Stoich. Hmwk:

1. $Pb + 2HCl(aq) \rightarrow PbCl_2 + H_2(aq)$

a) given: 0.36 mol Pb need: ? mol HCl Type: mol → mol

$$0.36\ \cancel{mol\ Pb} \times \frac{2\ mol\ HCl}{1\ \cancel{mol\ Pb}} = \boxed{0.72\ mol\ HCl}$$

2sf

b) given: 4.3 mol HCl need: ? mol H_2 Type: mol → mol

$$4.3\ mol\ HCl \times \frac{1\ mol\ H_2}{2\ mol\ HCl} = 2.15 \rightarrow \boxed{2.2\ mol\ H_2}$$

2sf

2. $N_2O_5 + H_2O \rightarrow 2\ HNO_3$ given: 0.51 mol N_2O_5 need: ? mol HNO_3

$$0.51\ mol\ N_2O_5 \times \frac{2\ mol\ HNO_3}{1\ mol\ N_2O_5} = \boxed{1.0\ mol\ HNO_3}$$

2sf

2b) given: 1.2 mol N_2O_5 need: ? mol H_2O Type: mol → mol

$$1.2\ mol\ N_2O_5 \times \frac{1\ mol\ H_2O}{1\ mol\ N_2O_5} = \boxed{1.2\ mol\ H_2O}$$

3. _C + 2 ZnO → 2 Zn + _CO_2

a) given: 0.38 mol ZnO need: ? mol CO_2 Type: mol → mol

$$0.38\ mol\ ZnO \times \frac{1\ mol\ CO_2}{2\ mol\ ZnO} = \boxed{0.19\ mol\ CO_2}$$

2sf

b) given: 3.7 mol Zn need: ? mol ZnO Type: mol → mol

$$3.7\ mol\ Zn \times \frac{2\ mol\ ZnO}{2\ mol\ Zn} = \boxed{3.7\ mol\ ZnO}$$

4. $Br_2(g) + 2\,NaI \rightarrow 2\,NaBr + I_2(g)$

a) given: 0.69mol Br_2 need: ? g NaBr Type: mole → mass

$$0.69 \text{ mol } Br_2 \times \underbrace{\frac{2 \text{ mol NaBr}}{1 \text{ mol } Br_2}}_{\text{molar ratio}} \times \frac{102.90 \text{ g NaBr}}{1 \text{ mol NaBr}} = 142 \rightarrow \boxed{140 \text{ g NaBr}}$$

2sf 1.42×10^2 1.4×10^2

b) given: 20.0g Br_2 need: ? mol I_2 Type: mass → mol

$$20.0 \text{ g } Br_2 \times \frac{1 \text{ mol } Br_2}{159.80 \text{ g } Br_2} \times \frac{1 \text{ mol } I_2}{1 \text{ mol } Br_2} = \boxed{1.25\times10^{-1} \text{ or } 0.125 \text{ mol } I_2}$$

3sf

5. $2P + 3Br_2(g) \rightarrow 2PBr_3$ given: 8.78g Br_2 need: ?g PBr_3 Type: mass→mass

a) $$8.78 \text{ g } \cancel{Br_2} \times \frac{1 \text{ mol } Br_2}{159.80 \text{ g } \cancel{Br_2}} \times \underbrace{\frac{2 \text{ mol } PBr_3}{3 \text{ mol } Br_2}}_{\text{molar ratio}} \times \frac{270.67 \text{ g } PBr_3}{1 \text{ mol } PBr_3} = \boxed{9.91 \text{ g } PBr_3}$$

5b) $2P + 3Br_2(g) \rightarrow 2\,PBr_3$

given: 12.87 g P need: ? g PBr_3 Type: mass → mass

$$12.87 \text{ g P} \times \frac{1 \text{ mol P}}{30.97 \text{ g P}} \times \underbrace{\frac{2 \text{ mol } PBr_3}{2 \text{ mol P}}}_{\text{molar ratio}} \times \frac{270.67 \text{ g } PBr_3}{1 \text{ mol } PBr_3} = \boxed{112.5 \text{ g } PBr_3}$$

6. $N_2(g) + 3H_2(g) \rightarrow 2\,NH_3(g)$

a) given: 21.48g NH_3 need: ?g N_2 mass → mass

$$21.48 \text{ g } NH_3 \times \frac{1 \text{ mol } NH_3}{17.04 \text{ g } NH_3} \times \frac{1 \text{ mol } N_2}{2 \text{ mol } NH_3} \times \frac{28.02 \text{ g } N_2}{1 \text{ mol } N_2} = \boxed{17.66 \text{ g } N_2}$$

b) $$2.24 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2.02 \text{ g } H_2} \times \frac{1 \text{ mol } N_2}{3 \text{ mol } H_2} \times \frac{28.02 \text{ g } N_2}{1 \text{ mol } N_2} = \boxed{10.4 \text{ g } N_2}$$

given: 2 ...

