text{ L of O}_2}$$

6. How many grams of Silver chloride can be produced from 34.0 g of Silver nitrate? Assume an excess of NaCl.



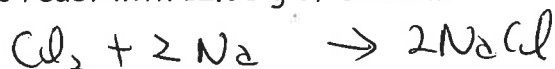
$$34.0 \text{ g AgNO}_3 \times \frac{1 \text{ mol AgNO}_3}{169.9 \text{ g AgNO}_3} \times \frac{1 \text{ mol AgCl}}{1 \text{ mol AgNO}_3} \times \frac{143.4 \text{ g AgCl}}{1 \text{ mol AgCl}} = \boxed{28.7 \text{ g AgCl}}$$

7. How many grams of Copper (I) sulphide could be produced from 19.8 g of Copper (I) chloride reacting with an excess of Hydrogen Sulphide gas?



$$19.8 \text{ g CuCl} \times \frac{1 \text{ mol CuCl}}{99.0 \text{ g CuCl}} \times \frac{1 \text{ mol Cu}_2\text{S}}{2 \text{ mol CuCl}} \times \frac{159.1 \text{ g Cu}_2\text{S}}{1 \text{ mol Cu}_2\text{S}} = \boxed{15.9 \text{ g Cu}_2\text{S}}$$

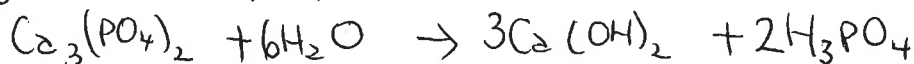
8. Chlorine gas reacts with sodium metal to produce sodium chloride. What mass of Chlorine will be needed to react with 12.30 g of Sodium?



$$12.30 \text{ g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} \times \frac{1 \text{ mol Cl}_2}{2 \text{ mol Na}} \times \frac{71.0 \text{ g Cl}_2}{1 \text{ mol Cl}_2} = \boxed{19.0 \text{ g Cl}_2}$$

**KEY**

9. Calcium phosphate and water react to form Calcium hydroxide and Phosphoric acid. How many grams of Calcium phosphate will be needed if 72.0 g of water react?



$$72.0\text{g H}_2\text{O} \times \frac{1\text{ mol H}_2\text{O}}{18.0\text{g H}_2\text{O}} \times \frac{1\text{ mol Ca}_3(\text{PO}_4)_2}{6\text{ mol H}_2\text{O}} \times \frac{310.3\text{ g Ca}_3(\text{PO}_4)_2}{1\text{ mol Ca}_3(\text{PO}_4)_2} = \boxed{207\text{g Ca}_3(\text{PO}_4)_2}$$

10. What mass of PbO is obtained by heating 100.0 g of PbCO<sub>3</sub> according to the following equation:



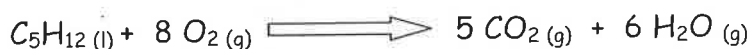
$$100.0\text{g PbCO}_3 \times \frac{1\text{ mol PbCO}_3}{267.2\text{ g PbCO}_3} \times \frac{1\text{ mol PbO}}{1\text{ mol PbCO}_3} \times \frac{223.2\text{g PbO}}{1\text{ mol PbO}} = \boxed{83.5\text{g PbO}}$$

11. How much zinc is required to produce 10.00 g of ZnCl<sub>2</sub> according to the following equation:



$$10.0\text{g ZnCl}_2 \times \frac{1\text{ mol ZnCl}_2}{136.4\text{ g ZnCl}_2} \times \frac{1\text{ mol Zn}}{1\text{ mol ZnCl}_2} \times \frac{65.4\text{g Zn}}{1\text{ mol Zn}} = \boxed{4.79\text{g Zn}}$$

12. Pentane burns according to the reaction:



- a. What volume in ml of CO<sub>2</sub>(g) at S.T.P is produced when 100.0 g of C<sub>5</sub>H<sub>12</sub>(l) is burned? (Assume an excess of O<sub>2</sub>).

$$100.0\text{g C}_5\text{H}_{12} \times \frac{1\text{ mol C}_5\text{H}_{12}}{72.0\text{g C}_5\text{H}_{12}} \times \frac{5\text{ mol CO}_2}{1\text{ mol C}_5\text{H}_{12}} \times \frac{22.4\text{ L}}{1\text{ mol CO}_2} = 156\text{ L of CO}_2 = \boxed{156,000\text{ mL of CO}_2}$$

