Teacher

Chemistry I
Chapter 11 Work Sheet

1. A portable hydrogen generator utilizes the reaction

$$CaH_2 + 2H_2O \longrightarrow Ca(OH)_2 + 2H_2$$

How many grams of H_2 can be produced by a 50.0 g cartridge of CaH_2? 4.8(0) g **4.80g**

2. Iodine can be made by the reaction

$$2NaIO_3 + 5NaHSO_3 \longrightarrow 3NaHSO_4 + 2Na_2SO_4 + H_2O + I_2$$

To produce each kg of iodine, how much $NaIO_3$ and how much $NaHSO_3$ must be used? **1.56 kg $NaIO_3$ 2.05 kg $NaHSO_3$**

3. How much $KClO_3$ must be heated to obtain 3.50 g of oxygen in a decomposition reaction where potassium chloride is the other product? **8.94g $KClO_3$** $2KClO_3 \longrightarrow 2KCl + 3O_2$

4. How much iron (III) oxide will be produced by the complete oxidation of 1.00 x 10^2 g of iron? The reaction is

$$4Fe_{(s)} + 3O_{2(g)} \longrightarrow 2Fe_2O_{3(s)}$$ **143g**

5. In a rocket motor fueled with butane, C_4H_{10}, how many kilograms of liquid oxygen should be provided with each kilogram of butane to provide for complete combustion?

$$2C_4H_{10(l)} + 13O_{2(l)} \longrightarrow 8CO_{2(g)} + 10H_2O_{(g)}$$ **3.58kg**

6. Chloropicrin, CCl_3NO_2, can be made cheaply for use as an insecticide by a process which utilizes the reaction

$$CH_3NO_2 + 3Cl_2 \longrightarrow CCl_3NO_2 + 3HCl$$

How much nitromethane, CH_3NO_2, is needed to form 500.0 g of chloropicrin? ~~186.( ) g~~ **185.7g**

7. Ethyl alcohol, C_2H_5OH, is made by the fermentation of glucose, $C_6H_{12}O_6$, as indicated by the following reaction

$$C_6H_{12}O_{6(aq)} \longrightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$$

How many grams of alcohol can be made from 2.00 g of glucose? 1.02g

8. How much 83.4% pure salt cake ($NaSO_4$) could be produced form 2.50 x 10^2 g of 94.5% pure salt?

$$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

344g

9. In the *Mond process* for purifying nickel, the volatile nickel carbonyl, $Ni(CO)_4$, is produced by the following reaction

$$Ni_{(s)} + 4CO_{(g)} \longrightarrow Ni(CO)_{4(g)}$$

How much CO is used up in volatilizing each gram of nickel? 1.91g

10. When copper is heated with an excess of sulfur, Cu_2S is formed. How many grams of Cu_2S could be produced if 100.0 g of copper is heated with 50.0 g of sulfur? 125 g Cu_2S

$2Cu + S \rightarrow Cu_2S$

11. The reduction of Cr_2O_3 by Al proceeds quantitatively on ignition of a suitable fuse.

$$2Al + Cr_2O_3 \longrightarrow Al_2O_3 + 2Cr$$

(a) How much metallic chromium can be made by bringing to reaction temperature a mixture of 5.0 g Al and 20.0 g Cr_2O_3? 9.6g Cr
(b) Which reactant remains at the completion of the reaction, and how much? 5.9g Cr_2O_3

12. A mixture of 1.00 kg of CS_2 and 2.00 kg of Cl_2 is passed through a hot reaction tube, where the following reaction takes place:

$$CS_{2(g)} + 3Cl_{2(g)} \longrightarrow CCl_{4(g)} + S_2Cl_{2(s)}$$

(a) How much CCl_4 can be made by complete reaction of the limiting starting material? (b) Which starting material is in excess, and how much of it remains unreacted? 1.45 kg CCl_4 0.28(5) kg CS_2

13. The following reaction proceeds until the limiting substance is all consumed.

$$2Al + 3MnO \longrightarrow Al_2O_3 + 3Mn$$

A mixture containing 100.0 g Al and 200.0 g MnO was heated to initiate the reaction. Which initial substance remained in excess, and how much? Al, ~~49.( ) g~~ 49.28g

14. Determine the volume occupied by 4.0 g of oxygen at STP.

2.8 L

15. What volume of hydrogen will combine with 12 L of chlorine to form hydrogen chloride? What volume of hydrogen chloride will be formed? Assume STP. 12 L H_2 24 L HCl

$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$

16. What volume of hydrogen will unite with 6.0 L of nitrogen to form ammonia? What volume of ammonia will be produced? Assume STP.

