* Watch your sig figs

Stoichiometry - Limiting Reagents

1) $Mg_{(s)} + 2HCl_{(aq)} \rightarrow Mg^{2+}Cl^{1-}_{2\,(aq)} + H_{2\,(g)}$

a) (1) $4.00\,g\,\underbrace{HCl}_{LR} \times \frac{1\,mol\,HCl}{37.5\,g\,HCl} \times \frac{1\,mol\,H_2}{2\,mol\,HCl} \times \frac{2\,g\,H_2}{1\,mol\,H_2} = \underbrace{0.107\,g\,H_2}_{max}$

(11) $3.00\,g\,Mg \times \frac{1\,mol\,Mg}{24.3\,g\,Mg} \times \frac{1\,mol\,H_2}{1\,mol\,Mg} \times \frac{2\,g\,H_2}{1\,mol\,H_2} = 0.247\,g\,H_2$

b) $0.107\,g\,H_2 \times \frac{1\,mol\,H_2}{2\,g\,H_2} \times \frac{22.4\,L}{1\,mol} = 1.20\,L$ sf!!

2) $50.0\,kg\,\underbrace{KCl}_{LR} \times \frac{1\,mol\,KCl}{74.5\,g\,KCl} \times \frac{4\,mol\,KNO_3}{4\,mol\,KCl} \times \frac{101\,g}{1\,mol\,KNO_3} = \underbrace{67.8\,kg\,KNO_3}_{max}$

$50.0\,kg\,HNO_3 \times \frac{1\,mol\,HNO_3}{63\,g\,HNO_3} \times \frac{4\,mol\,KNO_3}{4\,mol\,HNO_3} \times \frac{101\,g}{1\,mol\,KNO_3} = 80.2\,kg\,KNO_3$

$50.0\,kg\,KCl \times \frac{1\,mol\,KCl}{74.5\,g\,KCl} \times \frac{2\,mol\,Cl_2}{4\,mol\,KCl} \times \frac{71\,g\,Cl_2}{1\,mol\,Cl_2} = \underbrace{23.8\,kg\,Cl_2}_{max}$

3) $20.0\,g\,\underbrace{P_4}_{LR} \times \frac{1\,mol\,P_4}{124\,g\,P_4} \times \frac{1\,mol\,PH_3}{1\,mol\,P_4} \times \frac{34\,g\,PH_3}{1\,mol\,PH_3} = \underbrace{5.48\,g\,PH_3}_{max}$

$50.0\,g\,NaOH \times \frac{1\,mol\,NaOH}{40\,g\,NaOH} \times \frac{1\,mol\,PH_3}{3\,mol\,NaOH} \times \frac{34\,g\,PH_3}{1\,mol\,PH_3} = 14.2\,g\,PH_3$

4) $Cl_{2\,(g)} + 2NaBr_{(aq)} \rightarrow 2NaCl_{(aq)} + Br_{2\,(l)}$

LR

$25.0\text{g}\ \text{NaBr} \times \frac{1\text{mol NaBr}}{102.9\text{g NaBr}} \times \frac{1\text{mol Br}_2}{2\text{mol NaBr}} \times \frac{160\text{g Br}_2}{1\text{mol Br}_2} = 19.4\text{g Br}_2$ max

$25.0\text{g Cl}_2 \times \frac{1\text{mol Cl}_2}{71\text{g Cl}_2} \times \frac{1\text{mol Br}_2}{1\text{mol Cl}_2} \times \frac{160\text{g Br}_2}{1\text{mol Br}_2} = 56.3\text{g Br}_2$

5) $25.0\text{g Ag} \times \frac{1\text{mol Ag}}{108\text{g}} \times \frac{2\text{mol Ag}_2\text{S}}{4\text{mol Ag}} \times \frac{248\text{g}}{1\text{mol Ag}_2\text{S}} = 28.7\text{g Ag}_2\text{S}$ max

LR

$5.00\text{g H}_2\text{S} \times \frac{1\text{mol H}_2\text{S}}{34\text{g}} \times \frac{2\text{mol Ag}_2\text{S}}{2\text{mol H}_2\text{S}} \times \frac{248\text{g}}{1\text{mol Ag}_2\text{S}} = 36.5\text{g Ag}_2\text{S}$

$4.00\text{g O}_2 \times \frac{1\text{mol O}_2}{32\text{g}} \times \frac{2\text{mol Ag}_2\text{S}}{1\text{mol O}_2} \times \frac{248\text{g}}{1\text{mol Ag}_2\text{S}} = 62.0\text{g Ag}_2\text{S}$