- b. How many molecules of C<sub>5</sub>H<sub>12</sub>(l) would burn if only 50.0 g of O<sub>2</sub>(g) is available?

$$50.0\text{g O}_2 \times \frac{1\text{ mol O}_2}{32.0\text{g O}_2} \times \frac{1\text{ mol C}_5\text{H}_{12}}{8\text{ mol O}_2} \times \frac{6.02 \times 10^{23}\text{ molecules C}_5\text{H}_{12}}{1\text{ mol C}_5\text{H}_{12}} = \boxed{1.18 \times 10^{23}\text{ molecules of C}_5\text{H}_{12}}$$

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13. The net reaction for photosynthesis is water and carbon dioxide combining to form oxygen gas and glucose ( $C_6H_{12}O_6$ ). How many grams of carbon dioxide must a plant take in through its leaves to make 60.0 g of glucose? (Balanced? ☺...ASSume an excess of water)



$$60.0g C_6H_{12}O_6 \times \frac{1 \text{ mol } C_6H_{12}O_6}{180.0g C_6H_{12}O_6} \times \frac{6 \text{ mol } CO_2}{1 \text{ mol } C_6H_{12}O_6} \times \frac{44.0g CO_2}{1 \text{ mol } CO_2} = \boxed{88.0g CO_2}$$

14. Animals require glucose for energy which is released in a combustion reaction. Balanced?



- a. What mass of  $O_2$  is required to burn 75.0 g of glucose?

$$75.0g C_6H_{12}O_6 \times \frac{1 \text{ mol } C_6H_{12}O_6}{180.0g C_6H_{12}O_6} \times \frac{9 \text{ mol } O_2}{1 \text{ mol } C_6H_{12}O_6} \times \frac{32.0g O_2}{1 \text{ mol } O_2} = \boxed{120. g O_2}$$

- b. What mass of water will be produced?

$$75.0g C_6H_{12}O_6 \times \frac{1 \text{ mol } C_6H_{12}O_6}{180.0g C_6H_{12}O_6} \times \frac{6 \text{ mol } H_2O}{1 \text{ mol } C_6H_{12}O_6} \times \frac{18.0g H_2O}{1 \text{ mol } H_2O} = \boxed{45.0g H_2O}$$

- c. What volume, in ml's, of  $CO_2(g)$  will be produced at S.T.P?

$$75.0g C_6H_{12}O_6 \times \frac{1 \text{ mol } C_6H_{12}O_6}{180.0g C_6H_{12}O_6} \times \frac{6 \text{ mol } CO_2}{1 \text{ mol } C_6H_{12}O_6} \times \frac{22.4 L CO_2}{1 \text{ mol } CO_2} \times \frac{1000mL}{1L} = \boxed{56,000 mL \text{ of } CO_2}$$

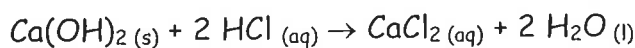


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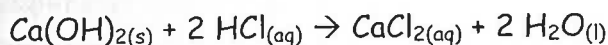
KEY

15. How many litres of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

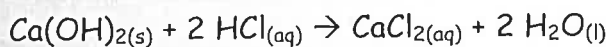


$$5.00 \text{ g Ca(OH)}_2 \times \frac{1 \text{ mol Ca(OH)}_2}{74.1 \text{ g Ca(OH)}_2} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Ca(OH)}_2} \times \frac{1 \text{ L of HCl}}{0.100 \text{ mol HCl}} = \boxed{1.35 \text{ L of HCl}}$$

For the following questions, please use this reaction:

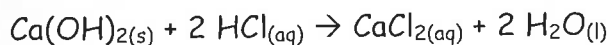


16. How many liters of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?



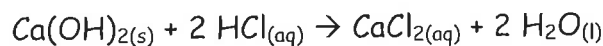
$$5.00 \text{ g Ca(OH)}_2 \times \frac{1 \text{ mol Ca(OH)}_2}{74.1 \text{ g Ca(OH)}_2} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Ca(OH)}_2} \times \frac{1 \text{ L of HCl}}{0.100 \text{ mol HCl}} = \boxed{1.35 \text{ L of HCl}}$$

17. How many grams of calcium hydroxide are needed to react with 69.50 ml of 0.350 M hydrochloric acid?  
= 0.06950 L



$$0.06950 \text{ L HCl} \times \frac{0.350 \text{ mol HCl}}{1 \text{ L HCl}} \times \frac{1 \text{ mol Ca(OH)}_2}{2 \text{ mol HCl}} \times \frac{74.1 \text{ g Ca(OH)}_2}{1 \text{ mol Ca(OH)}_2} = \boxed{0.901 \text{ g Ca(OH)}_2}$$

