Chapter 11 – Extra Limiting Reagent Problem

1.)

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

75.0 g   100.0 g

↓ ÷ 137.33 g/n   ↓ ÷ 245.2 g/n

0.5462 moles   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

∴ 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

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

x = 23.9 g PF_3 Formed

2.)

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

10.00 g   9.00 g

↓ ÷ 79.90 g/n   ↓ ÷ 70.90 g/n

0.1252 moles   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 →

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

$$\frac{1\ TiCl_4}{2\ Cl_2} = \frac{x\ TiCl_4}{0.1269\ Cl_2}$$ $x = 0.06345$ moles $TiCl_4$ Formed

$$0.06345 \text{ moles } TiCl_4 = \frac{x\,g}{189.7\,g/n}$$ **$x = 12.0$ g $TiCl_4$ Formed**

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

2.00g 7.00g

↓÷283.9g/n ↓÷208.2g/n

0.007045 moles 0.03362 moles

$$\frac{1\ P_4O_{10}}{6\ PCl_5} = \frac{x\ P_4O_{10}}{0.03362\ PCl_5}$$ $x = 0.005603$ moles P_4O_{10} needed To react with all of PCl_5

∴ PCl_5 is limiting

$$\frac{10\ POCl_3}{6\ PCl_5} = \frac{x\ POCl_3}{0.03362\ PCl_5}$$ $x = 0.05603$ mole $POCl_3$ Produced

$$0.05603 \text{ moles } POCl_3 = \frac{x\,g}{153.3\,g/n}$$ **$x = 8.59$g $POCl_3$ Produced**

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

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 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 $1\,Mg_3N_2$ Formed is the same as the number of moles of N_2 used ∴ 0.0550 moles Mg_3N_2 Formed

0.0550 moles Mg_3N_2 = $\frac{x\,g}{101\,g/n}$

$X = 5.6\,g\ Mg_3N_2$ Formed

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

Assume any mass of Reactants

10 g ↓ ÷ 28.0 g/n → 0.357 moles CO

10 g ↓ ÷ 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 ↓ ÷ 23.00 g/n → 0.293 moles

3.03 g ↓ ÷ 2.016 g/n → 1.50 moles

(b) ∴ Na is limiting

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

∴

$$0.293 \text{ moles NaH} = \frac{x\,g}{24.01\,g/n}$$

x = 7.03 g NaH produced

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

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 $(92.45 g/n\ ClF_3)$

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

71.6 g Cl_2

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

125g (C₂H₂) → ÷ 26.18 g/n → 4.77 moles

125g (O₂) → ÷ → 3.91 moles

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

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

or

28.2 g H_2O

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75.0 g PCl_3, 100.0 g PbF_2

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

0.5462 moles, 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

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

x = 23.9 g PF_3 Formed

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

10.00 g TiO_2, 9.00 g Cl_2

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

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

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∴ PCl_5 is limiting

$$\frac{10\ POCl_3}{6\ PCl_5} = \frac{x\ POCl_3}{0.03362\ PCl_5}$$ $x = 0.05603$ mole $POCl_3$ Produced

$$0.05603 \text{ moles } POCl_3 = \frac{x\,g}{153.3\,g/n}$$ $x = 8.59\,g$ $POCl_3$ Produced

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

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(c.) The number of moles of 1 Mg_3N_2 Formed is the same as the number of moles of N_2 used ∴ 0.0550 moles Mg_3N_2 Formed

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X = 5.6g Mg_3N_2 Formed

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6.75 g → ÷ 23.00 g/m → 0.293 moles

3.03 g → ÷ 2.016 g/m → 1.50 moles

(b) ∴ Na is limiting

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

∴

$$0.293 \text{ moles NaH} = \frac{X\,g}{24.01\,g/m}$$

X = 7.03 g NaH produced

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

1500   2000   1000

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

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3.40 moles   7.16 moles.

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

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

71.6g Cl_2

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

125 g ↓ ÷ 26.18 g/m → 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**

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