Concentration Representation in Chemical Units

(i) Molarity $M = \frac{w_B \times 1000}{m_B \times V} = \frac{x \times 1000}{m_B \times \frac{100}{d}} = \frac{x \times d \times 10}{m_B}$

$w_B \rightarrow$ mass of solute in g

$m_B \rightarrow$ gram molecular mass of solute

$V \rightarrow$ volume of solution

$x \rightarrow$ % by mass of solute

$d \rightarrow$ density of solution in gm L^{-1}

(ii) Molality $m = \frac{w_B \times 1000}{m_B \times w_A}$

$w_A \rightarrow$ mass of solvent in g

(iii) mole fraction $x_A = \frac{n_A}{n_A + n_B}$, $x_B = \frac{n_B}{n_A + n_B}$

Stoichiometry

"Science never solves a problem without creating ten more"

— George Bernard Shaw

Stoichiometry : Quantitative Relations in Chemical Reactions

Stoichiometry is the calculation of the quantities of reactants and products involved in a chemical reaction

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

mole - mole , mass-mass, mass-volume , volume-volume

(i) Calculations based on mole- mole relationships

Example 1

$$KClO_3(s) \xrightarrow{\Delta} KCl(s) + O_2(g)$$

How many moles and how many grams of $KClO_3$ are required to produce 2.4 mole O_2?

Ans. 1.6, ~~196g~~ 164g

(2) When a mixture of 10 moles of SO_2 and 16 moles of O_2 were passed over a catalyst, 8 moles of SO_3 were formed at equilibrium. The number of moles of SO_2 and O_2 remaining unreacted were?

Ans. 2, 12

(3) $$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

How many moles of CO_2 will be obtained by decomposition of 50g $CaCO_3$?

Ans. 1/2

(4) SO_3 is prepared by the following two reactions:

$$S_8(s) + 8O_2(g) \rightarrow 8SO_2(g)$$

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

How many grams of SO_3 are produced from 1 mole of S_8?

Ans. 640g

(ii) Calculations based on mass-mass relationship

Example 1. Calculate the mass of CaO that can be prepared by heating 200 kg of limestone ($CaCO_3$) which is 95% pure.

Ans. 106.4 kg

② How many grams of oxygen are required to burn completely 570g of octane?

Ans. 2000g

③ Calculate the number of grams of magnesium chloride that could be obtained from 17.0 g of HCl when HCl is reacted with an excess of magnesium oxide. (Mg = 24)

Solution: $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

Ans. 22.12 g

④ How many kilograms of pure H_2SO_4 could be obtained from 1 kg of iron pyrites (FeS_2) according to the following reactions?

(Fe = 56)

$$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$$
$$2SO_2 + O_2 \rightarrow 2SO_3$$
$$SO_3 + H_2O \rightarrow H_2SO_4$$

Ans. 1.63 kg

Limiting reagent : Limiting reactant or reagent is the reactant that is entirely consumed when a reaction goes to completion. Other reactants which are not completely consumed in the reaction are called excess reactants.

OR

the reactant which gives least amount of product on being completely consumed is called limitting reactant.

example to explain LR concept

$$C + O_2 \rightarrow CO_2$$

Example: 1 the reaction, $2C(s) + O_2(g) \longrightarrow 2CO(g)$ is carried out by taking 24 g of carbon and 96 g of O_2. Find out

(a) Which reactant is left in excess?

(b) How much of it is left?

(c) How many moles of CO are formed?

(d) How many grams of other reactant should be taken so that nothing is left at the end of reaction?

Ans. (a) O_2 (b) 64 g (c) 2 (d) ~~72~~ g 48

(2) 0.5 mole $BaCl_2$ is mixed with 0.2 mole Na_3PO_4; the maximum number of moles of $Ba_3(PO_4)_2$ that can be formed is ?

Ans. 0.1

(3) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$

when 1 mole ammonia and 1 mole of O_2 are mixed, then the number of moles of NO formed will be:

Ans. 0.8

(4) If 30g Mg and 30 g O_2 are reacted, then the residual mixture contains ?

choose the correct option:

(a) 60g of MgO only (b) 40g MgO and 20g O_2

(c) 45g of MgO and 15g O_2 (d) 50g MgO and 10g O_2

Ans. (d)

Percentage yield

$$\text{Percentage yield} = \frac{\text{Actual yield}}{\text{theoretical yield}} \times 100$$

Example 1 For the reaction, $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

1.23 g of CaO is reacted with excess of hydrochloric acid and 1.85 g of $CaCl_2$ is formed. what is the percentage yield ?