18. If 350.0 ml's of 0.250 M Calcium chloride were produced, what mass of Calcium hydroxide was required? (Assume an excess of HCl)



$$0.3500 \text{ L CaCl}_2 \times \frac{0.250 \text{ mol CaCl}_2}{1 \text{ L CaCl}_2} \times \frac{1 \text{ mol Ca(OH)}_2}{1 \text{ mol CaCl}_2} \times \frac{74.1 \text{ g Ca(OH)}_2}{1 \text{ mol Ca(OH)}_2} = \boxed{6.46 \text{ g Ca(OH)}_2}$$

=

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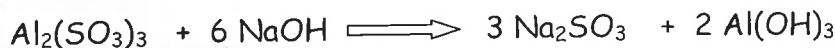
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# Chemistry 11

## Stoichiometry Worksheet #3

Directions: Answer in the space provided. Be sure to show ALL your work. Please highlight your answer for each question. Watch for sig figs...and Aliens ;)

1. Given the following equation:



a. If 10.0 g of  $\text{Al}_2(\text{SO}_3)_3$  is reacted with 10.0 g of NaOH, determine the limiting reagent

$$10.0 \text{ g Al}_2(\text{SO}_3)_3 \times \frac{1 \text{ mol Al}_2(\text{SO}_3)_3}{294.3 \text{ g Al}_2(\text{SO}_3)_3} \times \frac{3 \text{ mol Na}_2\text{SO}_3}{1 \text{ mol Al}_2(\text{SO}_3)_3} = \boxed{0.102 \text{ mol Na}_2\text{SO}_3}$$

(Limiting Reagent)

$$10.0 \text{ g NaOH} \times \frac{1 \text{ mol NaOH}}{40.0 \text{ g NaOH}} \times \frac{3 \text{ mol Na}_2\text{SO}_3}{6 \text{ mol NaOH}} = \boxed{0.125 \text{ mol Na}_2\text{SO}_3}$$

(EXCESS Reagent)

b. Determine the number of grams of  $\text{Na}_2\text{SO}_3$  produced

$$0.102 \text{ mol Na}_2\text{SO}_3 \times \frac{126.1 \text{ g Na}_2\text{SO}_3}{1 \text{ mol Na}_2\text{SO}_3} = \boxed{12.9 \text{ g Na}_2\text{SO}_3}$$

c. Determine the number of grams of excess reagent left over in the reaction

$$10.0 \text{ g Al}_2(\text{SO}_3)_3 \times \frac{1 \text{ mol Al}_2(\text{SO}_3)_3}{294.3 \text{ g Al}_2(\text{SO}_3)_3} \times \frac{6 \text{ mol NaOH}}{1 \text{ mol Al}_2(\text{SO}_3)_3} \times \frac{40.0 \text{ g NaOH}}{1 \text{ mol NaOH}} = \boxed{8.16 \text{ g NaOH}}$$

$$\therefore \boxed{10.0 \text{ g} - 8.16 \text{ g} = 1.8 \text{ g NaOH excess}}$$

d. Calculate how many grams of  $\text{Al}(\text{OH})_3$  are produced

$$10.0 \text{ g Al}_2(\text{SO}_3)_3 \times \frac{1 \text{ mol Al}_2(\text{SO}_3)_3}{294.3 \text{ g Al}_2(\text{SO}_3)_3} \times \frac{2 \text{ mol Al}(\text{OH})_3}{1 \text{ mol Al}_2(\text{SO}_3)_3} \times \frac{78.0 \text{ g Al}(\text{OH})_3}{1 \text{ mol Al}(\text{OH})_3} = \boxed{5.30 \text{ g Al}(\text{OH})_3}$$

Name: \_\_\_\_\_

KEY

Period: \_\_\_\_\_

2. Given the following equation:

a. If 25.4 g of  $\text{Al}_2\text{O}_3$  is reacted with 10.2 g of Fe, determine the limiting reagent

$$25.4 \text{ g Al}_2\text{O}_3 \times \frac{1 \text{ mol Al}_2\text{O}_3}{102.0 \text{ g Al}_2\text{O}_3} \times \frac{8 \text{ mol Al}}{4 \text{ mol Al}_2\text{O}_3} = 0.498 \text{ mol Al}$$

