

# The GIANT Stoich Review

## Part One: Just plain Stoichiometry

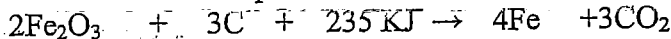
- 1 Calculate the amount of oxygen in grams produced by the reaction of 69.0 g of water.  $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$

$$69.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.0152 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} \times \frac{31.9988 \text{ g O}_2}{1 \text{ mol O}_2} \\ = 61.28 \text{ g O}_2$$

- 2 Calculate the energy in KJ produced by the reaction of 10.0 Kg of hydrogen with excess oxygen.  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + 213\text{KJ}$

$$10.0 \text{ Kg} \times \frac{1000 \text{ g H}_2}{1 \text{ Kg}} \times \frac{1 \text{ mol H}_2}{2.0158 \text{ g H}_2} \times \frac{213 \text{ KJ}}{2 \text{ mol H}_2} \\ = 528326.2 \text{ KJ}$$

- 3 Calculate the number of Fe atoms produced in the reaction if 500. J of energy are absorbed.

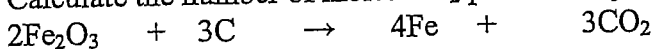


$$500 \text{ J} \times \frac{1}{235}$$

$$500 \text{ J} \times \frac{1 \text{ KJ}}{1000 \text{ J}} \times \frac{4 \text{ mol Fe}}{235 \text{ KJ}} \times \frac{6.02 \times 10^{23} \text{ part. Fe}}{1 \text{ mol Fe}} \times \frac{1 \text{ atom Fe}}{1 \text{ particle Fe}}$$

$$= 5.12 \times 10^{21} \text{ atoms Fe}$$

- 4 Calculate the number of moles  $\text{CO}_2$  produced by the reaction of 8.45 g of C.



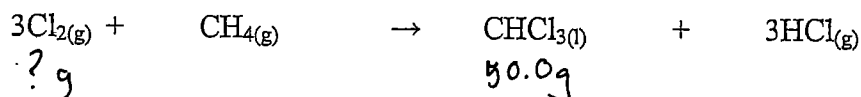
$$8.45 \text{ g C} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}} \times \frac{3 \text{ mol CO}_2}{3 \text{ mol C}} = 0.704 \text{ mol CO}_2$$

- 5 How many liters of  $O_2$ , measured at STP, will be released on the decomposition of 2.65 g of mercury (II) oxide:  $2HgO \rightarrow 2Hg + O_2$

$$2.65 \text{ g HgO} \times \frac{1 \text{ mol HgO}}{216.5894 \text{ g HgO}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol HgO}} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2}$$

$$= 0.137 \text{ L O}_2$$

- 6 Chloroform or trichloromethane,  $CHCl_3$ , may be prepared in the laboratory by the reaction between Chlorine and methane. Calculate the number of grams of chlorine that are required to produce 50.0 g of trichloromethane.

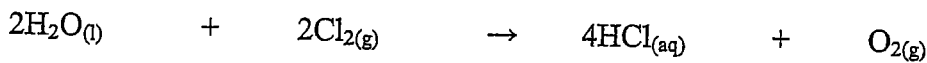


$$50.0 \text{ g CHCl}_3 \times \frac{1 \text{ mol CHCl}_3}{119.377 \text{ g CHCl}_3} \times \frac{3 \text{ mol Cl}_2}{1 \text{ mol CHCl}_3} \times \frac{70.0954 \text{ g Cl}_2}{1 \text{ mol Cl}_2}$$

$$= 89.09 \text{ g Cl}_2$$

7

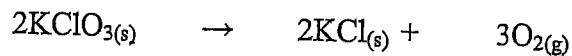
The purification ability and bleaching action of bleaching activity of chlorine both come from the effective release of oxygen by the reaction below. How many grams of oxygen will be liberated by 255 g of chlorine?



$$255 \text{ g Cl}_2 \times \frac{1 \text{ mol Cl}_2}{70.9054 \text{ g Cl}_2} \times \frac{1 \text{ mol O}_2}{2 \text{ mol Cl}_2} \times \frac{31.9988 \text{ g O}_2}{1 \text{ mol O}_2} = 57.54 \text{ g O}_2$$

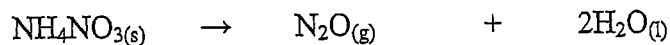
8

What mass of potassium chlorate must be decomposed to produce 1.50 liters of oxygen at STP?



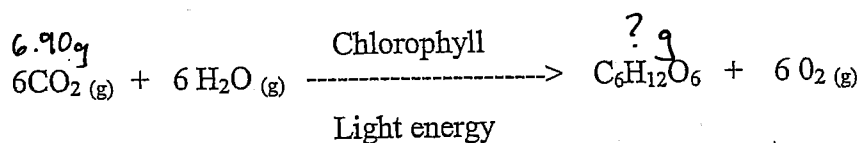
$$1.50 \text{ L O}_2 \times \frac{1 \text{ mol O}_2}{22.4 \text{ L O}_2} \times \frac{2 \text{ mol KClO}_3}{3 \text{ mol O}_2} \times \frac{122.5492 \text{ g KClO}_3}{1 \text{ mol KClO}_3} = 5.47 \text{ g KClO}_3$$

- 9 Dinitrogen oxide  $N_2O$  - Known also as nitrous oxide and laughing gas - was one of early anesthetics, and has recently regained popularity in this role in the dental field. It is made by the decomposition of ammonium nitrate which equations shown below. How many grams of  $NH_4NO_3$  (s) are required to prepare 12.8 grams of  $N_2O$ ?



$$12.8 \text{ g } N_2O \times \frac{1 \text{ mol } N_2O}{44.0128 \text{ g } N_2O} \times \frac{1 \text{ mol } NH_4NO_3}{1 \text{ mol } N_2O} \times \frac{80.0432 \text{ g } NH_4NO_3}{1 \text{ mol } NH_4NO_3} = 23.28 \text{ g } NH_4NO_3$$

- 10 Photosynthesis is the process by which carbon dioxide is converted into sugar,  $C_6H_{12}O_6$ , with the help of sunlight and the chlorophyll of green plants acting as a catalyst. It may be summarized by the equation below. How many grams of sugar may be produced in the reaction that consumes 6.90 grams of carbon dioxide?



$$6.90 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.0098 \text{ g } CO_2} \times \frac{1 \text{ mol } C_6H_{12}O_6}{6 \text{ mol } CO_2} \times \frac{180.1572 \text{ g } \text{glucose}}{1 \text{ mol } \text{glucose}} = 4.71 \text{ g } C_6H_{12}O_6$$

11

Calculate the amount of oxygen in grams produced by the reaction of 125 g of water.