Ans. 76.1 %

(2) $C_7H_6O_3 + C_4H_6O_3 \longrightarrow C_9H_8O_4 + C_2H_4O_2$

Salicylic acid ($138.12\ g\ mol^{-1}$) | Acetic anhydride ($102.09\ g\ mol^{-1}$) | Aspirin ($180.15\ g\ mol^{-1}$) | Acetic acid ($60.05\ g\ mol^{-1}$)

what is the percentage yield if 0.85 g of aspirin formed in the reaction of 1 g of salicylic acid with excess of acetic anhydride

Ans. $\simeq 65\%$

Calculations involving per cent purity

<u>Example</u>: Chlorine evolved by the reaction of 45.31 g of pyrolusite (impure) and excess of HCl is found to
(MnO_2) (87 g) ← molecular mass
combine completely with the hydrogen produced by the reaction of 10 g of magnesium and excess of dilute hydrochloric acid. Find the % of purity of MnO_2 in the given pyrolusite.

reactions: $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

$$H_2 + Cl_2 \rightarrow 2HCl$$

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Ans. 80 %

<u>Q.</u> $C + O_2 \rightarrow CO_2$, 88 g CO_2 obtained from 30 g C & excess O_2. % purity of C ?

Analysis of mixtures:

Example: 3.68 g of a mixture of $CaCO_3$ and $MgCO_3$ when heated strongly leaves 1.92 g of a white residue. Find the percentage composition of the mixture.

Solution: Let mass of $CaCO_3 = x$ g

$\Rightarrow$ mass of $MgCO_3 = (3.68 - x)$ g

$$\underset{100g}{CaCO_3(s)} \xrightarrow{\Delta} \underset{56g}{CaO(s)} + CO_2(g)\uparrow$$

$$\underset{84g}{MgCO_3(s)} \xrightarrow{\Delta} \underset{40g}{MgO(s)} + CO_2(g)\uparrow$$

total residue left

$$\frac{56x}{100} + \frac{40\times(3.68-x)}{84} = 1.92$$

$\Rightarrow x = 2$

% of $CaCO_3 = \frac{2}{3.68}\times 100 = 54.35\%$

% of $MgCO_3 = 100 - 54.35 = 45.65\%$ or $\frac{1.68}{3.68}\times 100$

(iii) Calculations based on mass-volume relationship

Use $PV = nRT$ $\qquad n = \frac{w}{m}$

$$PV = \frac{w}{m}RT$$

Example 1 what volume of $NH_3(g)$ at 27°C and 1 atm pressure will be obtained by thermal decomposition of 26.25 g NH_4Cl?

Solution: $NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g)$

Ans. 12.315 L

(2) What quantity of copper (II) oxide will react with 2.80 litre of hydrogen at STP (Cu = 63.5)

$$CuO + H_2 \longrightarrow Cu + H_2O$$

Ans. 9.95 g

Calculations based on volume - volume relationship

based on two laws

(i) Avogadro's law (ii) Gay-Lussac's law

	$N_2(g)$ +	$3H_2(g)$ $\longrightarrow$	$2NH_3(g)$
	1 mol	3 mol	2 mol
	1 vol	3 vol	2 vol
at STP	22.4 L	3x22.4 L	2 x 22.4 L

Example 1 One litre of oxygen at STP is allowed to react with three times of carbon monoxide at STP. Calculate the volume of each gas found after the reaction

$$2CO + O_2 \longrightarrow 2CO_2$$

Ans. Vol of CO = 1 L

Vol of CO_2 = 2 L

(2) What volume of oxygen at STP is necessary for complete combustion of 20 litre of propane measured at 27°C and 760 mm pressure?

Ans. 91 L

(3) 1 litre mixture of CO and CO_2 is taken. This is passed through a tube containing red hot charcoal. The volume now becomes 1.6 litre. The volumes are measured under the same conditions. Find the composition of the mixture by volume.

