Chapter 11 – Extra Limiting Reagent Problem

1.)

$$2PCl_3 + 3PbF_2 \longrightarrow 2PF_3 + 3PbCl_2$$

$75.0\,g$ $\quad$ $100.0\,g$

$\downarrow \div 137.32\,g/n$ $\quad$ $\downarrow \div 245.2\,g/n$

0.5462 moles $\quad$ 0.4078 moles

$$\frac{2\,PCl_3}{3\,PbF_2} = \frac{x \text{ moles } PCl_3 \text{ needed}}{0.4078 \text{ moles } PbF_2 \text{ used}}$$

$x = 0.2719$ moles $PbCl_3$ needed

$\therefore PbF_2$ is limiting Reagent

$$\frac{2\,PF_3}{3\,PbF_2} = \frac{x \text{ moles } PF_3 \text{ produced}}{0.4078 \text{ moles } PbF_2 \text{ used}}$$

$x = 0.2719$ moles PF_3 Produced

$$0.2719 \text{ moles} = \frac{x\,g}{87.97\,g/n}$$

$\boxed{x = 23.9\,g\ PF_3 \text{ Formed}}$

2.)

$$TiO_2 + C + 2Cl_2 \longrightarrow TiCl_4 + CO_2$$

$10.00\,g$ $\quad$ $9.00\,g$

$\downarrow \div 79.90\,g/n$ $\quad$ $\downarrow \div 70.90\,g/n$

0.1252 moles $\quad$ 0.1269 moles

$$\frac{1\,TiO_2}{2\,Cl_2} = \frac{x\,TiO_2}{0.1269\,Cl_2}$$

$x = 0.06345$ moles TiO_2 needed To react with all of Cl_2 $\longrightarrow$

there is more than that amount of TiO_2 present and ∴ Cl_2 is the limiting reagent.

$$\frac{1\ TiCl_4}{2\ Cl_2} = \frac{X\ TiCl_4}{0.1269\ Cl_2} \qquad X = 0.06345 \text{ moles } TiCl_4 \text{ Formed}$$

$$0.06345 \text{ moles } TiCl_4 = \frac{X\ g}{189.7\ g/n} \qquad \boxed{X = 12.075\ g\ TiCl_4 \text{ Formed}}$$

3.) $P_4O_{10} + 6PCl_5 \longrightarrow 10POCl_3$

2.00 g 7.00 g

↓ ÷ 283.9 g/n ↓ ÷ 208.2 g/n

0.007045 moles 0.03362 moles

$$\frac{1\ P_4O_{10}}{6\ PCl_5} = \frac{X\ P_4O_{10}}{0.03362\ PCl_5} \qquad X = 0.005603 \text{ mole } P_4O_{10} \text{ needed to react with all of } PCl_5$$

∴ PCl_5 is limiting

$$\frac{10\ POCl_3}{6\ PCl_5} = \frac{X\ POCl_3}{0.03362\ PCl_5} \qquad X = 0.05603 \text{ mole } POCl_3 \text{ Produced}$$

$$0.05603 \text{ moles } POCl_3 = \frac{X\ g}{153.3\ g/n} \qquad \boxed{X = 8.59\ g\ POCl_3 \text{ Produced}}$$

4.) $3\ Mg_{(s)} + N_{2(g)} \longrightarrow Mg_3N_{2(s)}$

4.0g 4.0g

$\downarrow \div 24.3 g/n$ $\downarrow \div 28.0 g/n$

0.165 moles 0.143 moles

(a.) By inspection, Mg is limiting

(b.) $\frac{1\ N_2}{3\ Mg} = \frac{X\ N_2 \text{ used}}{0.165\ Mg \text{ used}}$ $X = 0.0550$ moles N_2 used

0.143 moles N_2 Total − 0.0550 moles N_2 used = 0.088 moles N_2 Remaining

$0.088 \text{ moles } N_2 = \frac{X\ g\ N_2}{28.0 g/n}$ $X = 2.5\ g\ N_2$ Left over

(c.) The number of moles of Mg_3N_2 Formed is the same as the number of Moles of N_2 used ∴ 0.0550 moles Mg_3N_2 Formed

$0.0550 \text{ moles } Mg_3N_2 = \frac{X\ g}{101 g/n}$

$X = 5.6\ g\ Mg_3N_2$ Formed

5.) $CO_{(g)} + 2H_{2(g)} \xrightarrow{Cu} CH_3OH_{(l)}$

Assume any mass of Reactants

$10_g \div 28.0_{g/n} = 0.357$ moles CO

$10_g \div 2.01_{g/n} = 5.0$ moles H_2

From the balanced equation, there must be two times as many moles of H_2 as CO. In this case there is H_2 in Excess

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

(B) H_2 is limiting

(C) If all 10.0 moles of H_2 is used then 20.0 moles HCl is Produced

(D) 2 moles of Cl_2 remain

7.) (a) $2Na_{(s)} + H_{2(g)} \longrightarrow 2NaH_{(s)}$

$6.75_g \div 23.00_{g/n} = 0.293$ moles

$3.03_g \div 2.016_{g/n} = 1.50$ moles

(b) ∴ Na is limiting

(c) For every 2 moles of Na used, 2 moles NaH is produced

∴

0.293 moles NaH $= \frac{x_g}{24.01_{g/n}}$

$x = 7.03_g$ NaH produced

8.) $4W + 3S + 2P = W_4S_3P_2$

1500 2000 1000

$\frac{4W}{1\ W_4S_3P_2} = \frac{X \text{ wrenches needed}}{500\ W_4S_3P_2}$

by the same logic 1500 screwdrivers and 1000 Pliers are needed and enough of each are available.

X = 2000 wrenches needed for 500 tool sets. Only 1500 are available ∴

No 500 kits cannot be made

9.)

(a) $Cl_{2(g)} + 3F_{2(g)} \longrightarrow 2ClF_{3(g)}$

3.40 moles 7.16 moles.

(b) To react all of the Cl_2, 10.2 moles of F_2 are required. Only 7.16 moles are present therefore F_2 is limiting

(c) $7.16 \text{ moles } F_2 \left(\frac{2\ ClF_3}{3\ F_2}\right) =$ 4.77 moles ClF_3 or 441. g $\left(92.45 \text{ g/n } ClF_3\right)$

(d) $7.16 \text{ moles } \cancel{F_2} \left(\frac{1\ Cl_2}{3\ \cancel{F_2}}\right) = 2.39 \text{ moles } Cl_2 \text{ used}$ ∴ 1.01 moles Cl_2 left

71.6 g Cl_2

10.) (a) $2\,C_2H_{2(g)} + 5O_{2(g)} \longrightarrow 4CO_{2(g)} + 2H_2O_{(g)}$

$125\,g$ ÷ $26.18\,g/n$ = 4.77 moles

$125\,g$ ÷ = 3.91 moles

(b) $\frac{2\,C_2H_2}{5\,O_2} = \frac{x\,C_2H_2}{3.91\text{ moles } O_2}$ $x = 1.56$ moles C_2H_2 Needed ∴ O_2 is limiting

(c) $3.91\text{ moles } O_2\left(\frac{2\,H_2O}{5\,O_2}\right) =$ **1.56 moles H_2O**

or

28.0 g H_2O