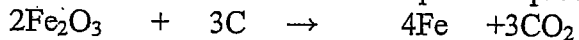
$$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$$

$$125 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.0152 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} \times \frac{31.9988 \text{ g O}_2}{1 \text{ mol O}_2}$$

$$= 111.01 \text{ g O}_2$$

12

Calculate the mass of carbon required to produce 5.67 g of iron.

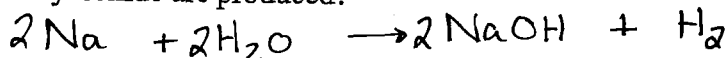


$$5.67 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.845 \text{ g Fe}} \times \frac{3 \text{ mol C}}{4 \text{ mol Fe}} \times \frac{12.011 \text{ g C}}{1 \text{ mol C}}$$

$$= 0.915 \text{ g C}$$

13

25.0 g of sodium reacts with water, how many grams of hydrogen are produced?  
How many grams of sodium hydroxide are produced?

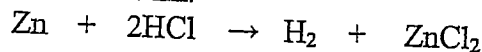


$$25.0 \text{ g Na} \times \frac{1 \text{ mol Na}}{22.9898 \text{ g Na}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol Na}} \times \frac{2.0158 \text{ g H}_2}{1 \text{ mol H}_2} = 1.096 \text{ g H}_2$$

$$25.0 \text{ g Na} \times \frac{1 \text{ mol Na}}{22.9898 \text{ g Na}} \times \frac{2 \text{ mol NaOH}}{2 \text{ mol Na}} \times \frac{39.9971 \text{ g NaOH}}{1 \text{ mol NaOH}} = 43.49 \text{ g NaOH}$$

14

Calculate the volume of H<sub>2</sub> gas produced at STP by the reaction of 400.0 mL of 0.800 M HCl with excess Zn.



$$\text{mol} = M \times V_L$$

$$= (0.800 \text{ M})(0.400 \text{ L})$$

$$= 0.32 \text{ moles}$$

$$0.32 \text{ mol HCl} \times \frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} \times \frac{22.4 \text{ L H}_2}{1 \text{ mol H}_2}$$

$$= 3.584 \text{ L H}_2$$

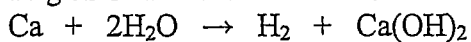
15

Calculate the mass of KF required to produce 100. L of  $F_2$  gas at STP.



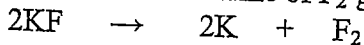
$$100. \text{ L } F_2 \times \frac{1 \text{ mol } F_2}{22.4 \text{ L } F_2} \times \frac{2 \text{ mol } KF}{1 \text{ mol } F_2} \times \frac{58.0967 \text{ g } KF}{1 \text{ mol } KF} = 518.72 \text{ g } KF$$

16 16 g of Ca react with water. Calculate the volume of  $H_2$  gas produced at STP.



$$16 \text{ g } Ca \times \frac{1 \text{ mol } Ca}{40.078 \text{ g } Ca} \times \frac{1 \text{ mol } H_2}{1 \text{ mol } Ca} \times \frac{22.4 \text{ L } H_2}{1 \text{ mol } H_2} = 8.94 \text{ L } H_2$$

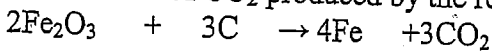
17 Calculate the volume of  $F_2$  gas at STP produced by the electrolysis of 8.2 g of KF.



$$8.2 \text{ g } KF \times \frac{1 \text{ mol } KF}{58.0967 \text{ g } KF} \times \frac{1 \text{ mol } F_2}{2 \text{ mol } KF} \times \frac{22.4 \text{ L } F_2}{1 \text{ mol } F_2} = 1.58 \text{ L } F_2$$

18

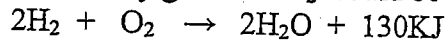
Calculate the number of molecules of  $CO_2$  produced by the reaction of 2.45 g of iron III oxide.



$$2.45 \text{ g } Fe_2O_3 \times \frac{1 \text{ mol } Fe_2O_3}{159.6882 \text{ g } Fe_2O_3} \times \frac{3 \text{ mol } CO_2}{2 \text{ mol } Fe_2O_3} \times \frac{6.02 \times 10^{23} \text{ molec. } CO_2}{1 \text{ mol } CO_2} = 1.39 \times 10^{22} \text{ molec. } CO_2$$

19

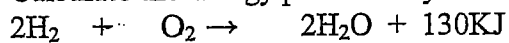
How many grams of  $H_2$  would be needed to produce 260. KJ of energy?



$$260 \text{ KJ} \times \frac{2 \text{ mol } H_2}{130 \text{ KJ}} \times \frac{2.0158 \text{ g } H_2}{1 \text{ mol } H_2} = 8.0632 \text{ g } H_2$$

20

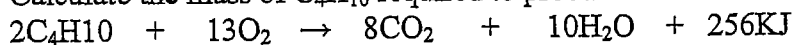
Calculate the energy produced by the complete reaction of 150.g  $H_2$ .



$$150 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2.0158 \text{ g } H_2} \times \frac{130 \text{ KJ}}{2 \text{ mol } H_2} = 4836.79 \text{ KJ}$$