Reaction in the tube $\Longrightarrow$ $CO_2(g) + C(s) \rightarrow 2CO(g)$

Ans. Vol. of CO = 400 mL

& vol. of CO_2 = 600 mL

Mole concept

Aspireone Book
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Q 3 (A) $n_O = \frac{1}{16}$, $N = \frac{1}{16} \times N_A = \frac{N_A}{16}$

(B) $n_{O_2} = \frac{1}{32}$, $N = 2 \times \frac{1}{32} \times N_A = \frac{N_A}{16}$

(C) $n_{O_3} = \frac{1}{16 \times 3}$, $N = 3 \times \frac{1}{16 \times 3} \times N_A = \frac{N_A}{16}$

6. $\boxed{76\ cm = 760\ mm\ of\ Hg = 1\ atm}$

$22400\ mL \rightarrow 1\ mol$

$n = \frac{448}{22400} = \frac{2}{100} = 0.02 = \frac{wt}{Mm} = \frac{2}{M}$

$Mn = \frac{2}{0.02} = 100$ e.g. O_3 48 g

atomic wt. $= \frac{100}{3} = 33.3\ g \rightarrow 6.022 \times 10^{23}$

actually 1 atom weighs $= \frac{33.3}{6.023 \times 10^{23}}$

$= 5.55 \times 10^{-23}\ g$

8. $CaCO_3 \rightarrow 10g$

$P = 20 + 6 + 8 \times 3 = 50$

$n = \frac{10}{100}$, $N = \frac{10}{100} \times 6.022 \times 10^{23} \times 50$

(1) $n = \frac{3.5}{28}$, $N = \frac{\cancel{3.5}^{1.25}}{\cancel{28}_{4}} \times \frac{6.02 \times 10^{23}}{10}$

$= \cancel{1.25 \times 10}$

$= 7.525 \times 10^{22}$ (C)

$\frac{\cancel{3.5}^{5}}{\cancel{28}_{4}} \times \frac{6.02 \times 10^{23}}{10}$

$= 1.25 \times 6.02 \times 10^{22} = 7.525 \times 10^{22}$ (C)

Representation of concentration

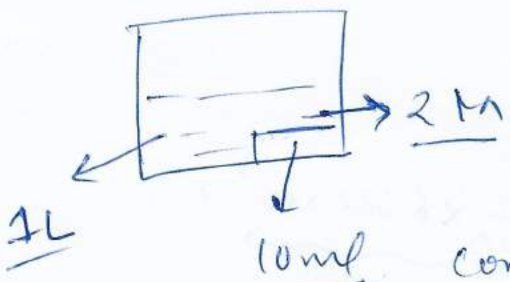
(i) Molarity = no. of moles present per litre of solution.

$$M = \frac{\text{no. of moles of solute}}{\text{Vol. of solution in litres}}$$

$$M = \frac{n}{V}$$

unit $\rightarrow$ $mol\ L^{-1}$

$M \times V = n$



$n = 2 \times 1 = 2$ moles

Concⁿ = ?

1000ml → 2moles

10ml → $\frac{10 \times 2}{1000}$ $= \frac{2}{100}$

$$\frac{2/100}{10/1000} = 2$$

→ solution Solvent = water

density = d (g/mL)

x % by mass of Solute

M = ? M → molar mass of solute

M = ? $M = \frac{\cancel{\text{mole}}\ n}{V}$

100 g of solution → x g of solute

$n = x/M$.

Vol of solution $= \frac{100}{d}$ mL $\frac{g}{g/mL}$

in L $= \frac{100}{d \times 1000}$ L

$$M = \frac{x/M}{\frac{100}{d \times 1000}} = \frac{x \times d \times 10}{M}$$

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Q1

Let us take 100 g solution

38 g HCl in 100 g Solution

n of HCl $= \frac{38}{36.5}$

$$V = \frac{\text{mass}}{\text{density}} = \frac{100\,g}{1.20\,g\,mL^{-1}} = \frac{100}{1.20}\text{ mL}$$