(Excess Reagent)

$$10.2 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.8 \text{ g Fe}} \times \frac{8 \text{ mol Al}}{9 \text{ mol Fe}} = 0.162 \text{ mol Al}$$

(Limiting Reagent)

b. Determine the mass, in grams, of Al produced

$$0.162 \text{ mol Al} \times \frac{27.0 \text{ g}}{1 \text{ mol}} = 4.37 \text{ g Al}$$

c. Determine the number of grams of  $\text{Fe}_3\text{O}_4$  produced

$$10.2 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.8 \text{ g Fe}} \times \frac{3 \text{ mol Fe}_3\text{O}_4}{9 \text{ mol Fe}} \times \frac{231.4 \text{ g Fe}_3\text{O}_4}{1 \text{ mol Fe}_3\text{O}_4} = 14.1 \text{ g Fe}_3\text{O}_4$$

d. Determine the number of grams of excess reagent left over in the reaction

$$10.2 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.8 \text{ g Fe}} \times \frac{4 \text{ mol Al}_2\text{O}_3}{9 \text{ mol Fe}} \times \frac{102.0 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} = 8.29 \text{ g Al}_2\text{O}_3$$

$$\text{Excess Reagent left} = 25.4 \text{ g} - 8.29 \text{ g}$$

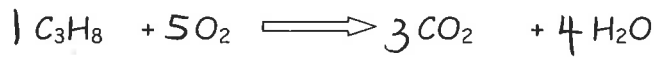
$$= 17.1 \text{ g Al}_2\text{O}_3$$

Name: \_\_\_\_\_

KEY

Period: \_\_\_\_\_

3. Given the following reaction:



If you start with 14.8 g of  $\text{C}_3\text{H}_8$  and 3.44 g of  $\text{O}_2$ ,

a. Determine the limiting reagent

$$14.8 \text{ g C}_3\text{H}_8 \times \frac{1 \text{ mol C}_3\text{H}_8}{44.0 \text{ g C}_3\text{H}_8} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8} = 1.01 \text{ mol CO}_2$$

(Excess Reagent)

$$3.44 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{3 \text{ mol CO}_2}{5 \text{ mol O}_2} = 0.0645 \text{ mol CO}_2$$

(Limiting Reagent)

b. Determine the grams of carbon dioxide produced

$$0.0645 \text{ mol CO}_2 \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} = 2.84 \text{ g CO}_2$$

c. Determine the grams of  $\text{H}_2\text{O}$  produced

$$3.44 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{4 \text{ mol H}_2\text{O}}{5 \text{ mol O}_2} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 1.55 \text{ g H}_2\text{O}$$

d. Determine the number of grams of excess reagent left

$$3.44 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{1 \text{ mol C}_3\text{H}_8}{5 \text{ mol O}_2} \times \frac{44.0 \text{ g C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} = 0.946 \text{ g C}_3\text{H}_8$$

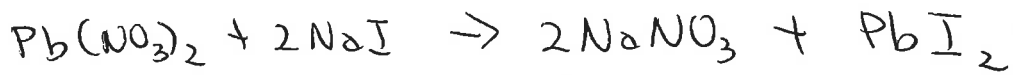
$$\text{Excess C}_3\text{H}_8 = 14.8 \text{ g} - 0.946 \text{ g} = 13.9 \text{ g C}_3\text{H}_8 \text{ excess}$$

Name: \_\_\_\_\_

KEY

Period: \_\_\_\_\_

4. Write the balanced equation for the reaction of lead (II) nitrate with sodium iodide to form sodium nitrate and lead (II) iodide



a. If you start with 25.0 grams of lead (II) nitrate and 15.0 grams of sodium iodide, what is the limiting reagent?

$$25.0\text{g Pb}(\text{NO}_3)_2 \times \frac{1\text{mol Pb}(\text{NO}_3)_2}{331.2\text{g Pb}(\text{NO}_3)_2} \times \frac{1\text{mol PbI}_2}{1\text{mol Pb}(\text{NO}_3)_2} = \boxed{0.0755\text{mol Pb}(\text{NO}_3)_2}$$

(EXCESS reagent)

$$15.0\text{g NaI} \times \frac{1\text{mol NaI}}{149.9\text{g NaI}} \times \frac{1\text{mol Pb}(\text{NO}_3)_2}{2\text{mol NaI}} = \boxed{0.0500\text{mol Pb}(\text{NO}_3)_2}$$