21

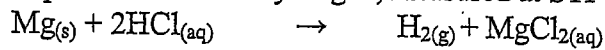
Calculate the mass of  $C_4H_{10}$  required to produce  $2.06 \times 10^6$  J of energy.



$$2.06 \times 10^6 \text{ J} \times \frac{1 \text{ KJ}}{1000 \text{ J}} \times \frac{2 \text{ mol } C_4H_{10}}{256 \text{ KJ}} \times \frac{58.123 \text{ g } C_4H_{10}}{1 \text{ mol } C_4H_{10}} = 935.42 \text{ g } C_4H_{10}$$

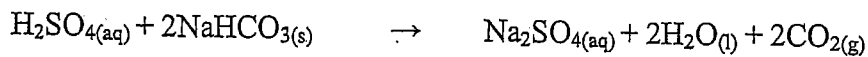


72 What quantity of magnesium must a student react with excess hydrochloric acid to produce 85.0 ml hydrogen, measured at STP?



$$85.0 \text{ mL H}_2 \times \frac{1 \text{ L H}_2}{1000 \text{ mL H}_2} \times \frac{1 \text{ mol H}_2}{22.4 \text{ L H}_2} \times \frac{1 \text{ mol Mg}}{1 \text{ mol H}_2} \times \frac{24.305 \text{ g Mg}}{1 \text{ mol Mg}} \\ = 0.092 \text{ g Mg}$$

73 When sodium hydrogen carbonate is treated with sulfuric acid, carbon dioxide bubbles off:

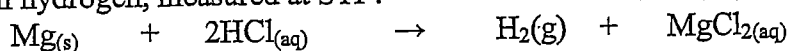


What volume of  $\text{CO}_2$ , measured at STP, is available from 8.58 g  $\text{NaHCO}_3$ ?

$$8.58 \text{ g NaHCO}_3 \times \frac{1 \text{ mol NaHCO}_3}{84.0069 \text{ g NaHCO}_3} \times \frac{2 \text{ mol CO}_2}{2 \text{ mol NaHCO}_3} \times \frac{22.4 \text{ L CO}_2}{1 \text{ mol CO}_2} \\ = 2.29 \text{ L CO}_2$$

24

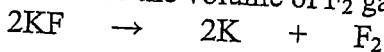
What mass of magnesium must react with excess hydrochloric acid to produce 85.0 ml hydrogen, measured at STP?



$$85.0 \text{ mL H}_2 \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ mol H}_2}{22.4 \text{ L H}_2} \times \frac{1 \text{ mol Mg}}{1 \text{ mol H}_2} \times \frac{24.305 \text{ g Mg}}{1 \text{ mol Mg}} = 0.092 \text{ g Mg}$$

25

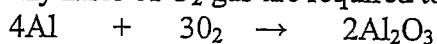
Calculate the volume of  $\text{F}_2$  gas at STP produced by the reaction of 15.6 g of KF.



$$15.6 \text{ g KF} \times \frac{1 \text{ mol KF}}{58.0967 \text{ g KF}} \times \frac{1 \text{ mol F}_2}{2 \text{ mol KF}} \times \frac{22.4 \text{ L F}_2}{1 \text{ mol F}_2} = 3.01 \text{ L F}_2$$

26

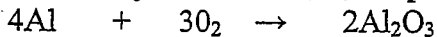
How many litres of  $\text{O}_2$  gas are required to produce 100. g  $\text{Al}_2\text{O}_3$ ?



$$100. \text{ g Al}_2\text{O}_3 \times \frac{1 \text{ mol Al}_2\text{O}_3}{101.9612 \text{ g Al}_2\text{O}_3} \times \frac{3 \text{ mol O}_2}{2 \text{ mol Al}_2\text{O}_3} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 32.95 \text{ L O}_2$$

27

How many moles of  $\text{Al}_2\text{O}_3$  are produced by the reaction 200. g Al?



$$200. \text{ g Al} \times \frac{1 \text{ mol Al}}{26.9815 \text{ g Al}} \times \frac{2 \text{ mol Al}_2\text{O}_3}{4 \text{ mol Al}} = 3.71 \text{ mol Al}_2\text{O}_3$$

28

How many litres of  $O_2$  gas are required to produce 100. g  $Al_2O_3$ ?

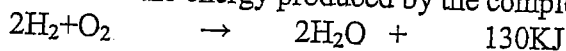
$$4Al + 3O_2 \rightarrow 2Al_2O_3$$

$$100. \text{ g } Al_2O_3 \times \frac{1 \text{ mol } Al_2O_3}{101.9612 \text{ g } Al_2O_3} \times \frac{3 \text{ mol } O_2}{2 \text{ mol } Al_2O_3} \times \frac{22.4 \text{ L } O_2}{1 \text{ mol } O_2}$$

$$= 32.95 \text{ L } O_2$$

29

Calculate the energy produced by the complete reaction of 150. g  $H_2$ .

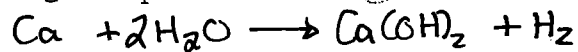


$$150 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2.0158 \text{ g } H_2} \times \frac{130 \text{ KJ}}{2 \text{ mol } H_2} = 4836.79 \text{ KJ}$$

30

25.0 g of calcium reacts with water, how many grams of hydrogen are produced?

How many grams of calcium hydroxide are produced?

