

30.0g	50.0g		
80.06g/mol	163.94g/mol	149.12g/mol	85.00g/mol

Let NH_4NO_3 be limiting

$$m_{\text{Na}_3\text{PO}_4 \text{ req'd}} = m_{\text{NH}_4\text{NO}_3} \times \frac{1}{M_{\text{NH}_4\text{NO}_3}} \times \text{mol ratio} \times M_{\text{Na}_3\text{PO}_4}$$

$$= 30.0\text{g NH}_4\text{NO}_3 \times \frac{1\text{mol NH}_4\text{NO}_3}{80.06\text{g}} \times \frac{1\text{mol Na}_3\text{PO}_4}{3\text{mol NH}_4\text{NO}_3} \times \frac{163.94\text{g Na}_3\text{PO}_4}{1\text{mol Na}_3\text{PO}_4}$$

$$= 20.48\text{g Na}_3\text{PO}_4$$

$$m_{\text{req'd}} < m_{\text{have.}}$$

$$20.48\text{g} \quad 50.0\text{g}$$

$\therefore \text{NH}_4\text{NO}_3$ is limiting

Na_3PO_4 is excess

$$m_{\text{Na}_3\text{PO}_4 \text{ remaining}} = m_{\text{have}} - m_{\text{req'd}}$$

$$= 50.0\text{g} - 20.5\text{g}$$

$$= 29.5\text{g}$$

$$m_{(\text{NH}_4)_3\text{PO}_4} = m_{\text{NH}_4\text{NO}_3} \times \frac{1}{M_{\text{NH}_4\text{NO}_3}} \times \text{mol ratio} \times M_{(\text{NH}_4)_3\text{PO}_4}$$

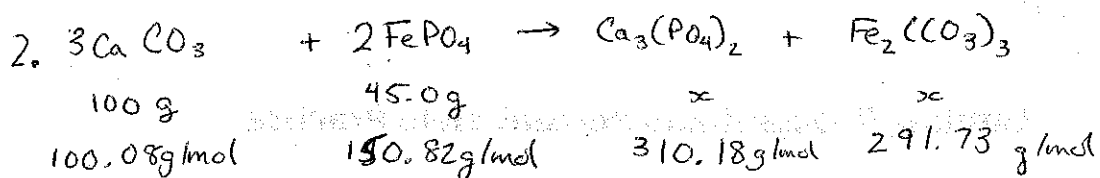
$$= 30.0\text{g} \times \frac{1\text{mol NH}_4\text{NO}_3}{80.06\text{g}} \times \frac{1\text{mol } (\text{NH}_4)_3\text{PO}_4}{3\text{mol NH}_4\text{NO}_3} \times \frac{149.12\text{g } (\text{NH}_4)_3\text{PO}_4}{1\text{mol } (\text{NH}_4)_3\text{PO}_4}$$

$$= 18.6\text{g } (\text{NH}_4)_3\text{PO}_4$$

$$m_{\text{NaNO}_3} = m_{\text{NH}_4\text{NO}_3} \times \frac{1}{M_{\text{NH}_4\text{NO}_3}} \times \text{mol ratio} \times M_{\text{NaNO}_3}$$

$$= 30.0\text{g} \times \frac{1\text{mol NH}_4\text{NO}_3}{80.06\text{g}} \times \frac{3\text{mol NaNO}_3}{3\text{mol NH}_4\text{NO}_3} \times \frac{85.00\text{g}}{1\text{mol NaNO}_3}$$

$$= 31.9\text{g NaNO}_3$$



Let CaCO_3 be limiting

$$\begin{aligned}
 M_{\text{FePO}_4 \text{ req'd}} &= M_{\text{CaCO}_3} \times \frac{1}{M_{\text{CaCO}_3}} \times \text{mol ratio} \times M_{\text{CaCO}_3} \\
 &= 100\text{g} \times \frac{1\text{mol CaCO}_3}{100.08\text{g}} \times \frac{2\text{mol FePO}_4}{3\text{mol CaCO}_3} \times \frac{150.82\text{g}}{1\text{mol FePO}_4} \\
 &= 100.5\text{g}
 \end{aligned}$$

$$M_{\text{req'd}} > M_{\text{have}} \rightarrow \text{FePO}_4 \text{ limiting}$$