6) LR

$70.0\text{g H}_2\text{S} \times \frac{1\text{mol H}_2\text{S}}{34\text{g}} \times \frac{2\text{mol SO}_2}{2\text{mol H}_2\text{S}} \times \frac{64\text{g}}{1\text{mol SO}_2} = 132\text{g SO}_2$ max

$125\text{g O}_2 \times \frac{1\text{mol O}_2}{32\text{g}} \times \frac{2\text{mol SO}_2}{3\text{mol O}_2} \times \frac{64\text{g}}{1\text{mol SO}_2} = 167\text{g SO}_2$

either LR

$70.0\text{g H}_2\text{S} \times \frac{1\text{mol H}_2\text{S}}{34\text{g}} \times \frac{3\text{mol O}_2}{2\text{mol H}_2\text{S}} \times \frac{32\text{g O}_2}{1\text{mol O}_2} = 98.8\text{g O}_2$ reacted

$\therefore 125\text{g O}_2 - 98.8\text{g O}_2 = 26\text{g O}_2$ left over

max product made

or $132\text{g SO}_2 \times \frac{1\text{mol SO}_2}{64\text{g}} \times \frac{3\text{mol O}_2}{2\text{mol SO}_2} \times \frac{32\text{g O}_2}{1\text{mol O}_2} = 99.0\text{g}$ reacted

works both ways! take your pick!

- max amt

7) $17.5\text{g C} \times \frac{1\text{mol C}}{12\text{g}} \times \frac{1\text{mol CS}_2}{5\text{mol C}} \times \frac{76\text{g}}{1\text{mol CS}_2} = 22.2\text{g CS}_2$

$39.5\text{g SO}_2 \times \frac{1\text{mol SO}_2}{64\text{g}} \times \frac{1\text{mol CS}_2}{2\text{mol SO}_2} \times \frac{76\text{g}}{1\text{mol CS}_2} = 23.5\text{g CS}_2$

8) $41.5\text{g CaP} \times \frac{1\text{mol CaP}}{310\text{g}} \times \frac{1\text{mol P}_4}{2\text{mol CaP}} \times \frac{124\text{g}}{1\text{mol P}_4} = 8.30\text{g P}_4$

$26.5\text{g SiO}_2 \times \frac{1\text{mol SiO}_2}{60\text{g}} \times \frac{1\text{mol P}_4}{6\text{mol SiO}_2} \times \frac{124\text{g}}{1\text{mol P}_4} = 9.13\text{g P}_4$

LR

$7.80\text{g C} \times \frac{1\text{mol C}}{12\text{g}} \times \frac{1\text{mol P}_4}{10\text{mol C}} \times \frac{124\text{g}}{1\text{mol P}_4} = 8.06\text{g P}_4$ max

9) LR

$15.65\text{g C}_5\text{H}_{12} \times \frac{1\text{mol CH}}{72\text{g}} \times \frac{5\text{mol CO}_2}{1\text{mol CH}} \times \frac{22.4\text{L}}{1\text{mol CO}_2} = 24.34\text{ L CO}_2$ max

Here's an easier way for this one!

$40.0\text{L O}_2 \times \frac{1\text{mol O}_2}{22.4\text{L}} \times \frac{5\text{mol CO}_2}{8\text{mol O}_2} \times \frac{22.4\text{L}}{1\text{mol CO}_2} = 25.0\text{L CO}_2$

10) $H_2(g) + Cl_2(g) \rightarrow 2\,HCl(g)$

$4.50\text{g H}_2 \times \frac{1\text{mol H}_2}{2\text{g}} \times \frac{2\text{mol HCl}}{1\text{mol H}_2} \times \frac{36.5\text{g}}{1\text{mol HCl}} = 164\text{g HCl}$

$140.0\text{g Cl}_2 \times \frac{1\text{mol Cl}_2}{71\text{g}} \times \frac{2\text{mol HCl}}{1\text{mol Cl}_2} \times \frac{36.5\text{g}}{1\text{mol HCl}} = 143.9\text{ g HCl}$ max

LR

$140.0\text{g } Cl_2 \times \frac{1\text{mol } Cl_2}{71\text{g}} \times \frac{1\text{mol } H_2}{1\text{mol } Cl_2} \times \frac{2\text{g } H_2}{1\text{mol } H_2} = 3.944\text{g } H_2$ reacted