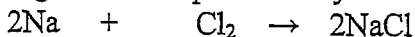


$$25.0 \text{ g } Ca \times \frac{1 \text{ mol } Ca}{40.078 \text{ g } Ca} \times \frac{1 \text{ mol } H_2}{1 \text{ mol } Ca} \times \frac{2.0158 \text{ g } H_2}{1 \text{ mol } H_2} = 1.26 \text{ g } H_2$$

31

Calculate the number of grams  $NaCl$  produced by the complete reaction of

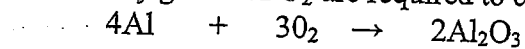
520. g  $Cl_2$ .



$$520 \text{ g } Cl_2 \times \frac{1 \text{ mol } Cl_2}{70.9054 \text{ g } Cl_2} \times \frac{2 \text{ mol } NaCl}{1 \text{ mol } Cl_2} \times \frac{58.4425 \text{ g } NaCl}{1 \text{ mol } NaCl}$$

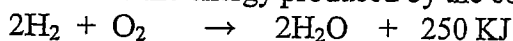
$$= 857.20 \text{ g } NaCl$$

32 How many grams of  $O_2$  are required to consume 100. g Al?



$$100. \text{ g Al} \times \frac{1 \text{ mol Al}}{26.9815 \text{ g Al}} \times \frac{3 \text{ mol } O_2}{4 \text{ mol Al}} \times \frac{31.9988 \text{ g } O_2}{1 \text{ mol } O_2} = 88.95 \text{ g } O_2$$

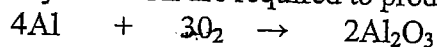
33 Calculate the energy produced by the complete reaction of 150. g  $H_2$ .



$$150. \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2.0158 \text{ g } H_2} \times \frac{250 \text{ KJ}}{2 \text{ mol } H_2} = 9301.52 \text{ KJ}$$

34

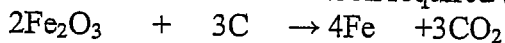
How many moles Al are required to produce 300. g  $Al_2O_3$ ?



$$300. \text{ g } Al_2O_3 \times \frac{1 \text{ mol } Al_2O_3}{101.9612 \text{ g } Al_2O_3} \times \frac{4 \text{ mol Al}}{2 \text{ mol } Al_2O_3} = 5.88 \text{ mol Al}$$

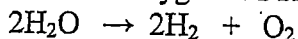
35

Calculate the mass of carbon required to consume 5.67 g of iron III oxide.



$$5.67 \text{ g } Fe_2O_3 \times \frac{1 \text{ mol } Fe_2O_3}{159.6882 \text{ g } Fe_2O_3} \times \frac{3 \text{ mol C}}{2 \text{ mol } Fe_2O_3} \times \frac{12.011 \text{ g C}}{1 \text{ mol C}} = 0.6397 \text{ g C}$$

- 36 Calculate the volume of oxygen at STP produced by the reaction of 69.0 g of water.



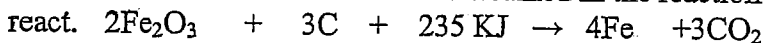
$$69.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.0152 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 42.897 \text{ L O}_2$$

- 37 How many litres of  $\text{O}_2$ , measured at STP, will be released on the decomposition of 8.56 g of mercury (II) oxide:



$$8.56 \text{ g HgO} \times \frac{1 \text{ mol HgO}}{216.5894 \text{ g HgO}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol HgO}} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 0.443 \text{ L O}_2$$

- 38 Calculate the number of Fe atoms consumed in the reaction if 100. g of  $\text{Fe}_2\text{O}_3$



$$100. \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.6882 \text{ g Fe}_2\text{O}_3} \times \frac{4 \text{ mol Fe}}{2 \text{ mol Fe}_2\text{O}_3} \times \frac{6.02 \times 10^{23} \text{ part. Fe}}{1 \text{ mol Fe}} \times \frac{1 \text{ atom Fe}}{1 \text{ part. Fe}} = 7.54 \times 10^{23} \text{ atoms Fe}$$

39

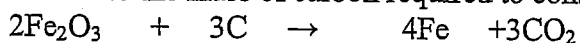
- Calculate the number of moles  $\text{CO}_2$  produced by the reaction of 8.45 g of C.



$$8.45 \text{ g C} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}} \times \frac{3 \text{ mol CO}_2}{3 \text{ mol C}} = 0.704 \text{ mol CO}_2$$

40

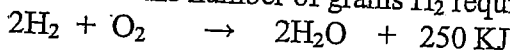
Calculate the mass of carbon required to consume 5.67 g of iron III oxide.



$$5.67 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.6882 \text{ g Fe}_2\text{O}_3} \times \frac{3 \text{ mol C}}{2 \text{ mol Fe}_2\text{O}_3} \times \frac{12.011 \text{ g C}}{1 \text{ mol C}}$$

$$= 0.640 \text{ g C}$$

41

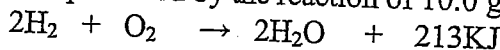
Calculate the number of grams  $\text{H}_2$  required to produce 500. J of energy.

$$500 \text{ J} \times \frac{1 \text{ KJ}}{1000 \text{ J}} \times \frac{2 \text{ mol H}_2}{250 \text{ KJ}} \times \frac{2.0158 \text{ g H}_2}{1 \text{ mol H}_2}$$

$$= 8.06 \times 10^{-3} \text{ g H}_2$$

42

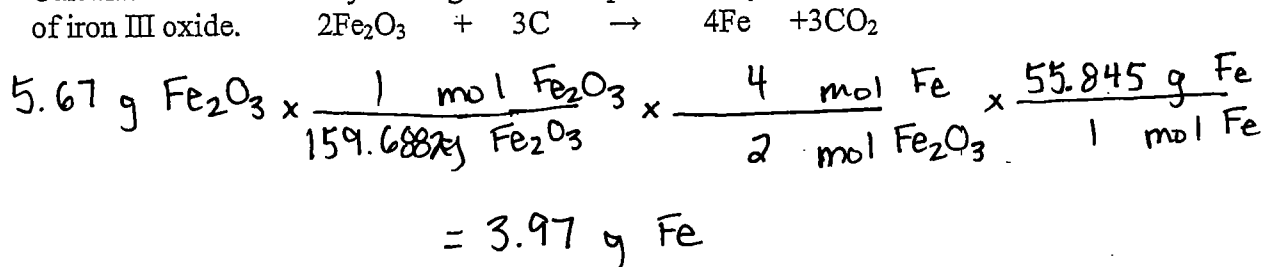
Calculate the energy in KJ produced by the reaction of 10.0 g of hydrogen with excess oxygen.