$$\begin{aligned}
 M_{\text{Ca}_3(\text{PO}_4)_2} &= M_{\text{FePO}_4} \times \frac{1}{M_{\text{FePO}_4}} \times \text{mol ratio} \times M_{\text{Ca}_3(\text{PO}_4)_2} \\
 &= 45.0\text{g} \times \frac{1\text{mol FePO}_4}{150.82\text{g FePO}_4} \times \frac{1\text{mol Ca}_3\text{PO}_4}{2\text{mol FePO}_4} \times \frac{310.18\text{g Ca}_3(\text{PO}_4)_2}{1\text{mol Ca}_3(\text{PO}_4)_2}
 \end{aligned}$$

$$M_{\text{Ca}_3(\text{PO}_4)_2} = 46.27\text{g Ca}_3(\text{PO}_4)_2$$

$$\begin{aligned}
 M_{\text{Fe}_2(\text{CO}_3)_3} &= M_{\text{FePO}_4} \times \frac{1}{M} \times \text{mol ratio} \times M_{\text{Fe}_2(\text{CO}_3)_3} \\
 &= 45.0\text{g FePO}_4 \times \frac{1\text{mol FePO}_4}{150.82\text{g FePO}_4} \times \frac{1\text{mol Fe}_2(\text{CO}_3)_3}{2\text{mol FePO}_4} \times \frac{291.73\text{g Fe}_2(\text{CO}_3)_3}{1\text{mol Fe}_2(\text{CO}_3)_3}
 \end{aligned}$$

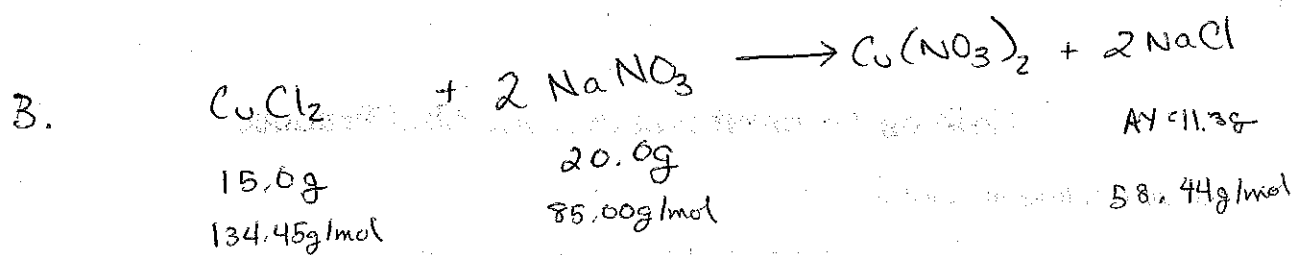
$$M_{\text{Fe}_2(\text{CO}_3)_3} = 43.52\text{g Fe}_2(\text{CO}_3)_3$$

$$\begin{aligned}
 M_{\text{CaCO}_3 \text{ limiting req'd}} &= M_{\text{FePO}_4} \times \frac{1}{M_{\text{FePO}_4}} \times \text{mol ratio} \times M_{\text{CaCO}_3} \\
 &= 45.0\text{g} \times \frac{1\text{mol FePO}_4}{150.82\text{g FePO}_4} \times \frac{3\text{mol CaCO}_3}{2\text{mol FePO}_4} \times \frac{100.08\text{g}}{1\text{mol CaCO}_3}
 \end{aligned}$$

$$M_{\text{CaCO}_3 \text{ req'd}} = 44.79\text{g CaCO}_3$$

$$\begin{aligned}
 M_{\text{remain}} &= M_{\text{have}} - M_{\text{req'd}} \\
 &= 100\text{g} - 44.79\text{g} \\
 &= 55.21
 \end{aligned}$$

$$55.21\text{g CaCO}_3 \text{ remain}$$



Let NaNO_3 be limiting

$$M_{\text{CuCl}_2 \text{ req'd}} = M_{\text{NaNO}_3} \times \frac{1}{M_{\text{NaNO}_3}} \times \text{mol ratio} \times M_{\text{CuCl}_2}$$

$$= 20\text{g NaNO}_3 \times \frac{1\text{mol NaNO}_3}{85.00\text{g}} \times \frac{1\text{mol CuCl}_2}{2\text{mol NaNO}_3} \times \frac{134.45\text{g CuCl}_2}{1\text{mol CuCl}_2}$$