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$$

18 L H_2

12 L NH_3

17. What volume of O_2 at STP is required for the complete combustion of 1.00 mole of carbon disulfide liquid? What volumes of CO_2 and SO_2 gas are produced at STP?

$CS_2 + 3O_2 \longrightarrow CO_2 + 2SO_2$ 67.2 L O_2 22.4 L CO_2 44.8 L SO_2

18. How many liters of oxygen, at STP, can be obtained form 100.0 g of potassium chlorate?

$2KClO_{3(s)} \text{ -----> } 2KCl_{(s)} + 3O_{2(g)}$ 27.4 L O_2

19. How many grams of zinc must be dissolved in sulfuric acid in order to obtain 500.0 mL of hydrogen gas at STP? (This is a single replacement reaction.) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ 1.46 g Zn

20. Exactly 500.0 mL of a gas at STP has a mass of 0.581 g. The composition of the gas is as follows: C = 92.24%, H = 7.76%. Derive its molecular formula.

C_2H_2

Chemistry I

Chapter 11 Worksheet

1.) $\frac{50.0\,g\ CaH_2}{42.10\,g/mole} = 1.190\ mole\ Ca$ $\qquad CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$

$\frac{1\ mole\ CaH_2}{2\ mole\ H_2} = \frac{1.190\ mole\ CaH_2}{X\ mole\ H_2}$

$X = 2.38\ mole\ H$

$2.38\ mole\ H_2 = \frac{X\,g}{2.016\,g/mole}$

4.80 g H_2

2.) $2NaIO_3 + 5NaHSO_3 \longrightarrow 3NaHSO_4 + 2Na_2SO_4 + H_2O + I_2$

$(1\,kg) = \frac{1000.\,g\ I_2}{253.8\,g/mole} = 3.940\ mole\ I_2$

$\frac{1\ mole\ I_2}{2\ mole\ NaIO_3} = \frac{3.940\ mole\ I_2}{X\ mole\ NaIO_3}$ $\qquad X = 7.880\ mole\ NaIO_3$

$7.880\ mole\ NaIO_3 = \frac{X\,g}{197.9\,g/mole}$

$X = 1559\,g$ or **1.56 kg $NaIO_3$**

$\frac{1\ mole\ I_2}{5\ mole\ NaHSO_3} = \frac{3.940\ mole\ I_2}{X\ mole\ NaHSO_3}$ $\qquad X = 19.70\ mole\ NaHSO_3$

$19.70\ mole = \frac{X\,g}{104.06\,g/mole}$

$X = 2049\,g$ or **2.05 kg $NaHSO_3$**

3.) $2KClO_3 \longrightarrow 2KCl + 3O_2$

$$\frac{3.50\,g\ O_2}{32.0\,g/mole} = 0.1094\ mole\ O_2$$

$$\frac{2\ mole\ KClO_3}{3\ mole\ O_2} = \frac{X\ mole\ KClO_3}{0.1094\ mole\ O_2}$$

$$x = 7.293 \times 10^{-2}\ mole\ KClO_3$$

$$7.293 \times 10^{-2}\ mole = \frac{x\,g}{122.60\,g/mole}$$

$$x = \boxed{8.94\,g\ KClO_3}$$

4.) $4Fe_{(s)} + 3O_{2(g)} \longrightarrow 2Fe_2O_3$

$$\frac{1.00 \times 10^2\,g\ Fe}{55.85\,g/mole} = 1.791\ mole\ Fe$$

$$\frac{2\ Fe_2O_3}{4\ Fe} = \frac{X\ Fe_2O_3}{1.791\ Fe}$$

$$x = 0.8952\ mole\ Fe_2O_3$$

$$0.8952\ mole = \frac{x\,g}{159.7}$$

$$x = \boxed{143\,g\ Fe_2O_3}$$

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5.) $2C_4H_{10(g)} + 13O_{2(g)} \longrightarrow 8CO_{2(g)} + 10H_2O_{(g)}$