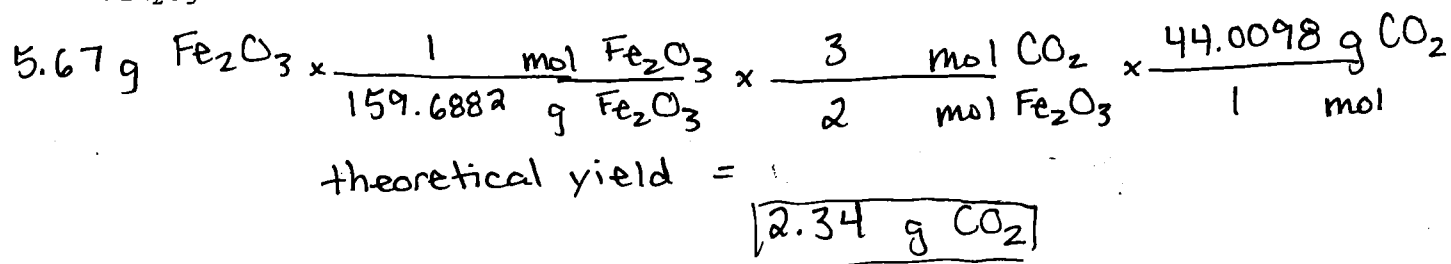
$$10.0 \text{ g H}_2 \times \frac{1 \text{ mol H}_2}{2.0158 \text{ g H}_2} \times \frac{213 \text{ KJ}}{2 \text{ mol H}_2} = 528.33 \text{ KJ}$$

## Part Two: Theoretical & Percent Yield

1 Calculate the theoretical yield in grams of Fe produced by the reaction of 5.67 g of iron III oxide.



2 Calculate the mass of carbon dioxide produced when 5.67 g of iron III oxide reacts with excess C. If the percentage yield is 85.0 % calculate the actual yield.

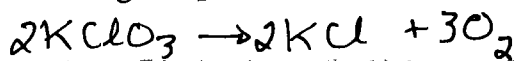


$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$$

$$\text{actual} = \frac{\% \text{ yield (theoretical)}}{100}$$
$$= \frac{85\% (2.34 \text{ g})}{100}$$
$$= \boxed{1.989 \text{ g CO}_2}$$

3 If 5.45 g of  $\text{KClO}_3$  are decomposed to form  $\text{KCl}$  and 1.95 g of  $\text{O}_2$  are collected.

Calculate the theoretical and percentage yields.



theoretical yield.

$$5.45 \text{ g KClO}_3 \times \frac{1 \text{ mol KClO}_3}{122.5492 \text{ g KClO}_3} \times \frac{3 \text{ mol O}_2}{2 \text{ mol KClO}_3} \times \frac{31.9988 \text{ g O}_2}{1 \text{ mol O}_2} = 2.13 \text{ g O}_2$$

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

$$= \frac{1.95 \text{ g O}_2}{2.13 \text{ g O}_2} \times 100$$

$$= 91.5\%$$

4 Calculate the theoretical yield in grams of  $\text{Fe}$  produced by the reaction of 5.67 g of iron III oxide. If the actual yield is 2.00 g calculate the percentage yield.



$$5.67 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.6882 \text{ g Fe}_2\text{O}_3} \times \frac{4 \text{ mol Fe}}{2 \text{ mol Fe}_2\text{O}_3} \times \frac{55.845 \text{ g Fe}}{1 \text{ mol Fe}}$$

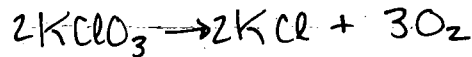
$$\text{theoretical yield} = 3.97 \text{ g Fe}$$

$$\% \text{ yield} = \frac{2.00 \text{ g Fe}}{3.97 \text{ g Fe}} \times 100$$

$$= 50.4\%$$



If 32.7 g of  $\text{KClO}_3$  are decomposed to form  $\text{KCl}$  and 11.7 g of  $\text{O}_2$  are collected. Calculate the theoretical and percentage yield.



$$32.7 \text{ g } \text{KClO}_3 \times \frac{1 \text{ mol } \text{KClO}_3}{122.5492 \text{ g } \text{KClO}_3} \times \frac{3 \text{ mol } \text{O}_2}{2 \text{ mol } \text{KClO}_3} \times \frac{31.9988 \text{ g } \text{O}_2}{1 \text{ mol } \text{O}_2}$$

$$\text{theoretical yield} = 12.81 \text{ g } \text{O}_2$$

$$\begin{aligned} \% \text{ yield} &= \frac{11.7 \text{ g } \text{O}_2}{12.81 \text{ g } \text{O}_2} \times 100 \\ &= 91.3\% \end{aligned}$$

6

100. g  $\text{Al}$  reacts with excess  $\text{O}_2$  to produce 150. g  $\text{Al}_2\text{O}_3$  according to  
Calculate the theoretical and percentage yield.  $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$ .

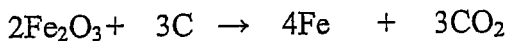
$$100 \text{ g } \text{Al} \times \frac{1 \text{ mol } \text{Al}}{26.9815 \text{ g } \text{Al}} \times \frac{2 \text{ mol } \text{Al}_2\text{O}_3}{4 \text{ mol } \text{Al}} \times \frac{101.9612 \text{ g } \text{Al}_2\text{O}_3}{1 \text{ mol } \text{Al}_2\text{O}_3}$$

$$\text{theoretical yield} = 188.95 \text{ g}$$

$$\begin{aligned} \% \text{ yield} &= \frac{150 \text{ g}}{188.95 \text{ g}} \times 100 \\ &= 79.4\% \end{aligned}$$

7

500. g of  $\text{Fe}_2\text{O}_3$  are refined to produce 200. g of Fe. Calculate the percentage yield of Fe.



