Key

3. Chlorine gas can be produced in the laboratory by adding concentrated hydrochloric acid to manganese(IV) oxide in the following reaction: **$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O$**

a. Calculate the mass of MnO_2 needed to produce 25.0g of ~~Cl_2~~ $MnCl_2$

$25g\,Cl_2 \times \frac{1 mol\,Cl_2}{125.84g} \times \frac{1 mol\,MnO_2}{1 mol\,MnCl_2} \times \frac{86.94g}{1 mol} = 17.27g\,MnO_2$

b. What mass of H_2O is produced when 0.091g of $MnCl_2$ is generated?

$.091g\,MnCl_2 \times \frac{1 mol\,MnCl_2}{125.84g} \times \frac{2 mol\,H_2O}{1 mol\,MnCl_2} \times \frac{18.02g}{1 mol\,H_2O} = 0.026g\,H_2O$

Part 5: Volume Stoichiometry- Write out the conversion factor needed to solve the following problems:

1. If an excess of nitrogen gas reacts with 25.0 L of hydrogen gas at STP, according to the reaction below, how many L of ammonia will be produced? **$N_{2(g)} + 3H_{2(g)} \text{--->} 2NH_{3(g)}$**

$25L\,H_2 \times \frac{2L\,NH_3}{3L\,H_2} = 16.67L\,NH_3$

2. What volume of oxygen gas would react with 35.0 L of hydrogen gas at STP, according to the equation below?

$2H_{2(g)} + O_{2(g)} \text{---->} 2H_2O_{(g)}$

$35L\,H_2 \times \frac{1L\,O_2}{2L\,H_2} = 17.5L\,O_2$

Part 6: Limiting Reagents: Write out the conversion factor needed to solve the following problems:

1. Use the folowing equation for the oxidation of aluminum in the following problems. **$4Al + 3O_2 \longrightarrow 2Al_2O_3$**

a.) Which reactant is limiting if 0.32 mol Al and 0.26 mol O_2 are available?

$.32mol\,Al \times \frac{2mol\,Al_2O_3}{4mol\,Al} = .16mol\,Al_2O_3$ ∴ Al is LR

$.26mol\,O_2 \times \frac{2mol\,Al_2O_3}{3mol\,O_2} = .17mol\,Al_2O_3$

b.) How many moles of Al_2O_3 are formed from the reaction of 6.38×10^{-3} mol of O_2 and 9.15×10^{-3} mol of Al?

$6.38 \times 10^{-3} mol\,O_2 \times \frac{2mol\,Al_2O_3}{3mol\,O_2} = .00425\,mol\,Al_2O_3$

$9.15 \times 10^{-3} mol\,Al \times \frac{2mol\,Al_2O_3}{4mol\,Al} = .004575$

c.) If 3.17g of Al and 2.55g of O_2 are available, which reactant is limiting?

$3.17g\,Al \times \frac{1mol\,Al}{26.982g} \times \frac{2mol\,Al_2O_3}{4mol\,Al} = .0587$

$2.55g\,O_2 \times \frac{1mol\,O_2}{32g} \times \frac{2mol\,Al_2O_3}{3mol\,O_2} = .0531$ ∴ O_2 is LR

2. A reaction such as the one shown here is often used to demonstrate a single replacement reaction.

$3CuSO_4(aq) + 2Fe(s) \longrightarrow 3Cu(s) + Fe_2(SO_4)_3(aq)$

If you place 0.092 mol of iron filings in a solution containing 0.158 mol of $CuSO_4$, what is the limiting reactant? How many moles of Cu will be formed?

$.158mol\,CuSO_4 \times \frac{3mol\,Cu}{3mol\,CuSO_4} = .158\,mol$

$.092mol\,Fe \times \frac{3mol\,Cu}{2mol\,Fe} = .138mol\,Cu$ ∴ Fe is LR

3. Nickel replaces silver from silver nitrate in solution according to the following equation:

$2AgNO_3 + Ni \longrightarrow 2Ag + Ni(NO_3)_2$

a.) If you have 22.9g of Ni and 112g of $AgNO_3$, which reactant is in excess?

$22.9g\,Ni \times \frac{1mol\,Ni}{58.693g\,Ni} \times \frac{1mol\,Ni(NO_3)_2}{1mol\,Ni} = .39mol$

$112g\,AgNO_3 \times \frac{1mol\,AgNO_3}{169.88} \times \frac{1mol}{2mol} = .33$ ∴ $AgNO_3$ is LR

b.) What mass of nickel (II) nitrate would be produced given the quantities above?

$.33mol\,Ni(NO_3)_2 \times \frac{182.713g}{1mol} = 60.3g\,Ni(NO_3)_2$

Part 7: Percent Yield: : Write out the conversion factor needed to solve the following problems:

1. Assume the following hypothetical reaction takes place.

$$2A + 7B \rightarrow 4C + 3D$$

Calculate the percentage yield in each of the cases: actual

a. The reaction of 0.0251 mol of A produces 0.0349 mol of C

$.0251 \text{ mol } A \times \frac{4 \text{ mol } C}{2 \text{ mol } A} = .0502 \text{ mol } C$ theoretical $\% \text{ yield} = \frac{.0349}{.0502} \times 100 = 69.5\%$

b. The reaction of 1.19 mol of A produces 1.41 mol of D

$1.19 \text{ mol } A \times \frac{3 \text{ mol } D}{2 \text{ mol } A} = 1.785 \text{ mol } D$ $\% \text{ yield} = \frac{1.41}{1.785} \times 100 = 78.99\%$

c. The reaction of 189 mol of B produces 39 mol of D

$189 \text{ mol } B \times \frac{3 \text{ mol } D}{7 \text{ mol } B} = 81 \text{ mol } D$ $\% \text{ yield} = \frac{39}{81} \times 100 = 48.15\%$

d. The reaction of 3500 mol of B produces 1700 mol of C

$3500 \text{ mol } B \times \frac{4 \text{ mol } C}{7 \text{ mol } B} = 2000 \text{ mol } C$ $\% \text{ yield} = \frac{1700}{2000} \times 100 = 85\%$

2. Elemental Phosphorous can be produced by heating calcium phosphate from rocks with silica from sand and carbon in the form of coke. The following reaction takes place: $Ca_3(PO_4)_2 + 3SiO_2 + 5C \rightarrow 3CaSiO_3 + 2P + 5CO$

a. If 57 mol of $Ca_3(PO_4)_2$ is used and 101 mol of $CaSiO_3$ is obtained what is the percentage yield?

$57 \text{ mol } Ca_3(PO_4)_2 \times \frac{3 \text{ mol } CaSiO_3}{1 \text{ mol } Ca_3(PO_4)_2} = 171 \text{ mol } CaSiO_3$ $\% \text{ yield} = \frac{101}{171} \times 100 = 59\%$

b. Determine the percentage yield obtained if 1280 mol of carbon is consumed and 622 mol of $CaSiO_3$ is produced.

$1280 \text{ mol } C \times \frac{3 \text{ mol } CaSiO_3}{5 \text{ mol } C} = 768 \text{ mol } CaSiO_3$

$\% \text{ yield} = \frac{622}{768} \times 100 = 80.99\%$