Station 1

Nitromethane burns according to the reaction:

$\underline{4}\ CH_3NO_{2\,(l)} + \underline{3}\ O_{2\,(g)} \rightarrow \underline{4}\ CO_{2\,(g)} + \underline{6}\ H_2O_{(l)} + \underline{2}\ N_{2\,(g)}$

a) What mass of H_2O is produced when 0.150g of CH_3NO_2 is burned?

$$0.150\,g\,CH_3NO_2 \times \frac{1\,mol\,CH_3NO_2}{61.05\,g\,CH_3NO_2} \times \frac{6\,mol\,H_2O}{4\,mol\,CH_3NO_2} \times \frac{18.02\,g\,H_2O}{1\,mol\,H_2O} = 0.0664\,g\,H_2O$$

b) What combined volume of gas at STP is produced if 0.316g of CH_3NO_2 is burned?

$$0.316\,g\,CH_3NO_2 \times \frac{1\,mol\,CH_3NO_2}{61.05\,g\,CH_3NO_2} \times \frac{4\,mol\,CO_2}{4\,mol\,CH_3NO_2} \times \frac{22.4\,L\,CO_2}{1\,mol\,CO_2} = 0.116\,L\,CO_2$$

$$" \times \frac{2\,mol\,N_2}{4\,mol\,CH_3NO_2} \times \frac{22.4\,L\,N_2}{1\,mol\,N_2} = 0.0580\,L\,N_2$$

$$0.116\,L\,CO_2 + 0.0580\,L\,N_2 = \boxed{0.174\,L\,CO_2\text{ and }N_2}$$

c) What volume of $O_{2\,(g)}$ at STP is required to produce 0.250g of CO_2?

$$0.250\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44.01\,g\,CO_2} \times \frac{3\,mol\,O_2}{4\,mol\,CO_2} \times \frac{22.4\,L\,O_2}{1\,mol\,O_2} = \boxed{0.0954\,L\,O_2}$$

Not so great	Feel a bit unsure	Confident	Super confident

Station 2

Consider the following reaction:

$\underline{2}$ $Ca_3(PO_4)_2$ + $\underline{6}$ SiO_2 + $\underline{10}$ C → ___ P_4 + $\underline{6}$ $CaSiO_3$ + $\underline{10}$ CO

a) What mass of P_4 is produced when 41.5g of $Ca_3(PO_4)_2$, 26.5 g of SiO_2 and 7.80 g of C are reacted?

$$41.5g\ Ca_3(PO_4)_2 \times \frac{1\ mol\ Ca_3(PO_4)_2}{310.18\ g\ Ca_3(PO_4)_2} \times \frac{1\ mol\ P_4}{2\ mol\ Ca_3(PO_4)_2} \times \frac{123.88g\ P_4}{1\ mol\ P_4} = 8.29g\ P_4$$

$$26.5g\ SiO_2 \times \frac{1\ mol\ SiO_2}{60.09\ g\ SiO_2} \times \frac{1\ mol\ P_4}{6\ mol\ SiO_2} \times \frac{123.88\ g\ P_4}{1\ mol\ P_4} = 9.11g\ P_4$$

$$7.80g\ C \times \frac{1\ mol\ C}{12.01\ g\ C} \times \frac{1\ mol\ P_4}{10\ mol\ C} \times \frac{123.88\ g\ P_4}{1\ mol\ P_4} = \boxed{8.05g\ P_4}$$

b) How many grams of each excess reactant will remain unreacted?

$$7.80g\ C \times \frac{1\ mol\ C}{12.01g\ C} \times \frac{2\ mol\ Ca_3(PO_4)_2}{10\ mol\ C} \times \frac{310.18g\ Ca_3(PO_4)_2}{1\ mol\ Ca_3(PO_4)_2} = 40.3g$$

$$41.5g - 40.3g = \boxed{1.2g\ Ca_3(PO_4)_2}$$

$$7.80g\ C \times \frac{1\ mol\ C}{12.01g\ C} \times \frac{6\ mol\ SiO_2}{10\ mol\ C} \times \frac{60.09g\ SiO_2}{1\ mol\ SiO_2} = 23.4g\ SiO_2$$

$$26.5g - 23.4g = \boxed{3.1g\ SiO_2}$$

Not so great	Feel a bit unsure	Confident	Super confident

Station 3

A sample of high purity silicon is prepared by strongly heating a mixture of hydrogen and silicon tetrachloride in a sealed tube:

$$\_\_\_\_ SiCl_{4\,(g)} + \underline{\ 2\ } H_{2\,(g)} \rightarrow \_\_\_\_ Si_{(s)} + \underline{\ 4\ } HCl_{(g)}$$

If exactly 1.00g of silicon is ~~required~~ produced and the reaction is a 73.8% yield, what mass of each of $SiCl_4$ and H_2 must react?

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

$$73.8\% = \frac{1.00}{x} \times 100\%$$

$$\frac{1.00g}{0.738} = x = 1.36\ g_{Si}\ (theoretical)$$

$$1.36g_{Si} \times \frac{1\ mol_{Si}}{28.09g_{Si}} \times \frac{1\ mol_{SiCl_4}}{1\ mol_{Si}} \times \frac{169.89\ g_{SiCl_4}}{1\ mol_{SiCl_4}} = \boxed{8.23\ g_{SiCl_4}}$$

$$1.36\ g_{Si} \times \frac{1\ mol_{Si}}{28.09g_{Si}} \times \frac{2\ mol_{H_2}}{1\ mol_{Si}} \times \frac{2.02g_{H_2}}{1\ mol_{H_2}} = \boxed{0.196\ g_{H_2}}$$

Not so great	Feel a bit unsure	Confident	Super confident

Question #4:

What volume of $CO_{2\,(g)}$ at STP can be made when 0.0250 L of $C_5H_{12\,(l)}$ (density = 626.0 g/L), is reacted with 40.0 L of $O_{2\,(g)}$ at STP, according to the reaction:

$$\_\_\_\_ \ C_5H_{12\,(l)} + \underline{\ 8\ }\ O_{2\,(g)} \rightarrow \underline{\ 5\ }\ CO_{2\,(g)} + \underline{\ 6\ }\ H_2O_{(l)}$$

$$0.0250\,L_{C_5H_{12}} \times \frac{626.0\,g_{C_5H_{12}}}{1\,L_{C_5H_{12}}} \times \frac{1\,mol_{C_5H_{12}}}{72.17\,g_{C_5H_{12}}} \times \frac{5\,mol_{CO_2}}{1\,mol_{C_5H_{12}}} \times \frac{22.4\,L_{CO_2}}{1\,mol_{CO_2}} = \boxed{24.3\,L_{CO_2}}$$

$$40.0\,L_{O_2} \times \frac{1\,mol_{O_2}}{22.4\,L_{O_2}} \times \frac{5\,mol_{CO_2}}{8\,mol_{O_2}} \times \frac{22.4\,L_{CO_2}}{1\,mol_{CO_2}} = 25.0\,L_{CO_2}$$

How much of the excess reactant will be left over?

$$24.3\,L_{CO_2} \times \frac{1\,mol_{CO_2}}{22.4\,L_{CO_2}} \times \frac{8\,mol_{O_2}}{5\,mol_{CO_2}} \times \frac{22.4\,L_{O_2}}{1\,mol_{O_2}} = 38.8\,L_{O_2}$$

$$40.0\,L_{O_2} - 38.8\,L_{O_2} = \boxed{1.2\,L_{O_2}}$$

Not so great	Feel a bit unsure	Confident	Super confident