$$500. \text{ g } \text{Fe}_2\text{O}_3 \times \frac{1 \text{ mol } \text{Fe}_2\text{O}_3}{159.6882 \text{ g } \text{Fe}_2\text{O}_3} \times \frac{4 \text{ mol } \text{Fe}}{2 \text{ mol } \text{Fe}_2\text{O}_3} \times \frac{55.845 \text{ g } \text{Fe}}{26.9815 \text{ g } \text{Fe}} = \frac{168.96 \text{ g } \text{Fe}}{349.713}$$

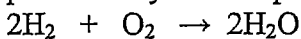
$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$$

$$= \frac{200}{\frac{168.96}{349.713}} \times 100$$

$$= \frac{118.4\%}{57.2\%}$$

8

Calculate the number of grams water produced by the complete reaction of 14.5 g of oxygen (theoretical yield).



$$14.5 \text{ g } \text{O}_2 \times \frac{1 \text{ mol } \text{O}_2}{31.9988 \text{ g } \text{O}_2} \times \frac{2 \text{ mol } \text{H}_2\text{O}}{1 \text{ mol } \text{O}_2} \times \frac{18.0152 \text{ g } \text{H}_2\text{O}}{1 \text{ mol } \text{H}_2\text{O}} = 16.33 \text{ g } \text{H}_2\text{O}$$

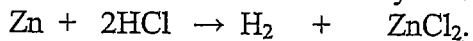
9

Calculate the theoretical yield in grams of  $\text{CO}_2$  produced by the reaction of 15.6 g of iron III oxide.



$$15.6 \text{ g } \text{Fe}_2\text{O}_3 \times \frac{1 \text{ mol } \text{Fe}_2\text{O}_3}{159.6882 \text{ g } \text{Fe}_2\text{O}_3} \times \frac{3 \text{ mol } \text{CO}_2}{2 \text{ mol } \text{Fe}_2\text{O}_3} \times \frac{44.0098 \text{ g } \text{CO}_2}{1 \text{ mol } \text{CO}_2} = 6.45 \text{ g } \text{CO}_2$$

10 25.5 mL of 0.100 M HCl reacts with excess Zn to produce 25.3 mL of H<sub>2</sub> gas at STP. Calculate the theoretical yield in mL and the percentage yield of H<sub>2</sub> gas.



$$\text{mol} = M \times V_L$$

$$= (0.100\text{M})(0.025\text{L})$$

$$= 0.0025 \text{ mol HCl} \times \frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} \times \frac{22.4 \text{ L H}_2}{1 \text{ mol H}_2} \times \frac{1000 \text{ mL}}{1 \text{ L}}$$

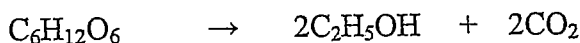
$$\text{theoretical yield} = 28 \text{ mL H}_2$$

$$\% \text{ yield} = \frac{25.3 \text{ mL}}{28 \text{ mL}} \times 100$$

$$= 90.4 \%$$

11

The fermentation of sugar in the presence of zymase, an enzyme in yeast, can be described by the equation below. If 500. g of sugar is fermented and 200. g of alcohol are produced, calculate the theoretical and percentage yield of alcohol.



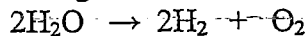
$$500 \text{ g C}_6\text{H}_{12}\text{O}_6 \times \frac{1 \text{ mol C}_6\text{H}_{12}\text{O}_6}{180.1572 \text{ g C}_6\text{H}_{12}\text{O}_6} \times \frac{2 \text{ mol C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_6\text{H}_{12}\text{O}_6} \times \frac{29.0615 \text{ g C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_2\text{H}_5\text{OH}}$$

$$\text{theoretical yield} = 161.31 \text{ g C}_2\text{H}_5\text{OH}$$

$$\% \text{ yield} = \frac{200 \text{ g}}{161.31 \text{ g}} \times 100 = 124.0 \%$$

12

Calculate the theoretical yield of oxygen in grams produced by the reaction of 69.0 g of water. If the actual yield of  $O_2$  is 50.0 g, calculate the percentage yield.



$$69.0 \text{ g } H_2O \times \frac{1 \text{ mol } H_2O}{18.0152 \text{ g } H_2O} \times \frac{1 \text{ mol } O_2}{2 \text{ mol } H_2O} \times \frac{31.9988 \text{ g } O_2}{1 \text{ mol } O_2}$$

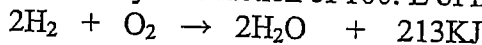
theoretical yield. = 61.28 g  $O_2$

$$\% \text{ yield} = \frac{50.0 \text{ g}}{61.28 \text{ g}} \times 100$$

$$= 81.6\%$$

13

Calculate the energy produced by the reaction of 100. L of hydrogen at STP with excess oxygen.



$$100 \text{ L} \times \frac{1 \text{ mol } H_2}{22.4 \text{ L}} \times \frac{213 \text{ KJ}}{2 \text{ mol } H_2} = 475.45 \text{ KJ}$$

$$100 \text{ L } H_2 \times \frac{1 \text{ mol } H_2}{22.4 \text{ L}} \times \frac{1 \text{ mol } O_2}{2 \text{ mol } H_2} \times \frac{22.4 \text{ L}}{1 \text{ mol } O_2}$$

theoretical yield = 50.0 L

14

If the actual volume of oxygen is 40.0 L, what is the % yield.