$$= 15.82\text{g CuCl}_2$$

$M_{\text{CuCl}_2 \text{ req'd}} > M_{\text{CuCl}_2 \text{ have}} \therefore \text{CuCl}_2 \text{ is limiting}$

$$M_{\text{NaCl}} = M_{\text{CuCl}_2} \times \frac{1}{M_{\text{CuCl}_2}} \times \text{mol ratio} \times M_{\text{NaCl}}$$

$$= 15.0\text{g} \times \frac{1\text{mol CuCl}_2}{134.45\text{g}} \times \frac{2\text{mol NaCl}}{1\text{mol CuCl}_2} \times \frac{58.44\text{g NaCl}}{1\text{mol NaCl}}$$

$$= 13.04\text{g NaCl}$$

$$\% \text{ yield} = \frac{\text{AY}}{\text{TY}} \times 100\%$$

$$= \left(\frac{11.3\text{g}}{13.04\text{g}} \right) \times 100\%$$

$$= 86.66\%$$

$$= 86.7\%$$

$$M_{\text{NaNO}_3 \text{ req'd}} = M_{\text{CuCl}_2} \times \frac{1}{M_{\text{CuCl}_2}} \times \text{mol ratio} \times M_{\text{NaNO}_3}$$

$$= 15.0\text{g} \times \frac{1\text{mol CuCl}_2}{134.45\text{g CuCl}_2} \times \frac{2\text{mol NaNO}_3}{1\text{mol CuCl}_2} \times \frac{85.00\text{g NaNO}_3}{1\text{mol NaNO}_3}$$

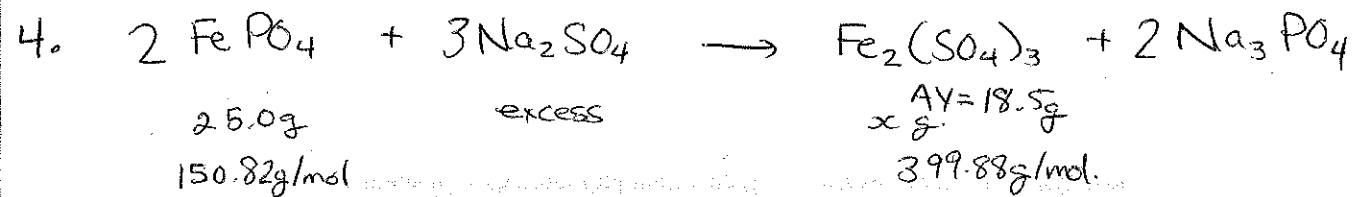
$$= 18.97\text{g}$$

$$M_{\text{remain}} = M_{\text{have}} - M_{\text{req'd}}$$

$$= 20.0\text{g} - 18.9\text{g}$$

$$= 1.1\text{g}$$

$\therefore 1.1\text{g NaNO}_3 \text{ remain}$



$$m_{\text{Fe}_2(\text{SO}_4)_3} = m_{\text{FePO}_4} \times \frac{1}{M_{\text{FePO}_4}} \times \text{mol ratio} \times M_{\text{Fe}_2(\text{SO}_4)_3}$$

$$= 25.0\text{g} \times \frac{1 \text{ mol FePO}_4}{150.82\text{g FePO}_4} \times \frac{1 \text{ mol Fe}_2(\text{SO}_4)_3}{2 \text{ mol FePO}_4} \times \frac{399.88\text{g Fe}_2(\text{SO}_4)_3}{1 \text{ mol Fe}_2(\text{SO}_4)_3}$$

$$= 33.14$$

$$m = 33.1 \text{ g Fe}_2(\text{SO}_4)_3$$

$$\% \text{ yield} = \left(\frac{\text{AY}}{\text{TY}} \right) \times 100\%$$

$$= \frac{18.5\text{g}}{33.1\text{g}} \times 100\%$$

$$\% \text{ yield} = 55.9\%$$



$$15.0\text{g}$$

$$142.04\text{g/mol}$$

$$\text{AY} =$$

$$\text{TY} =$$

$$\% \text{ yield} = 65.0\%$$

$$163.94\text{g/mol}$$

$$m_{\text{Na}_3\text{PO}_4} = m_{\text{Na}_2\text{SO}_4} \times \frac{1}{M_{\text{Na}_2\text{SO}_4}} \times \text{mol ratio} \times M_{\text{Na}_3\text{PO}_4}$$