$\frac{1000 g\ C_4H_{10}}{58.12 g/mole} = 17.21 mole\ C_4H_{10}$

$\frac{13 moles\ O_2}{2 moles\ C_4H_{10}} = \frac{X mole\ O_2}{17.21 mole\ C_4H_{10}}$

$X = 111.9 mole\ O_2$

$111.9 mole\ O_2 = \frac{X g}{32.00 g/mole}$

3579.7 g or **3.580 kg O_2**

6.) $CH_3NO_2 \quad 3Cl_2 \longrightarrow CCl_3NO_2 + 3HCl$

$\frac{500.0 g\ CCl_3NO_2}{164.37 g/mole}$ 3.042 mole CCl_3NO_2

$\frac{3.042 mole\ CCl_3NO_2}{mole\ CH_3NO_2} = \frac{1 mole\ CCl_3NO_2}{1 mole\ CH_3NO_2}$

$X = 3.042 mole\ CH_3NO_2$

$3.042 mole\ CH_3NO_2 = \frac{X g}{61.04 g/mole}$

$X =$ **185.7 g CH_3NO_2**

7.) $C_6H_{12}O_{6(aq)} \longrightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$

$$\frac{2.00\,g\ C_6H_{12}O_6}{180.16\,g/mole} = 1.110\times10^{-2}\ mole\ C_6H_{12}O_6$$

$$\frac{2\ mole\ C_2H_5OH}{1\ mole\ C_6H_{12}O_6} = \frac{X\ mole\ C_2H_5OH}{1.110\times10^{-2}\ mole\ C_6H_{12}O_6}$$

2.220×10^{-2} mole C_2H_5OH

$$2.220\times10^{-2}\ mole\ C_2H_5OH = \frac{X\,g}{46.07\,g/mole}$$

$X = $ **1.02 g C_2H_5OH**

8.) $2\,NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2\,HCl$

$(2.50\times10^2\,g)(0.945) = 236.25\,g$ NaCl in sample $\quad \frac{236.25\,g\ NaCl}{58.45\,g/mole} = 4.042$ mole NaCl

$$\frac{1\ mole\ Na_2SO_4}{2\ mole\ NaCl} = \frac{X\ mole\ Na_2SO_4}{4.042\ mole\ NaCl}$$

2.021 mole Na_2SO_4

$$2.021\ mole\ Na_2SO_4 = \frac{X\,g}{142.0\,g/mole}$$

$287.0\,g\ Na_2SO_4$

$$\frac{287.0\,g\ Na_2SO_4}{X}(100) = 83.4\%\ pure$$

$X = $ **344 g**

7.) $Ni_{(s)} + 4\,CO_{(g)} \longrightarrow Ni(CO)_{4\,(g)}$

$\frac{1.00\,g\,Ni}{58.69\,g/mole} = 1.704 \times 10^{-2}$ mole Ni

Mole of Ni : Mole of CO = 1 : 4

$(4)(1.704 \times 10^{-2}$ mole$)$ = 0.06816 mole CO used

0.06816 mole CO = $\frac{x\,g}{28.01\,g/mole}$

= **1.91 g CO**

10.) $2\,Cu + S \longrightarrow Cu_2S$

100.0 g + 50.0 g

↓ ↓

1.574 mole + 1.560 mole We need twice as many moles of Cu as of S so Cu is limiting reactant

$\frac{1.574 \text{ mole Cu}}{x \text{ mole } Cu_2S} = \frac{2 \text{ mole Cu}}{1 \text{ mole } Cu_2S}$

x = 0.7870

mole Cu_2S = $\frac{x}{159.2}$

x = **125 g Cu_2S**

11.) $2 Al + Cr_2O_3 \longrightarrow Al_2O_3 + 2 Cr$

a.) $\frac{5.0 g Al}{26.98 g/mole} = 0.1853$ mole Al

There must be twice as much (moles) of Al as of Cr_2O_3. There is not so Al is limiting.