$$= \frac{100}{1.20 \times 1000}\text{ L}$$

$$M = \frac{38/36.5}{\frac{100}{1.20 \times 1000}} = 12.49\,M$$

(ii) molality = $\frac{\text{moles of solute}}{\text{mass of Solvent in kg}}$

A → Solvent, B → Solute, W_B → wt. of solute

n_A → moles of Solvent, n_B → moles of Solute

M_B → mol. wt. of solute

W_A → wt. of Solvent in g

$$m = \frac{n_B}{W_A/1000} = \frac{W_B/M_B}{W_A/1000}$$

unit → mol/Kg

x %, d

$n_B = x/M_B$

100 g of solution has x g solute

wt. of solvent = 100 − x

$$m = \frac{x/M_B}{\frac{(100-x)}{1000}}$$

$$= \frac{38/36.5}{\frac{(100-38)}{1000}} = 16.7 \text{ mol/Kg}$$

(iii) mole fraction

n_A n_B

$$X_A = \frac{n_A}{n_A+n_B}, \quad x_B = \frac{n_B}{n_A+n_B}$$

mole fraction of A

$$x_A + x_B = 1$$

Q. $x_B = 0.3$, $x_A = 0.7$

(3) $x_B = 0.2$, $x_A = 0.8$
$\downarrow$
water

$n_B = 0.2$, $n_A = 0.8$

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}} = \frac{0.2}{0.8 \times 18/1000}$$

$$= \frac{2 \times 1000}{8 \times 18}$$

$$= \underline{13.88\ m}$$

Stoichiometry

"Science never solves a problem without creating ten more"

—George Bernard Shaw

Stoichiometry → finding the quantity of reactants & products

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

1 mol	3 mol	2 mol
28 g	6 g	34 g
1 mL	3 mL	2 mL

(i) Calculations based on mole-mole relationship

$$2KClO_3 \xrightarrow{\Delta} 2KCl(s) + 3O_2(g)$$

?   2.4 mol

3 mol O_2 $\longrightarrow$ 2 mol $KClO_3$

2.4 mol $\longrightarrow$? $= \frac{2.4 \times 2}{3}$

$= 1.6$ mol

mass of $KClO_3 = 1.6 \times (39 + 35.5 + 48)$

$= 164$ g

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(3) $\underline{CaCO_3} \longrightarrow \underline{CaO}(s) + \underline{CO_2}(g)$

50 g

$n = \frac{50}{100} = \frac{1}{2}$ $\frac{1}{2}$ mol CO_2

(2) $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

	$2SO_2$	O_2	$2SO_3$	
n	10	16		
	−8	−4	$\underline{8}$	
Left	$\underline{2}$	$\underline{12}$		
	−2	−1	2	If react further
left	0	$\underline{11}$	$\underline{10}$	

(4) 1 mol $S_8 \rightarrow$ 8 mol SO_2

2 mol $SO_2 \rightarrow$ 2 mol SO_3

8 mol $SO_2 \rightarrow$ 8 mol SO_3

mass $= 8 \times (32 + 48)$

$= 8 \times 80 = 640$ g

(ii) mass- mass relationship

(1) $CaCO_3 \rightarrow CaO + CO_2$ ($Ca = 40$)

$CaCO_3$: 100 g, CaO: 56

$\frac{200 \text{ kg} \times 95}{100}$

$= 190$ kg

100 g $CaCO_3 \rightarrow$ 56 g CaO

100 kg $CaCO_3 \rightarrow$ 56 kg CaO

190 kg $CaCO_3 \rightarrow$? $\frac{190 \times 56}{100}$

$= 106.4$ kg

(2) $C_8H_{18} + \frac{25}{2}O_2 \longrightarrow 8CO_2 + 9H_2O$

$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

$n = 570$

2×114 g $C_8H_8 \rightarrow 25 \times 32$ g O_2

570 g $\rightarrow$? $= \frac{570 \times 25 \times 32}{2 \times 114}$

$= 2000$ g

$$4 \text{ mole } FeS_2 \rightarrow 8 \text{ mol } H_2SO_4$$

$$\frac{1000}{120} \text{ kmol } FeS_2 \rightarrow 2 \times \frac{1000}{120} \text{ mol } H_2SO_4$$

$$\text{wt. of } H_2SO_4 = \frac{2}{120} \times \frac{1000 \times 98}{1000} \text{ kg}$$

$$= 1.63 \text{ kg}$$

$$FeS_2 \longrightarrow H_2SO_4$$

$$1 \text{ mol } FeS_2 \rightarrow 2 \text{ mol } S \rightarrow 2 \text{ mol } H_2SO_4$$

Limitting Reagent

$$C(s) + O_2(g) \longrightarrow CO_2(g)$$

1 mol	1 mol	1 mol CO_2
1 mol	0.5 mol O_2	0.5 mol
−0.5	0.5	
0.5	0	
Excess reagent	L.R.	