$$= 15.0\text{g} \times \frac{1 \text{ mol Na}_2\text{SO}_4}{142.04\text{g}} \times \frac{2 \text{ mol Na}_3\text{PO}_4}{3 \text{ mol Na}_2\text{SO}_4} \times \frac{163.94\text{g}}{1 \text{ mol}}$$

$$\text{TY } m_{\text{Na}_3\text{PO}_4} = 11.5\text{g}$$

$$\text{AY} = 7.50\text{g}$$

$$\% \text{ yield} = \frac{\text{AY}}{\text{TY}} \times 100\%$$

$$\text{AY} = \frac{\% \text{ yield}}{100\%} \times \text{TY}$$

$$= \frac{65\%}{100\%} \times 11.5\text{g}$$



16.4 L
@STP

0.980 mol

L
@STP.

$$n_{\text{C}_2\text{H}_6} = V \times \frac{1}{V_{\text{molar}}}$$

$$= 16.4 \text{ L} \times \frac{1 \text{ mol C}_2\text{H}_6}{22.4 \text{ L}}$$

$$= 0.7321 \text{ mol C}_2\text{H}_6$$

$$n_{\text{O}_2 \text{ req'd}} = n_{\text{C}_2\text{H}_6} \times \text{mol ratio}$$

$$= 0.7321 \text{ mol C}_2\text{H}_6 \times \frac{7 \text{ mol O}_2}{2 \text{ mol C}_2\text{H}_6}$$

$$= 2.56 \text{ mol O}_2$$

n_{O_2} have < n_{O_2} req'd

$\therefore \text{O}_2$ is limiting

$$V_{\text{CO}_2} = n_{\text{O}_2} \times \text{mol ratio} \times V_{\text{molar}}$$

$$= 0.980 \text{ mol O}_2 \times \frac{4 \text{ mol CO}_2}{7 \text{ mol O}_2} \times \frac{22.4 \text{ L CO}_2}{1 \text{ mol CO}_2}$$

(a)

$$V_{\text{CO}_2} = 12.5 \text{ L CO}_2$$

$$N_{\text{O}} = V_{\text{CO}_2} \times \frac{1}{V_{\text{molar}}} \times \text{mol ratio} \times N_{\text{A}}$$

$$= 12.5 \text{ L CO}_2 \times \frac{1 \text{ mol CO}_2}{22.4 \text{ L}} \times \frac{2 \text{ mol O}}{1 \text{ mol CO}_2} \times \frac{6.022 \times 10^{23} \text{ O atom}}{1 \text{ mol O}}$$

(b)

$$N_{\text{O}} = 6.72 \times 10^{23} \text{ O atoms}$$

$$n_{\text{CO}_2 \text{ req'd}} = n_{\text{O}_2} \times \text{mol ratio}$$

$$= 0.980 \text{ mol O}_2 \times \frac{2 \text{ mol C}_2\text{H}_6}{7 \text{ mol O}_2}$$

$$= 0.28 \text{ mol CO}_2$$

$$n_{\text{CO}_2 \text{ remain}} = n_{\text{CO}_2 \text{ have}} - n_{\text{CO}_2 \text{ req'd}}$$

$$= 0.7321 \text{ mol CO}_2 - 0.28 \text{ mol CO}_2$$

(c)

$$= 0.452 \text{ mol C}_2\text{H}_6$$

d

$$m_{C_2H_6} = n \times M$$

$$= 0.452 \text{ mol} \times \frac{30.08 \text{ g}}{\text{mol}}$$

$$= 13.6 \text{ g } C_2H_6$$

e

$$N_C = n \times \text{mol ratio} \times N_A$$

$$= 0.452 \text{ mol } C_2H_6 \times \frac{2 \text{ mol } C}{1 \text{ mol } C_2H_6} \times \frac{6.022 \times 10^{23} \text{ C atom}}{1 \text{ mol } C}$$

$$= 5.45 \times 10^{23} \text{ C atom}$$

$$N_H = n \times \text{mol ratio} \times N_A$$

$$= 0.452 \text{ mol } C_2H_6 \times \frac{6 \text{ mol } H}{1 \text{ mol } C_2H_6} \times \frac{6.022 \times 10^{23} \text{ H atom}}{1 \text{ mol } H}$$

$$= 1.63 \times 10^{24} \text{ H atom}$$