$\frac{20.0 g Cr_2O_3}{152.0} = 0.1316$ mole Cr_2O_3

0.1853 mole Al produces 0.1853 mole Cr

$0.1853 \text{ mole Cr} = \frac{x g}{51.996 g/mole}$

$x =$ **9.6 g Cr**

$\frac{0.1853 \text{ mole Al used}}{x \text{ mole } Cr_2O_3 \text{ used}} = \frac{2 \text{ mole Al}}{1 \text{ mole } Cr_2O_3}$

0.09265 mole Cr_2O_3 used leaves 0.03895 mole Cr_2O_3 left

$0.03895 \text{ mol } Cr_2O_3 = \frac{x}{151.99}$

$x =$ **5.9 g Cr_2O_3 remaining**

12.) $CS_{2(l)} + 3Cl_{2(g)} \longrightarrow CCl_{4(l)} + S_2Cl_{2(l)}$

1000 g CS_2 → 13.14 mole

2000 g Cl_2 → 28.21 mole

Cl_2 is limiting

mole Cl_2 : mole CCl_4 = 3:1

so 9.40 mole CCl_4 is produced

$9.40 \text{ mole} = \frac{x g}{153.82 g/mole}$

$x = 1446 g$

or **1.45 kg CCl_4**

b.) $\frac{1 \text{ mole } CS_2}{3 \text{ mole } Cl_2} = \frac{x \text{ mole used of } CS_2}{28.21 \text{ mole } Cl_2 \text{ used}}$

$x = 9.40$ mole CS_2 used

so 13.14 mole started − 9.40 mole used

3.74 mole remaining

$3.74 \text{ mole } CS_2 = \frac{x g}{76.13 g/mole}$

$x =$ **285 g CS_2 remaining**

$$2Al + 3MnO \longrightarrow Al_2O_3 + 3Mn$$

$$\frac{100.0\,g\,Al}{26.98\,g/mol} = 3.706\ mole\ Al \qquad \frac{200.0\,g\,MnO}{70.94} = 2.819\ mole\ MnO$$

To react all of Mn we need only 1.897 mole Al. MnO is limiting reagent and Al is in excess by 1.827 mole

$$.827\ mole\ Al = \frac{x\,g}{26.98\,g/mole} = \boxed{49.28\,g\ Al\ in\ excess}$$

1.00 mole of any gas at [illegible] occupies 22.4 L.

$$\frac{4.0\,g\,O_2}{32.0\,g/mole} = 0.12\ mole\ O_2$$

$$\frac{22.4\,L}{1.00\,mole\,O_2} = \frac{x\,L}{0.125\,mole\,O_2}$$

$$x = \boxed{2.8\,L\ of\ O_2}$$

15.) $H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}$

$$\frac{X \text{ mole } Cl_2}{12 \text{ L } Cl_2} = \frac{1 \text{ mole } Cl_2}{22.4 \text{ L } Cl}$$

$X = 0.5357 \text{ mole } Cl_2$

mole Cl_2 : mole H_2 = 1:1 therefore

0.5357 mole H_2 or **12 L of H_2**

Two times as many mole of $HCl_{(g)}$ so

24 L of HCl

* Note relationships of Volumes of gases that react

16.) $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

Volume ratios are

$1 N_2 : 3 H_2$

$1 N_2 : 2 NH_3$

therefore 6.0 L of N_2 will react with **18 L of H_2** and produce **12 L of NH_3**

17.) $CS_{2(l)} + 3O_{2(g)} \longrightarrow CO_2 + 2SO_2$

1.00 mole CS_2 requires 3.00 mole of O_2

$$\frac{x\ L}{3.00\ mole\ O_2} = \frac{22.4\ L}{1.00\ mole\ O_2}$$

$$x = \boxed{67.2\ L\ O_2}$$

1.00 mole $CO_2 \Longrightarrow \boxed{22.4\ L\ CO_2}$

2.00 mole $SO_2 \Longrightarrow \boxed{44.8\ L\ SO_2}$

18.) $2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$

$$\frac{100.0\ g\ KClO_3}{122.55\ g/mole} = 0.81598\ mole\ KClO_3$$

$$\frac{3\ mole\ O_2}{2\ mole\ KClO_3} = \frac{x\ mole\ O_2}{0.81598}$$

$$x = 1.224\ mole\ O_2$$

$$\frac{22.4\ L}{1.00\ mole\ O_2} = \frac{x\ L}{1.224\ mole\ O_2}$$

$$x = \boxed{27.4\ L\ O_2}$$

Chemistry I

Chapter 11 worksheet

1.) $\frac{50.0g\ CaH_2}{42.03g/mole} = 1.190\ mole\ CaH_2$ $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$