* ∴ $4.50\text{g } H_2$ to start $- 3.944\text{g } H_2$ reacted $= 0.56\text{g } H_2$ left over

11) $55.0\text{g } FeCO_3 \times \frac{1\text{mol } FeCO_3}{115.8\text{g}} \times \frac{2\text{mol } Fe_2O_3}{4\text{mol } FeCO_3} \times \frac{159.6\text{g}}{1\text{mol } Fe_2O_3} = 37.9\text{g } Fe_2O_3$ (LR, max)

$40.0\text{L } O_2 \times \frac{1\text{mol}}{22.4\text{L}} \times \frac{2\text{mol } Fe_2O_3}{1\text{mol } O_2} \times \frac{159.6\text{g}}{1\text{mol } Fe_2O_3} = 570.9\text{g } Fe_2O_3$ (INXS)

$37.9\text{g } Fe_2O_3 \times \frac{1\text{mol } Fe_2O_3}{159.6\text{g}} \times \frac{1\text{mol } O_2}{2\text{mol } Fe_2O_3} \times \frac{32\text{g } O_2}{1\text{mol } O_2} = 3.80\text{g } O_2$ reacted

$40.0\text{L } O_2 \times \frac{1\text{mol } O_2}{22.4\text{L}} \times \frac{32\text{g } O_2}{1\text{mol } O_2} = 57.1\text{g } O_2$ to start

$57.1\text{g } O_2$ had $- 3.80\text{g}$ used $= 53.3\text{g } O_2$ left

12) 2 wheels + 1 frame + 1 handlebars = 1 bike

a) $5050\text{ wheels} \times \frac{1\text{ bike}}{2\text{ wheels}} = 2525\text{ bikes}$

$3013\text{ frames} \times \frac{1\text{ bike}}{1\text{ frame}} = 3013\text{ bikes}$

$2455\text{ handlebars} \times \frac{1\text{ bike}}{1\text{ handlebar}} = 2455\text{ bikes}$ (LR, max)

$2455\text{ bikes} \times \frac{1\text{ frame}}{1\text{ bike}} = 2455\text{ frames}$

$3013 - 2455 = 558$ frames left

$2455 \text{ bikes} \times \frac{2 \text{ wheels}}{1 \text{ bike}} = 4910 \text{ wheels used}$ — 5050 wheels had

140 wheels left

13) a) $1.00\text{g SB} \times \frac{1\text{mol SB}}{84\text{g}} \times \frac{3\text{mol CO}_2}{3\text{mol SB}} \times \frac{22.4\text{L}}{1\text{mol CO}_2} = 0.267\text{L CO}_2$ max

(LR = SB)

$1.00\text{g CA} \times \frac{1\text{mol CA}}{192\text{g}} \times \frac{3\text{mol CO}_2}{1\text{mol CA}} \times \frac{22.4\text{L}}{1\text{mol CO}_2} = 0.350\text{L CO}_2$

b) LR = SB

c) $1.00\text{g SB} \times \frac{1\text{mol SB}}{84\text{g}} \times \frac{1\text{mol CA}}{3\text{mol SB}} \times \frac{192\text{g CA}}{1\text{mol CA}} = 0.762\text{g CA used}$

$1.00\text{g CA had} - 0.762\text{g used} = 0.24\text{g CA left over}$

14) $2.50\text{g NH}_3 \times \frac{1\text{mol NH}_3}{17\text{g}} \times \frac{4\text{mol NO}}{2\text{mol NH}_3} \times \frac{30\text{g NO}}{1\text{mol NO}} = 8.82\text{g NO}$

a) $2.85\text{g O}_2 \times \frac{1\text{mol O}_2}{32\text{g}} \times \frac{4\text{mol NO}}{5\text{mol O}_2} \times \frac{30\text{g NO}}{1\text{mol NO}} = 2.14\text{g NO}$ max

(LR)

b) $LR = O_2$

c) $2.85\text{g O}_2 \times \frac{1\text{mol O}_2}{32\text{g}} \times \frac{2\text{mol NH}_3}{5\text{mol O}_2} \times \frac{17\text{g NH}_3}{1\text{mol NH}_3} = 0.606\text{g NH}_3 \text{ used}$

$2.50\text{g NH}_3 - 0.606\text{g} \overset{NH_3}{=} 1.89\text{g NH}_3 \text{ left}$