Limitting reagent in a chemical reaction is the substance which gets consumed completely.

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

2 mol 5 mol

LR

$3H_2 \rightarrow 1N_2$

$5H_2 \rightarrow 5/3\ N_2$

$2 - 5/3$ -5

Left = $1/3$ 0 $10/3$ mol

$64 \rightarrow \frac{64}{32} = 2$ mol $\rightarrow$ 4 mol

$32g\ O_2 \rightarrow 24g\ C$

$64g\ O_2 \rightarrow \frac{64 \times 24}{32} = 48g$

E.R. LR

$3BaCl_2 + 2Na_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6NaCl$

0.5 0.2 0.1

$3 \rightarrow 2$

$0.5 \rightarrow 1/3 = 0.333$

$0.5 - 0.3$

Left = 0.2

(4) L.R.

$2Mg + O_2 \rightarrow 2MgO$

30g 30g

48g Mg $\rightarrow$ 32g O_2

30g $\rightarrow \frac{30 \times 32}{48} = 20g$

$30 - 20 = 10g$

$\frac{24}{16}$

24g Mg $\rightarrow$ 40g MgO

30g $\rightarrow \frac{30 \times 40}{24} = 50g$

% yield

$$C + O_2 \rightarrow CO_2$$

$\cancel{24g}$ 32g

12g — 44g

given in question

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

(1) $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

40
71
1

56 111

1.23 ⟶ ?

$$\text{Theoretical yield} = \frac{1.23 \times 111}{56}$$

$$\% \text{ yield} = \frac{1.85}{\left(\frac{1.23 \times 111}{56}\right)} \times 100 \approx 76.1\%$$

138.12 sal. acid ⟶ 180.15 g Aspirin

1 g ⟶ ? $= \frac{180.15}{138.12}$

$$\% \text{ yield} = \frac{0.85}{\left(\frac{180.15}{138.12}\right)} \times 100 \approx 65\%$$

% purity

$$C(s) + O_2(g) \rightarrow CO_2(g)$$

30g   88g

-24

6 g

out of 30g only 24 g is pure C

$$\boxed{\% \text{ purity} = \frac{24}{30} \times 100}$$

$$\rightarrow \% \text{ purity} = \frac{\text{actual amnt reacting}}{\text{Total amount}} \times 100$$

$$n_{H_2} = n_{Mg} = \frac{10}{24} = n_{Cl_2} = n_{MnO_2}$$

$$\text{mass of } MnO_2 = \frac{10}{24} \times 87$$

$$\% \text{ purity} = \frac{10 \times 87}{24 \times 45.31} \times 100 = 80\%$$

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2 \uparrow$$

x g

$$MgCO_3 \xrightarrow{\Delta} MgO + CO_2 \uparrow$$

$(3.68 - x)$

Mg = 24

Ca = 40

mass of CaO formed from x g $CaCO_3 \rightarrow$?

$100 \text{ g } CaCO_3 \rightarrow 56 \text{ g } CaO$

$x \text{ g} \rightarrow ? = \frac{56}{100} x$

~~80 g~~ 84 g $MgCO_3 \rightarrow$ 40 g MgO

$(3.68 - x) \longrightarrow ? = \frac{40}{84} \times (3.68 - x)$

$$\frac{40}{84}(3.68 - x) + \frac{56\,x}{100} = 1.92$$

$x = 2$

$\% \; CaCO_3 = \frac{2}{3.68} \times 100$, $\% \; MgCO_3 = \frac{1.68}{3.68} \times 100$

$= 54.35\,\%$ $\qquad = 45.65\,\%$

mass – volume

at STP 1 mol gas = 22.4 L S.T.P.