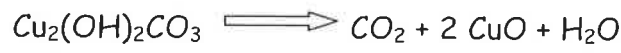
(LIMITING reagent)

b. How much excess reactant will be left over from the reaction

$$15.0\text{g NaI} \times \frac{1\text{mol NaI}}{149.9\text{g NaI}} \times \frac{1\text{mol Pb}(\text{NO}_3)_2}{2\text{mol NaI}} \times \frac{331.2\text{g Pb}(\text{NO}_3)_2}{1\text{mol Pb}(\text{NO}_3)_2} = \boxed{16.6\text{g Pb}(\text{NO}_3)_2}$$

$$\text{Excess Reactant} = 25.0\text{g} - 16.6\text{g} = \boxed{8.4\text{g Pb}(\text{NO}_3)_2 \text{ excess}}$$

5. When a sample of malachite ore containing 215.0 g of malachite,  $(\text{Cu}_2(\text{OH})_2\text{CO}_3)$  was heated, the products were copper (II) oxide, carbon dioxide and water.



a. What is the theoretical yield of CuO in grams?

$$215.0\text{g Cu}_2(\text{OH})_2\text{CO}_3 \times \frac{1\text{mol Cu}_2(\text{OH})_2\text{CO}_3}{221.0\text{g Cu}_2(\text{OH})_2\text{CO}_3} \times \frac{2\text{mol CuO}}{1\text{mol Cu}_2(\text{OH})_2\text{CO}_3} \times \frac{79.5\text{g CuO}}{1\text{mol CuO}} = \boxed{155\text{g CuO}}$$

b. If the reaction had an 84.0% yield, how many grams of CuO actually formed?

$$\% \text{ Yield} = \frac{\text{AY}}{\text{TY}} \times 100\%$$

$$84\% = \frac{\text{AY}}{155\text{g}} \times 100\%$$

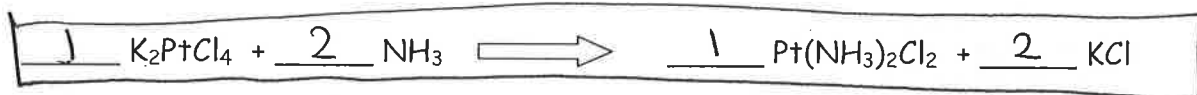
$$\boxed{\text{Actual Yield} = 130\text{g CuO}}$$

Name: \_\_\_\_\_

KEY

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6. Given the following equation:



a. Balance the equation.

Balanced above shown.

b. Determine the theoretical yield of KCl if you start with 34.5 grams of  $\text{NH}_3$ . (ASSume an excess of  $\text{K}_2\text{PtCl}_4$ ).

$$34.5 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.0 \text{ g NH}_3} \times \frac{2 \text{ mol KCl}}{2 \text{ mol NH}_3} \times \frac{74.6 \text{ g KCl}}{1 \text{ mol KCl}} = \boxed{151 \text{ g KCl}}$$

c. Starting with 34.5 g of  $\text{NH}_3$ , you isolated 76.4 g of KCl. What is the percent yield?

$$\% \text{ yield} = \frac{\text{AY}}{\text{TY}} \times 100\% = \frac{76.4 \text{ g}}{151 \text{ g}} \times 100\%$$

$$\% \text{ yield} = \frac{76.4 \text{ g}}{151 \text{ g}} \times 100\% = \boxed{50.6\% \text{ yield KCl}}$$

7. Given the following equation:

If 49.0 g of  $\text{H}_3\text{PO}_4$  is reacted with excess KOH, determine the percent yield of  $\text{K}_3\text{PO}_4$  if you isolate 49.0 g of  $\text{K}_3\text{PO}_4$ .

$$49.0 \text{ g H}_3\text{PO}_4 \times \frac{1 \text{ mol H}_3\text{PO}_4}{98.0 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol K}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} \times \frac{212.3 \text{ g K}_3\text{PO}_4}{1 \text{ mol K}_3\text{PO}_4} = \boxed{106.2 \text{ g K}_3\text{PO}_4}$$

$$\% \text{ yield} = \frac{\text{AY}}{\text{TY}} \times 100\% = \frac{49.0 \text{ g K}_3\text{PO}_4}{106.2 \text{ g K}_3\text{PO}_4} \times 100\%$$

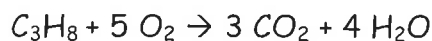
$$\% \text{ yield} = 46.1\% \text{ yield K}_3\text{PO}_4$$