$\frac{1\ mole\ CaH_2}{2\ mole\ H_2} = \frac{1.190\ mole\ CaH_2}{x\ mole\ H_2}$

$x = 2.38\ mole\ H_2$

$2.38\ mole\ H_2 = \frac{xg}{2.016\ g/mole}$

$4.80g\ H_2$

2.) $2NaIO_3 + 5NaHSO_3 \longrightarrow 3NaHSO_4 + 2Na_2SO_4 + H_2O + I_2$

$(1\ Kg) = \frac{1000.g\ I_2}{253.8g/mole} = 3.940\ mole\ I_2$

$\frac{1\ mole\ I_2}{2\ mole\ NaIO_3} = \frac{3.940\ mole\ I_2}{x\ mole\ NaIO_3}$ $x = 7.880\ mole\ NaIO_3$

$7.880\ mole\ NaIO_3 = \frac{xg}{197.9g/mole}$

$x = 1559g$ or **$1.56kg\ NaIO_3$**

$\frac{1\ mole\ I_2}{5\ mole\ NaHSO_3} = \frac{3.940\ mole\ I_2}{x\ mole\ NaHSO_3}$ $x = 19.70\ mole\ NaHSO_3$

$19.70\ mole = \frac{xg}{104.0g/mole}$

$x = 2049g$ or **$2.05kg\ NaHSO_3$**

3.) $2KClO_3 \longrightarrow 2KCl + 3O_2$

$$\frac{3.50\text{g } O_2}{32.0\text{g/mole}} = 0.1094 \text{ mole } O_2$$

$$\frac{2 \text{ mole } KClO_3}{3 \text{ mole } O_2} = \frac{X \text{ mole } KClO_3}{0.1094 \text{ mole } O_2}$$

$$X = 7.293 \times 10^{-2} \text{ mole } KClO_3$$

$$7.293 \times 10^{-2} \text{ mole} = \frac{X\text{g}}{122.60\text{g/mole}}$$

$$X = \boxed{8.94\text{g } KClO_3}$$

4.) $4Fe_{(s)} + 3O_{2(g)} \longrightarrow 2Fe_2O_{3(s)}$

$$\frac{1.00 \times 10^2 \text{g Fe}}{55.85 \text{g/mole}} = 1.791 \text{ mole Fe}$$

$$\frac{2\ Fe_2O_3}{4\ Fe} = \frac{X\ Fe_2O_3}{1.791\ Fe}$$

$$X = 0.8952 \text{ mole } Fe_2O_3$$

$$0.8952 \text{ mole} = \frac{X\text{g}}{159.7}$$

$$X = \boxed{143\text{g } Fe_2O_3}$$

5.) $2\,C_4H_{10(l)} + 13O_{2(g)} \longrightarrow 8\,CO_{2(g)} + 10\,H_2O_{(g)}$

$$\frac{1000\text{g } C_4H_{10}}{58.12\text{g/mole}} = 17.21\text{ mole } C_4H_{10}$$

$$\frac{13\text{ moles } O_2}{2\text{ moles } C_4H_{10}} = \frac{X\text{ mole } O_2}{17.21\text{ mole } C_4H_{10}}$$

$$X = 111.9\text{ mole } O_2$$

$$111.9\text{ mole } O_2 = \frac{X\text{ g}}{32.00\text{ g/mole}}$$

3579.7g or **3.580 kg O_2**

6.) $CH_3NO_2 + 3Cl_2 \longrightarrow CCl_3NO_2 + 3HCl$

$$\frac{500.0\text{g } CCl_3NO_2}{164.37\text{g/mole}} = 3.042\text{ mole } CCl_3NO_2$$