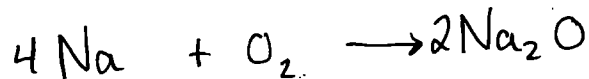
$$\% \text{ yield} = \frac{40.0 \text{ L}}{50.0 \text{ L}} \times 100$$

$$= 80\%$$

# Part Three: Limiting Reactant

1 If 25.0 g of Na are reacted with 40.0 g of O<sub>2</sub>, and one ionic compound is formed.

Equation:



- (a) Which reactant is in excess?
- (b) How many grams are in excess?
- (c) Calculate the amount of ~~AlCl<sub>3</sub>~~ produced.  
Na<sub>2</sub>O

$$25.0 \text{ g Na} \times \frac{1 \text{ mol Na}}{22.9898 \text{ g Na}} = 1.0874 \text{ mol Na} \quad \text{* limiting}$$

**HAVE**

$$40.0 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{31.9988 \text{ g O}_2} = 1.2500 \text{ mol O}_2 \quad \text{* excess}$$

a)

---

Na		O <sub>2</sub>
1.2500 mol	x	4 mol
		1 mol
= 5.00 mol Na		

Na		O <sub>2</sub>
1.0874 mol Na	x	1 mol O <sub>2</sub>
		4 mol Na
= 0.272 mol O <sub>2</sub>		

**NEED**

---

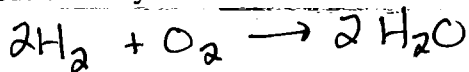
$$1.0874 \text{ mol Na} \times \frac{2 \text{ mol Na}_2\text{O}}{4 \text{ mol Na}} \times \frac{61.979 \text{ g Na}_2\text{O}}{1 \text{ mol Na}_2\text{O}}$$

~~1.0874~~      c) **= 33.70 g Na<sub>2</sub>O**

b)  $1.2500 \text{ mol} - 0.272 \text{ mol}$   
 $= 0.978 \text{ mol O}_2 \times \frac{31.9988 \text{ g O}_2}{1 \text{ mol O}_2} = 31.29 \text{ g O}_2$

2

20. mol  $\text{H}_2$  reacts with 8.0 mol  $\text{O}_2$  to produce  $\text{H}_2\text{O}$ . Determine the number of grams reactant in excess and number of grams  $\text{H}_2\text{O}$  produced. Identify the limiting reactant.



**HAVE**

20 mol  $\text{H}_2$  \* excess

8.0 mol  $\text{O}_2$   
\* limiting

**NEED**

$\text{H}_2$

$$8.0 \text{ mol } \text{O}_2 \times \frac{2 \text{ mol } \text{H}_2}{1 \text{ mol } \text{O}_2}$$

$$= 16.0 \text{ mol } \text{H}_2.$$

$\text{O}_2$

$$20 \text{ mol } \text{H}_2 \times \frac{1 \text{ mol } \text{O}_2}{2 \text{ mol } \text{H}_2}$$

$$= 10 \text{ mol } \text{O}_2$$

$$8.0 \text{ mol } \text{O}_2 \times \frac{2 \text{ mol } \text{H}_2\text{O}}{1 \text{ mol } \text{O}_2} \times \frac{18.0152 \text{ g } \text{H}_2\text{O}}{1 \text{ mol } \text{H}_2\text{O}} = \boxed{288.2432 \text{ g } \text{H}_2\text{O}}$$

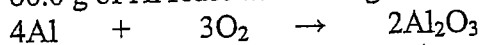
Excess ? ( $\text{H}_2$ )

$$20 \text{ mol } \text{H}_2 - 16.0 \text{ mol } \text{H}_2$$

$$= 4.0 \text{ mol } \text{H}_2 \times \frac{2.0158 \text{ g } \text{H}_2}{1 \text{ mol } \text{H}_2} = 8.06 \text{ g } \text{H}_2$$

3

60.0 g of Al react with 60.0 g of O<sub>2</sub>. Calculate the amount of excess reactant.



$$60.0 \text{ g Al} \times \frac{1 \text{ mol Al}}{26.9815 \text{ g Al}} = 2.224 \text{ mol Al} \text{ * limiting}$$

HAVE

$$60.0 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{31.9988 \text{ g O}_2} = 1.875 \text{ mol O}_2 \text{ * excess.}$$

<div style="border: 1px solid black; border-radius: 50%; padding: 2px; display: inline-block;">Al</div>	O <sub>2</sub>	x	$\frac{4 \text{ mol Al}}{3 \text{ mol O}_2}$	=	$1.875 \text{ mol O}_2$	=	2.5
<div style="border: 1px solid black; border-radius: 50%; padding: 2px; display: inline-block;">O<sub>2</sub></div>	Al	x	$\frac{3 \text{ mol O}_2}{4 \text{ mol Al}}$	=	$2.224 \text{ mol Al}$	=	1.668

Excess (O<sub>2</sub>)

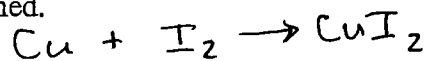
$$1.875 \text{ mol} - 1.668 \text{ mol} = 0.207 \text{ mol O}_2$$

$$0.207 \text{ mol O}_2 \times \frac{31.9988 \text{ g O}_2}{1 \text{ mol O}_2} = 6.62 \text{ g O}_2$$

4

If 75.4 g of Cu is reacted with 189.7 g of I<sub>2</sub>, then CuI<sub>2</sub> is formed.

a) Which reactant is in excess?



How many grams are in excess?

Calculate the mass of CuI<sub>2</sub> produced.

$$75.4 \text{ g Cu} \times \frac{1 \text{ mol Cu}}{63.546 \text{ g Cu}} = 1.187 \text{ mol Cu}$$

$$= 1.187 \text{ mol Cu}$$

\* excess

HAVE

$$189.7 \text{ g I}_2 \times \frac{1 \text{ mol I}_2}{253.808 \text{ g I}_2} = 0.7474 \text{ mol I}_2$$

\* limiting

Cu

I<sub>2</sub>

$$0.7474 \text{ mol I}_2 \times \frac{1 \text{ mol Cu}}{1 \text{ mol I}_2}$$

$$= 0.7474 \text{ mol Cu}$$

$$1.187 \text{ mol Cu} \times \frac{1 \text{ mol I}_2}{1 \text{ mol Cu}}$$

$$= 1.187 \text{ mol I}_2$$

Excess?  $1.187 \text{ mol Cu} - 0.7474 \text{ mol Cu}$

$$= 0.4396 \text{ mol Cu} \times \frac{63.546 \text{ g Cu}}{1 \text{ mol Cu}}$$

$$= 27.93 \text{ g Cu}$$

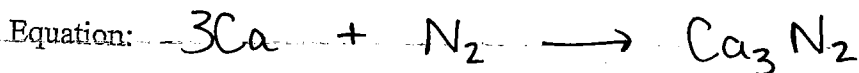
$$0.7474 \text{ mol I}_2 \times \frac{1 \text{ mol CuI}_2}{1 \text{ mol I}_2} \times \frac{317.354 \text{ g CuI}_2}{1 \text{ mol CuI}_2}$$

$$= 237.19 \text{ g CuI}_2$$



5

If 100.0 g of Ca are reacted with 100.0 g of  $N_2$ , then  $Ca_3N_2$  is formed.