Name: \_\_\_\_\_

KEY

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8. Consider the following reaction:

a. If I start with 5.00 grams of  $\text{C}_3\text{H}_8$ , what is my theoretical yield of water? (Assume an excess of  $\text{O}_2$ )

$$5.00 \text{ g C}_3\text{H}_8 \times \frac{1 \text{ mol C}_3\text{H}_8}{44.0 \text{ g C}_3\text{H}_8} \times \frac{4 \text{ mol H}_2\text{O}}{1 \text{ mol C}_3\text{H}_8} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \boxed{8.18 \text{ g H}_2\text{O}}$$

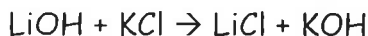
b. I got a percent yield of 75.0%. How many grams of water did I make?

$$\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$$

$$75\% = \frac{\text{AY}}{8.18 \text{ g H}_2\text{O}} \times 100\%$$

$$\boxed{\text{AY} = 6.14 \text{ g H}_2\text{O}}$$

9. Consider the following reaction:



a. What is the theoretical yield of lithium chloride if 20.0 grams of lithium hydroxide are reacted? (Assume an excess of KCl)

$$20.0 \text{ g LiOH} \times \frac{1 \text{ mol LiOH}}{23.9 \text{ g LiOH}} \times \frac{1 \text{ mol LiCl}}{1 \text{ mol LiOH}} \times \frac{42.4 \text{ g LiCl}}{1 \text{ mol LiCl}} = \boxed{35.5 \text{ g LiCl}}$$

b. 6.00 grams of lithium chloride were actually produced. What is the percent yield?

$$\% \text{ Yield} = \frac{\text{AY}}{\text{TY}} \times 100\%$$

$$= \frac{6.00 \text{ g}}{35.5 \text{ g}} \times 100\% = \boxed{16.9\% \text{ LiCl yield}}$$

Name: \_\_\_\_\_

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# Chemistry 11

## Stoichiometry Worksheet - Unit Review

Directions: Answer in the space provided. Have fun ☺

1. When 85.1 g of zinc are reacted with 125.65 g hydrochloric acid, HCl, to produce zinc chloride, ZnCl<sub>2</sub>, and hydrogen gas, H<sub>2</sub>, which reactant will be in excess and by how much? Calculate the number of grams of H<sub>2</sub>.



$$85.1\text{g Zn (LIMITING Reagent)} \times \frac{1\text{ mol Zn}}{65.4\text{g Zn}} \times \frac{1\text{ mol H}_2}{1\text{ mol Zn}} = 1.30\text{ mol H}_2 \times \frac{2.00\text{g}}{1\text{ mol H}_2} = 2.60\text{g H}_2 \text{ produced.}$$

$$125.65\text{g HCl (EXCESS Reagent)} \times \frac{1\text{ mol HCl}}{36.5\text{g HCl}} \times \frac{1\text{ mol H}_2}{2\text{ mol HCl}} = 1.72\text{ mol H}_2$$

$$\text{Excess Reactant Amount} = 1.30\text{ mol H}_2 \times \frac{2\text{ mol HCl}}{1\text{ mol H}_2} \times \frac{36.5\text{g HCl}}{1\text{ mol HCl}} = 94.9\text{g HCl}$$

$$\text{Excess HCl} = 125.65\text{g} - 94.9\text{g} = 30.75\text{g HCl excess}$$

2. If 10.45 g of aluminium are reacted with 66.55 g of copper (II) sulphate, CuSO<sub>4</sub>, then aluminium sulphate, Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, and copper are formed. Which reactant is in excess? By how much? Calculate the mass of each product.



$$10.45\text{g Al (EXCESS Reagent)} \times \frac{1\text{ mol Al}}{27.0\text{g Al}} \times \frac{1\text{ mol Al}_2(\text{SO}_4)_3}{2\text{ mol Al}} = 0.194\text{ mol Al}_2(\text{SO}_4)_3$$

$$66.55\text{g CuSO}_4 \text{ (Limiting Reagent)} \times \frac{1\text{ mol CuSO}_4}{159.6\text{g CuSO}_4} \times \frac{1\text{ mol Al}_2(\text{SO}_4)_3}{3\text{ mol CuSO}_4} = 0.139\text{ mol Al}_2(\text{SO}_4)_3$$