$$\frac{3.042\text{ mole } CCl_3NO_2}{X\text{ mole } CH_3NO_2} = \frac{1\text{ mole } CCl_3NO_2}{1\text{ mole } CH_3NO_2}$$

$$X = 3.042\text{ mole } CH_3NO_2$$

$$3.042\text{ mole } CH_3NO_2 = \frac{X\text{ g}}{61.04\text{ g/mole}}$$

X = **185.7g CH_3NO_2**

7.) $C_6H_{12}O_{6(aq)} \longrightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$

$$\frac{2.00\,g\ C_6H_{12}O_6}{180.16\,g/mole} = 1.110\times10^{-2}\ mole\ C_6H_{12}O_6$$

$$\frac{2\ mole\ C_2H_5OH}{1\ mole\ C_6H_{12}O_6} = \frac{x\ mole\ C_2H_5OH}{1.110\times10^{-2}\ mole\ C_6H_{12}O_6}$$

2.220×10^{-2} mole C_2H_5OH

$$2.220\times10^{-2}\ mole\ C_2H_5OH = \frac{x\,g}{46.07\,g/mole}$$

$x =$ **1.02 g C_2H_5OH**

8.) $2\ NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$

$(2.50\times10^{2}\,g)(0.945) = 236.25\,g$ NaCl in Sample $\quad \frac{236.25\,g\ NaCl}{58.45\,g/mole} = 4.042$ mole NaCl

$$\frac{1\ mole\ Na_2SO_4}{2\ mole\ NaCl} = \frac{x\ mole\ Na_2SO_4}{4.042\ mole\ NaCl}$$

$x = 2.021$ mole Na_2SO_4

$$2.021\ mole\ Na_2SO_4 = \frac{x\,g}{142.01\,g/mole}$$

$287.0\,g\ Na_2SO_4$

$$\frac{287.0\,g\ Na_2SO_4}{x}(100) = 83.4\%\ pure$$

$x =$ **344 g**

9.) $Ni_{(s)} + 4\,CO_{(g)} \longrightarrow Ni(CO)_{4\,(g)}$

$$\frac{1.00\,g\,Ni}{58.69\,g/mole} = 1.704 \times 10^{-2}\ \text{moles Ni}$$

Mole of Ni : Mole of CO = 1 : 4

$$(4)(1.704 \times 10^{-2}\ \text{moles}) = 0.06816\ \text{mole CO used}$$

$$0.06816\ \text{mole CO} = \frac{x\,g}{28.01\,g/mole}$$

$$x = \boxed{1.91\,g\ CO}$$

10.) $2\,Cu + S \longrightarrow Cu_2S$

100.0g + 50.0g

↓ ↓

1.574 mole + 1.560 mole we need twice as many moles of Cu as of S so Cu is limiting reagent.

$$\frac{1.574\ \text{mole Cu}}{X\ \text{mole}\ Cu_2S} = \frac{2\ \text{mole Cu}}{1\ \text{mole}\ Cu_2S}$$

$$X = 0.7870$$

$$\text{mole}\ Cu_2S = \frac{x}{159.2}$$

$$x = \boxed{125\,g\ Cu_2S}$$

11.) $2\,Al + Cr_2O_3 \longrightarrow Al_2O_3 + 2\,Cr$

a.) $\frac{5.0\,g\,Al}{26.98\,g/mole} = 0.1853$ mole Al

There must be twice as much (moles) of Al as of Cr_2O_3. There is not so Al is limiting.

$\frac{20.0\,g\,Cr_2O_3}{152.0} = 0.1316$ mole Cr_2O_3

0.1853 mole Al produces 0.1853 mole Cr

$0.1853 \text{ mole Cr} = \frac{x\,g}{51.996\,g/mole}$

$x = \boxed{9.6\,g\,Cr}$

$\frac{0.1853 \text{ mole Al used}}{x \text{ mole } Cr_2O_3 \text{ used}} = \frac{2 \text{ mole Al}}{1 \text{ mole } Cr_2O_3}$