... g N_2

mass → mass

7. $2\,Al_2O_3 \longrightarrow 4\,Al + 3O_2(g)$

a) given: $9.8\,g\ Al_2O_3$ need: ? g Al mass → mass (3 steps)

molar rati

$$9.8\,g\ Al_2O_3 \times \frac{1\,mol\ Al_2O_3}{101.96\,g\ Al_2O_3} \times \frac{4\,mol\ Al}{2\,mol\ Al_2O_3} \times \frac{26.98\,g\ Al}{1\,mol\ Al} = \boxed{5.2\,g\ Al}$$

b) given: $24.97\,g\ O_2$ need: ? g Al_2O_3 mass → mass

$$24.97\,g\ O_2 \times \frac{1\,mol\ O_2}{32.00\,g\ O_2} \times \frac{2\,mol\ Al_2O_3}{3\,mol\ O_2} \times \frac{101.96\,g\ Al_2O_3}{1\,mol\ Al_2O_3} = \boxed{53.04\,g\ Al_2O_3}$$

When volume is used replace molar mass with 22.4 L.

vol → vol mol → vol molar ratio x last step

$$\text{amt given} \times \frac{1\,\text{mol given}}{22.4\,L\ \text{given}} \times \frac{\#\,\text{mol needed}}{\#\,\text{mol given}} \times \frac{22.4\,L\ \text{needed}}{1\,\text{mol needed}} =$$

mol → vol (2 conv.)

vol → mol (2 conv.)

mass → vol

$$\text{amt given} \times \frac{1\,\text{mol given}}{\text{molar mass given}} \times \frac{\#\,\text{mol needed}}{\#\,\text{mol given}} \times \frac{22.4\,L\ \text{needed}}{1\,\text{mol needed}} =$$

vol → mass

$$\text{amt given} \times \frac{1\,\text{mol given}}{22.4\,L\ \text{given}} \times \frac{\#\,\text{mol needed}}{\#\,\text{mol given}} \times \frac{\text{molar mass needed}}{1\,\text{mol needed}} =$$

8a) given: $0.72 \text{ mol } F_2$ need: $? \text{ L } I_2$ type: mol → L (2 steps)

$$0.72 \text{ mol } F_2 \times \underbrace{\frac{1 \text{ mol } I_2}{1 \text{ mol } F_2}}_{\text{use coefficients}} \times \frac{22.4 \text{ L } I_2}{1 \text{ mol } I_2} = \boxed{16 \text{ L } I_2}$$

9a) given: $15.0 \text{ L } H_2$ need: ? mol Na type: L → mol (2 steps)

$$15.0 \text{ L } H_2 \times \frac{1 \text{ mol } H_2}{22.4 \text{ L } H_2} \times \overbrace{\frac{2 \text{ mol Na}}{1 \text{ mol } H_2}}^{\text{molar ratio}} = \boxed{1.34 \text{ mol Na}}$$

$(15.0 \times 2) \div 22.4 =$

$15.0 \times 2/22.4$

10a) given: $31.8 \text{ L } NH_3$ need: $? \text{ L } N_2$ type: L → L (3 steps)

$$31.8 \text{ L } NH_3 \times \frac{1 \text{ mol } NH_3}{22.4 \text{ L } NH_3} \times \frac{1 \text{ mol } N_2}{2 \text{ mol } NH_3} \times \frac{22.4 \text{ L } N_2}{1 \text{ mol } N_2} = \boxed{15.9 \text{ L } N_2}$$

$(31.8 \times 22.4) \div (22.4 \times 2) =$

Limiting Factor:

1. Complete 2 problems reactant 1 → product
   reactant 2 → product
2. compare the quantities for the products – the smaller # is the theoretical yield.
3. The reactant that had the smaller yield is the Limiting factor (LF).
4. $\% \text{ yield} = \frac{\text{actual yield (from experiment)}}{\text{theoretical yield}} \times 100$

$$\boxed{4HCl + O_2 \longrightarrow 2H_2O + 2Cl_2}$$

$950g\ HCl \rightarrow ?\ g\ Cl_2$

coefficients

$$750g\ HCl \times \frac{1\ mol\ HCl}{36.46g\ HCl} \times \underbrace{\frac{2\ mol\ Cl_2}{4\ mol\ HCl}}_{\text{molar ratio}} \times \frac{70.90\ g\ Cl_2}{1\ mol\ Cl_2}$$

Limiting Factor
LF

Theoretical yield

$$\boxed{\begin{array}{c} 730 \\ 729.22g\ Cl_2 \end{array}}$$

T.Y.

$320g\ O_2 \rightarrow ?\ g\ Cl_2$

1400

$$320g\ O_2 \times \frac{1\ mol\ O_2}{32.00g\ O_2} \times \underbrace{\frac{2\ mol\ Cl_2}{1\ mol\ O_2}}_{\text{molar ratio}} \times \frac{70.90g\ Cl_2}{1\ mol\ Cl_2} = 1418.\ g\ Cl_2$$

If the experiment produced 698 g Cl_2 what is the % yield?

$$\frac{698g}{730g} \times 100 = \boxed{96\%\ \text{yield}}$$

$$\overset{\text{mol } F_2}{\text{amount given}} \times \underbrace{\frac{\text{1 mol given}}{\text{molar mass given or } 22.4\text{L}}}_{\text{only needed if starting w/ grams or liters}} \times \underbrace{\frac{\#\text{ mol needed}}{\#\text{ mol given}}}_{\text{molar ratio used in every problem.}} \times \underbrace{\frac{\text{molar mass or } 22.4\text{L needed}}{\text{1 mol needed}}}_{\text{only used if needing g or L to finish.}}$$

given: $0.72\text{ mol } F_2$ needed: $?\text{ L } I_2$ type: mol → L

8a) $0.72\,\cancel{\text{mol } F_2} \times \frac{1\ \cancel{\text{mol } I_2}}{1\ \cancel{\text{mol } F_2}} \times \frac{22.4\text{ L } I_2}{1\ \cancel{\text{mol } I_2}} = \boxed{16\text{ L } I_2}$