- (a) Which reactant is in excess?  $N_2$   
 (b) How many grams are in excess?  
 (c) Calculate the amount of  $Ca_3N_2$  produced.

$$100.0 \text{ g Ca} \times \frac{1 \text{ mol Ca}}{40.078 \text{ g Ca}} = 2.495 \text{ mol Ca} \text{ * limiting}$$

HAVE

$$100.0 \text{ g } N_2 \times \frac{1 \text{ mol } N_2}{28.0134 \text{ g } N_2} = 3.5697 \text{ mol } N_2 \text{ * excess}$$

Ca

$$3.5697 \text{ mol } N_2 \times \frac{3 \text{ mol Ca}}{1 \text{ mol } N_2} = 10.7091$$

$N_2$

$$2.495 \text{ mol Ca} \times \frac{1 \text{ mol } N_2}{3 \text{ mol Ca}} = 0.8317 \text{ mol } N_2$$

Excess?  $3.5697 \text{ mol} - 0.8317 \text{ mol}$

$$= 2.738 \text{ mol } N_2 \times \frac{28.0134 \text{ g } N_2}{1 \text{ mol } N_2} = 76.70 \text{ g } N_2 \text{ Excess}$$

$$2.495 \text{ mol Ca} \times \frac{1 \text{ mol } Ca_3N_2}{3 \text{ mol Ca}} \times \frac{148.2474 \text{ g } Ca_3N_2}{1 \text{ mol } Ca_3N_2} = 123.29 \text{ g } Ca_3N_2$$

6

If 100.0 g of Ca are reacted with 100.0 g of Cl<sub>2</sub>, then CaCl<sub>2</sub> is formed.



- (a) Which reactant is in excess? Ca  
 (b) How many grams are in excess?  
 (c) Calculate the amount of CaCl<sub>2</sub> produced.

$$100.0 \text{ g Ca} \times \frac{1 \text{ mol Ca}}{40.078 \text{ g Ca}} = 2.495 \text{ mol Ca} \text{ * excess}$$

**HAVE**

$$100.0 \text{ g Cl}_2 \times \frac{1 \text{ mol Cl}_2}{70.9054 \text{ g Cl}_2} = 1.410 \text{ mol Cl}_2 \text{ * limiting}$$

(Ca)

$$1.410 \text{ mol Cl}_2 \times \frac{1 \text{ mol Ca}}{1 \text{ mol Cl}_2}$$

$$= 1.410 \text{ mol Ca}$$

**NEED**

(Cl<sub>2</sub>)

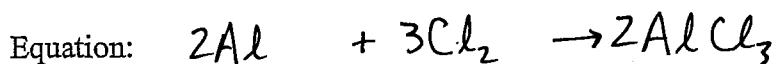
$$2.495 \text{ mol Ca} \times \frac{1 \text{ mol Cl}_2}{1 \text{ mol Ca}}$$

$$= 2.495 \text{ mol Cl}_2$$

Excess?  
 (Ca)  $2.495 \text{ mol} - 1.410 \text{ mol}$   
 $= 1.085 \text{ mol Ca} \times \frac{40.078 \text{ g Ca}}{1 \text{ mol Ca}}$   
 $= 43.48 \text{ g Ca}$

$$1.410 \text{ mol Cl}_2 \times \frac{1 \text{ mol CaCl}_2}{1 \text{ mol Cl}_2} \times \frac{110.9854 \text{ g CaCl}_2}{1 \text{ mol CaCl}_2} = 156.49 \text{ g CaCl}_2$$

7 If 25.0 g of Al are reacted with 40.0 g of  $\text{Cl}_2$ , then  $\text{AlCl}_3$  is formed.



- (a) Which reactant is in excess? Al  
(b) How many grams are in excess?  
(c) Calculate the amount of  $\text{AlCl}_3$  produced.

$$25.0 \text{ g Al} \times \frac{1 \text{ mol}}{26.9815 \text{ g}} = 0.9266 \text{ mol Al} \quad * \text{ excess}$$

**HAVE**

$$40.0 \text{ g Cl}_2 \times \frac{1 \text{ mol Cl}_2}{70.9054 \text{ g Cl}_2} = 0.5641 \text{ mol Cl}_2 \quad * \text{ limiting}$$

Al

$\text{Cl}_2$

$$0.5641 \text{ mol Cl}_2 \times \frac{2 \text{ mol Al}}{3 \text{ mol Cl}_2} = 0.3761 \text{ mol Al}$$

$$0.9266 \text{ mol Al} \times \frac{3 \text{ mol Cl}_2}{2 \text{ mol Al}} = 1.3899 \text{ mol Cl}_2$$

**NEED**

Excess?  $0.9266 \text{ mol} - 0.3761 \text{ mol}$

$$= 0.5505 \text{ mol Al} \times \frac{26.9815 \text{ g Al}}{1 \text{ mol Al}} = 14.85 \text{ g Al excess}$$

$$0.5641 \text{ mol Cl}_2 \times \frac{2 \text{ mol AlCl}_3}{3 \text{ mol Cl}_2} \times \frac{133.339 \text{ g AlCl}_3}{1 \text{ mol AlCl}_3}$$

$$= 50.14 \text{ g AlCl}_3$$