0.09265 mole Cr_2O_3 used leaves 0.03895 mole Cr_2O_3 left

$0.03895 \text{ mole } Cr_2O_3 = \frac{x}{151.996}$

$x = \boxed{5.9\,g\,Cr_2O_3 \text{ remaining}}$

12.) $CS_{2(g)} + 3Cl_{2(g)} \longrightarrow CCl_{4(g)} + S_2Cl_{2(l)}$

1000 g CS_2 → 13.14 mole

2000 g Cl_2 → 28.21 mole

Cl_2 is limiting

mole Cl_2 : mole CCl_4 = 3 : 1

So 9.40 mole CCl_4 is produced

$9.40 \text{ mole} = \frac{x\,g}{153.81\,g/mole}$

$x = 1446\,g$

or $\boxed{1.45\,kg\,CCl_4}$

b.) $\frac{1 \text{ mole } CS_2}{3 \text{ mole } Cl_2} = \frac{x \text{ mole used of } CS_2}{28.21 \text{ mole } Cl_2 \text{ used}}$

$x = 9.40$ mole CS_2 used

so 13.14 mole started − 9.40 mole used

3.74 mole remaining

$3.74 \text{ mole } CS_2 = \frac{x\,g}{76.13\,g/mole}$

$x = \boxed{285\,g\,CS_2 \text{ remaining}}$

13.) $2Al + 3MnO \longrightarrow Al_2O_3 + 3Mn$

$\frac{100.0g\ Al}{26.98g/mole} = 3.706\ mole\ Al$ $\frac{200.0g\ MnO}{70.94} = 2.819\ mole\ MnO$

To react all of Mn we need only 1.897 mole Al. MnO is limiting reagent and Al is in excess by 1.827 moles

$1.827\ moles\ Al = \frac{X g}{26.98 g/mole} = \boxed{49.28g\ Al\ in\ excess}$

14.)

1.00 mole of any gas at STP occupies 22.4L.

$\frac{4.0g\ O_2}{32.0g/mole} = 0.125\ mole\ O_2$

$\frac{22.4\ L}{1.00\ mole\ O_2} = \frac{X\ L}{0.125\ mole\ O_2}$

$X = \boxed{2.8\ L\ of\ O_2}$

15.) $H_{2(g)} + Cl_{2(g)} \longrightarrow 2\,HCl_{(g)}$

$$\frac{x \text{ mole } Cl_2}{12 \text{ L } Cl_2} = \frac{1 \text{ mole } Cl_2}{22.4 \text{ L } Cl_2}$$

$x = 0.5357 \text{ mole } Cl_2$

mole Cl_2 : mole H_2 = 1:1 therefore

0.5357 mole H_2 or **12 L of H_2**

Two times as many moles of $HCl_{(g)}$ so

24 L of HCl

* Note relationships of Volumes of gases that react

16.) $N_{2(g)} + 3H_{2(g)} \longrightarrow 2\,NH_{3(g)}$

Volume ratios are

$1\,N_2 : 3\,H_2$

$1\,N_2 : 2\,NH_3$

Therefore 6.0 L of N_2 will react with **18 L of H_2** and produce **12 L of NH_3**

7.) $CS_{2(l)} + 3O_{2(g)} \longrightarrow CO_2 + 2SO_2$

1.00 mole CS_2 requires 3.00 mole of O_2

$$\frac{X\,L}{3.00\text{ mole }O_2} = \frac{22.4\,L}{1.00\text{ mole }O_2}$$

$$X = \boxed{67.2\,L\,O_2}$$

1.00 mole $CO_2 \Longrightarrow \boxed{22.4\,L\,CO_2}$

2.00 mole $SO_2 \Longrightarrow \boxed{44.8\,L\,SO_2}$

18.) $2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$

$$\frac{100.0\,g\,KClO_3}{122.55\,g/mole} = 0.81598\text{ mole }KClO_3$$

$$\frac{3\text{ mole }O_2}{2\text{ mole }KClO_3} = \frac{X\text{ mole }O_2}{0.81598}$$

$$X = 1.224\text{ mole }O_2$$

$$\frac{22.4\,L}{1.00\text{ mole }O_2} = \frac{X\,L}{1.224\text{ mole }O_2}$$

$$X = \boxed{27.4\,L\,O_2}$$