Amount of PRODUCTS FORMED

$$0.139\text{ mol Al}_2(\text{SO}_4)_3 \times \frac{342.3\text{g Al}_2(\text{SO}_4)_3}{1\text{ mol Al}_2(\text{SO}_4)_3} = 47.6\text{g Al}_2(\text{SO}_4)_3$$

$$0.139\text{ mol Al}_2(\text{SO}_4)_3 \times \frac{3\text{ mol Cu}}{1\text{ mol Al}_2(\text{SO}_4)_3} \times \frac{63.5\text{g Cu}}{1\text{ mol Cu}} = 26.5\text{g Cu}$$

$$\text{Excess Reactant Amount} = 0.139\text{ mol Al}_2(\text{SO}_4)_3 \times \frac{2\text{ mol Al}}{1\text{ mol Al}_2(\text{SO}_4)_3} \times \frac{27.0\text{g Al}}{1\text{ mol Al}} = 7.51\text{g Al}$$

$$\text{Excess Al} = 10.45\text{g} - 7.51\text{g} = 2.94\text{g Al excess}$$



Name: \_\_\_\_\_

KEY

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3. Large amounts of uranium metals are produced by reacting uranium (IV) chloride with magnesium metal to produce magnesium chloride and uranium metal.



- a. How many grams of magnesium are required to completely react 155 g of uranium (IV) chloride?

$$155 \text{g UCl}_4 \times \frac{1 \text{ mol UCl}_4}{380.0 \text{ g UCl}_4} \times \frac{2 \text{ mol Mg}}{1 \text{ mol UCl}_4} \times \frac{24.3 \text{ g Mg}}{1 \text{ mol Mg}} = \boxed{19.8 \text{ g Mg}}$$

- b. How many grams of uranium metal will be produced?

$$155 \text{g UCl}_4 \times \frac{1 \text{ mol UCl}_4}{380.0 \text{ g UCl}_4} \times \frac{1 \text{ mol U}}{1 \text{ mol UCl}_4} \times \frac{238.0 \text{ g U}}{1 \text{ mol U}} = \boxed{97.0 \text{ g U}}$$

4. The methyl alcohol,  $\text{CH}_3\text{OH}$ , used in alcohol burners combines with oxygen gas to form carbon dioxide and water. How many ml's of oxygen gas at S.T.P are required to burn 34.2 g of methyl alcohol?



$$34.2 \text{g CH}_3\text{OH} \times \frac{1 \text{ mol CH}_3\text{OH}}{32.0 \text{ g CH}_3\text{OH}} \times \frac{3 \text{ mol O}_2}{2 \text{ mol CH}_3\text{OH}} \times \frac{22.4 \text{ L of O}_2}{1 \text{ mol O}_2} = \boxed{23.9 \text{ L of O}_2}$$

23900ml  
O<sub>2</sub>

5. What volume of 0.60M copper (II) sulphate will react with 45 ml of 1.50 M sodium hydroxide to form copper (II) hydroxide and sodium sulphate?



$$\frac{1.50 \text{ mol}}{1 \text{ L}} \text{NaOH} \times 0.045 \text{ L} \times \frac{1 \text{ mol Cu(OH)}_2}{2 \text{ mol NaOH}} \times \frac{1 \text{ L Cu(OH)}_2}{0.60 \text{ mol Cu(OH)}_2} = \boxed{0.0563 \text{ L Cu(OH)}_2}$$

Name: KEY

Period: \_\_\_\_\_

6. Caustic Soda (NaOH) is prepared commercially by passing an electric current through a concentrated solution of salt in water:



- a. What is the theoretical yield of caustic soda if 100.0 kg of sodium chloride is electrolysed?

$$100.0 \text{ kg NaCl} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol NaCl}}{58.5 \text{ g NaCl}} \times \frac{2 \text{ mol NaOH}}{2 \text{ mol NaCl}} \times \frac{40 \text{ g NaOH}}{1 \text{ mol NaOH}} =$$

**66 500 g or 68.5 Kg NaOH**

- b. What is the percent yield if the electrolysis produces 55.0 kg of caustic soda?

$$\% \text{ yield} = \frac{55.0 \text{ kg}}{68.5 \text{ kg}} \times 100\% = \boxed{80.3\% \text{ yield NaOH}}$$

7. Freon-12 ( $\text{CCl}_2\text{F}_2$ ) is a gas used as a refrigerant. It is prepared by the reaction:



If the % yield is 72.0, how many grams of antimony trifluoride ( $\text{SbF}_3$ ) will be produced if 25.0 g of Freon-12 is reacted with excess carbon tetrachloride?