32 g O_2 = 22.4 L at STP

(1) $NH_4Cl \longrightarrow NH_{3(g)} + HCl$

26.25 g

$n_{NH_4Cl} = n_{NH_3} = ? = \left(\frac{26.25}{53.5}\right) =$

$PV = nRT$

$\underset{atm}{1} \times \underset{L}{V} = \frac{26.25}{53.5} \times 0.0821 \times 300$

$V = 12.315\ L$

(2) $n_{H_2} = \frac{2.8}{22.4} = n_{CuO}$

$m_{CuO} = \frac{2.8}{22.4} \times 79.5 = 9.95\,g$

$\underline{P}\,V = \underline{n}\,R\,\underline{T}$

$V \propto n$

$\underline{2}\,CO + O_2 \rightarrow 2\,CO_2$

$$\begin{array}{lccc} & 3L & 1L & \\ & -2L & -1L & 2L \\ \hline \text{left} & 1L & 0 & 2L\ CO_2 \end{array}$$

at 27°C & 1atm

$C_3H_8 + 5O_2 \longrightarrow 3\,CO_2 + 4\,H_2O$

$\underline{20\,L}$ $\quad \underline{100L}$

$\underline{PV = \underline{n}\,\underline{R}\,T}$

$\frac{PV}{T} = nR$

$\frac{PV}{T} = c$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{1 \times 100}{300} = \frac{1 \times V}{273}\,(STP)$

$\underline{V = 91\,L}$

$n_{O_2} = \frac{PV}{RT} = \frac{1 \times 100}{0.0821 \times 300}$

$= 4.1$

Vol at S.T.P.

$= 22.4 \times 4.1$

$$\underbrace{CO}_{x\,L}$$

$$\underset{(1-x)L}{CO_2} + C(s) \rightarrow \underset{2(1-x)L}{2CO(g)}$$

$x + 2(1-x) = 1.6$

$x + 2 - 2x = 1.6$

$\underline{x = 0.4}$

$CO = 0.4\,L = 400\,mL$

$CO_2 = 0.6\,L = 600\,mL$

(i) P. Bahadur, Numerical Chemistry

(ii) R.C. Mukherjee

$\boxed{6\text{ hrs.}}$

11^{th} & 12^{th}

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(14) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

32.5

$n = \frac{32.5}{65} = \frac{1}{2}$

$\frac{1}{2}$

(15) $CO_2 + C(\text{graphite}) \rightarrow 2CO$

1L

Left $1L - x$

$2 \cdot x = 2 \times 0.5 = 1L$

Total volume $= 1 - x + 2x = 1.5 \Rightarrow \boxed{x = 0.5}$

(10) $\cancel{4}Al + 3O_2 \rightarrow 2Al_2O_3$

$4 \rightarrow 3$ mol

1mol $\rightarrow$ $3/4$ mol O_2 = $3/4 \times \cancel{32}^{8}$ = 24g O_2

$S_8 \longrightarrow BaSO_4$

16g

1mol $BaSO_4$ $\Rightarrow$ 1 mol S

mol S = ? = $\frac{16}{8\times32} \times 8 = \frac{1}{2}$ mol of S

mol of S_8 = $\frac{16}{8\times32} = \frac{1}{16}$

$\Rightarrow$ mol of S = $\frac{\cancel{8}\times16}{\cancel{8}\times32} = \frac{1}{2}$

$BaSO_4 \rightarrow Ba + S + 4O$

$\frac{1}{2}$ $BaSO_4$ $\qquad$ $\frac{1}{2}$

$S_8 \longrightarrow H_2S_2O_7$

2 mol of S $\longrightarrow$ 1 mol $H_2S_2O_7$ $\longrightarrow$ 2S

$n = 8/2$ $\qquad$ mol = 8

$\frac{1}{2}$

$FeS_3 \rightarrow 3S$

$\downarrow$

$3H_2SO_4$

$FeS_2 \longrightarrow H_2SO_4$

x mol FeS_2 $\longrightarrow$ $2H_2SO_4$

$FeS_3 \longrightarrow H_2SO_4$

$\downarrow$ $\qquad$ 1 mol of S

3S $\qquad$ S

$\frac{FeS_2}{480g} \longrightarrow H_2SO_4$

$$\begin{array}{r} 56 \\ 64 \\ \hline 120 \end{array}$$

$n_{FeS_2} = \frac{48\cancel{0}}{12\cancel{0}} = 4$

$H_2S_2O_7$

$1\,FeS_2 \rightarrow 2\,S$

$4\,FeS_2 \rightarrow 8\,S \longrightarrow 8\,H_2SO_4$

$n_{H_2SO_4} = 8$

16