$$\text{TY} = 25.0 \text{ g CCl}_2\text{F}_2 \times \frac{1 \text{ mol CCl}_2\text{F}_2}{121.0 \text{ g CCl}_2\text{F}_2} \times \frac{2 \text{ mol SbF}_3}{3 \text{ mol CCl}_2\text{F}_2} \times \frac{178.8 \text{ g SbF}_3}{1 \text{ mol SbF}_3} = 24.6 \text{ g SbF}_3$$

$$\% \text{ yield} = \frac{\text{AY}}{\text{TY}} \times 100\%$$

$$\boxed{\text{AY} = \frac{72(24.6)}{100} = 17.7 \text{ g SbF}_3}$$

8. What volume, in ml's, of 0.550 M Nickel (II) nitrate, will react with 85.0 ml of 0.250 M potassium carbonate to form nickel (I) carbonate and potassium nitrate,



$$\frac{0.250 \text{ mol}}{1 \text{ L}} \text{K}_2\text{CO}_3 \times 0.0850 \text{ L} \times \frac{1 \text{ mol Ni}(\text{NO}_3)_2}{1 \text{ mol K}_2\text{CO}_3} \times \frac{1 \text{ L}}{0.550 \text{ mol Ni}(\text{NO}_3)_2}$$

$$= 0.0386 \text{ L} = \boxed{38.6 \text{ mL of Ni}(\text{NO}_3)_2}$$

Name: \_\_\_\_\_

KEY

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9. 5.45 g of potassium chlorate is decomposed and forms potassium chloride and 1.95 g of oxygen gas.



- a. Calculate the theoretical yield of oxygen.

$$5.45 \text{ g KClO}_3 \times \frac{1 \text{ mol KClO}_3}{122.6 \text{ g KClO}_3} \times \frac{3 \text{ mol O}_2}{2 \text{ mol KClO}_3} \times \frac{32.0 \text{ g O}_2}{1 \text{ mol O}_2} = \boxed{2.13 \text{ g O}_2}$$

- b. Calculate the % yield of oxygen.

$$\% \text{ yield} = \frac{1.95 \text{ g}}{2.13 \text{ g}} \times 100\% = \boxed{92\% \text{ yield of O}_2}$$

10. If 15.50 g of lead (II) nitrate,  $\text{Pb}(\text{NO}_3)_2$ , are reacted with 3.81 g of sodium chloride,  $\text{NaCl}$ , then sodium nitrate,  $\text{NaNO}_3$ , and lead (II) chloride,  $\text{PbCl}_2$ , are formed.



- a. Which reactant will be in excess?

$$\begin{array}{l} 15.50 \text{ g Pb}(\text{NO}_3)_2 \\ \text{(Excess Reagent)} \end{array} \times \frac{1 \text{ mol Pb}(\text{NO}_3)_2}{331.2 \text{ g Pb}(\text{NO}_3)_2} \times \frac{2 \text{ mol NaNO}_3}{1 \text{ mol Pb}(\text{NO}_3)_2} = \boxed{0.0936 \text{ mol NaNO}_3}$$

$$\begin{array}{l} 3.81 \text{ g NaCl} \\ \text{(Limiting Reagent)} \end{array} \times \frac{1 \text{ mol NaCl}}{58.5 \text{ g NaCl}} \times \frac{2 \text{ mol NaNO}_3}{2 \text{ mol NaCl}} = \boxed{0.0651 \text{ mol NaNO}_3}$$

- b. Calculate the mass of the excess reactant.

$$0.0651 \text{ mol NaNO}_3 \times \frac{1 \text{ mol Pb}(\text{NO}_3)_2}{2 \text{ mol NaNO}_3} \times \frac{331.2 \text{ g Pb}(\text{NO}_3)_2}{1 \text{ mol Pb}(\text{NO}_3)_2} = 10.79 \text{ g Pb}(\text{NO}_3)_2$$

$$\text{Excess Reactant} = 15.50 \text{ g} - 10.79 \text{ g} = \boxed{4.71 \text{ g Pb}(\text{NO}_3)_2 \text{ excess}}$$

- c. Calculate the mass of lead (II) chloride produced.

$$0.0651 \text{ mol NaNO}_3 \times \frac{1 \text{ mol PbCl}_2}{2 \text{ mol NaNO}_3} \times \frac{278.2 \text{ g PbCl}_2}{1 \text{ mol PbCl}_2} = \boxed{9.06 \text{ g PbCl}_2}$$