Stichometery

Atomic Mass: → mass of an atom.

Relative atomic mass: Mass of an atom compare to $\frac{1}{12}$th part of C-12.

Unit: amu

1amu = $\frac{1}{12}$ part of C-12.

Relations:

1amu = $\frac{1}{12}$ part of C-12

$= \frac{1}{6\times10^{23}}$

$= 1.66 \times 10^{-24} g$

$= 1.66 \times 10^{-27} kg$

$= 1.66 \times 10^{-21} mg$

Why C-12 as standard
- →Relative abundance ↑
- →Stable
- →Whole Number. (12.000)
- → Solid.

Why not hydrogen?
→ because it is gas and to handle it, is very difficult.

MCQ:

1 amu is equal to?

a: $1.66 \times 10^{27} kg$
b: $1.66 \times 10^{-21} g$
[✓ c: $1.66 \times 10^{-21} mg$]
d: $1.66 \times 10^{-24} mg$

MCQ:

If 1amu = $1.66 \times 10^{-24} g$, then how many amu are present in 1g.

a: $1/1.66 \times 10^{-24}$ amu
b: 6.022×10^{23} amu
c: 1.66×10^{-24} amu
[✓ d: a, b]

b/c 1 amu = $1.66 \times 10^{-24} g$
1g = $1/1.66 \times 10^{-24}$ amu

MCQ:

WOF is correct for H = 1.008?

a: Relative atomic mass
b: Fractional atomic mass
c: Average atomic mass
[✓ d: All of above]

Average Atomic Mass:

$$AAM = \frac{R.A \times \text{isotopic mass}(1) + R.A \times \text{Isotopic}(2) + R.A \times \text{Isotopic}(3)}{100}$$

^1_1H ^2_1H ^3_1H

* Isotopic mass can never be in fraction.

For Chlorine:

$^{35}_{17}C$ $^{37}_{17}C$

75% 25%

$$AAM = \frac{35 \times 75 + 25 \times 37}{100}$$

$AAM = 35.5$

Mole:

↳ Counting unit.

Rep: 'n'

Symbol: "mol"

Atomic mass
Molecular mass $\xrightarrow{\text{Express}}$ gram (mole)
Ionic mass

$1\ H_2O = 18\text{amu}$ (Relative atomic mass)

$6.023 \times 10^{23}\ H_2O = 18g$ (Molar mass)

$1\ C = 12\text{amu}$ ⇔ $1\ NaCl = 58.5\ \text{amu}$

$6.023 \times 10^{23}\ C = 12g$

$6.023 \times 10^{23}\ NaCl = 58.5g$

Other Names:

→ Gram atom
→ Gram molecule
→ Gram Ion
→ Gram Formula Unit

} mole

20g atom of H → mole

20g of H atom → given mass

Formula:

$$n = \frac{\text{mass}}{\text{molarmass}} = \frac{N}{N_A} = \frac{V}{V_m} \qquad n \propto N \propto V$$

Molar Volume: Vol of 1 mole of any gas at STP is molar volume → 22.414 dm^3 or 22414 cm^3

RTP ↦ 24 dm^3

1 mole of CH_4 = 16g = 6×10^{23} molecules of CH_4 = 22.414 dm^3

0.5 mole of CH_4 = 8g = 3×10^{23} molecules of CH_4 = 11.212 dm^3

0.25 mole of CH_4 = 4g = 1.5×10^{23} molecules of CH_4 = 5.6 dm^3

MCQ: How many molecules of O_2 are present in 2 moles?

1 mole = 6×10^{23}
2 mole = 12×10^{23}

a: 6×10^{23} molecules
b: 3×10^{23} molecules
c: 1.5×10^{23} molecules
[✓ d: 12×10^{23} molecules]

MCQ:

How many moles of N_2 are present in 5.6 dm^3 of it.

1 mol of N_2 = 22.414
0.5 " " " = 11.212
0.25 " " " = 5.6

a: 1 mol
b: 0.5 mol
[✓ c: 0.25 mol]
d: 2 mol.

MCQ:

How much volume of O_2 is present in 8g of O_2:

32g = 1 mol 22.414
16g = 11.212
8g = 5.6

[✓ a: 5.6 dm^3]
b: 11.212 dm^3
c: 22.414 dm^3
d: 44.212 dm^3

MCQ:

How much mass of CH_4 is there in 12×10^{23} molec

16g = 6×10^{23}
32g = 12×10^{23}

a: 16g
b: 8g
c: 4g
[✓ d: 32g]

1 mole of CO_2 = 44g = 6×10^{23} = 22.414 dm^3

10 0.1 mol of CO_2 = 4.4g = 6×10^{22} = 2.2414 dm^3

100 0.01 mol of CO_2 = 0.44g = 6×10^{21} = 0.22414 dm^3

How many moles are there in $2.24 dm^3$ of CO_2?

How many moles are there in 6×10^{22} molecules of CO_2?

How many moles are there in 4.4g of CO_2?

→ 0.1

MCQ:

How much mass of O_2 is present in 0.01 mol?

[✓ a: 0.32g]   b: 3.2g

c: 32g   d: none.

MCQ:

WOF have maximum moles?

a: $11.212 dm^3$ of CO_2 (0.5)

[✓ b: 32g of O_2] (1mol)

c: 1.5×10^{23} molecules of N_2 (0.25)

d: SAME

MCQ:

WOF has highest mass.

[✓ a: 2 mole of CO_2] (88g)

b: 2 molecules of CO_2 (88amu)

c: 6×10^{23} molecules of CO_2 (44g)

d: SAME

MCQ:

WOF have least volume, mole and particles?

a: 1g of O_2 (32g)   b: 1g of N_2 (28g)

[✓ c: 1g of SO_2] (64g)   d: same

→ This will apply when given mass is same ← ($\frac{\text{mass}}{\text{molar mass}}$ $V \propto N \propto n$

MCQ: When 0.1 mol of H_2SO_4 ionizes how many H^+ ions will produce.

a: $0.2 \times N_A$ b: $2 \times 6 \times 10^{23}$

c: 1.2×10^{23} ⓓ All of these

$H_2SO_4 \rightarrow 2H^{+1} + SO_4^{-2}$

$1 \longrightarrow 2$

$0.1 \longrightarrow 0.2$

Num of $H^+ = n \times N_A$

$= 0.2 \times N_A \Rightarrow 0.2 \times 6 \times 10^{23} \Rightarrow 2 \times 6 \times 10^{22}$

MCQ:

How many H^+ atoms are present in 9 gram of ice? (H_2O)

a: $N_A/4$ b: $N_A/2$

c: $2N_A$ ⓓ : N_A

No. of particles = $n \times N_A \times$ atomicity

$= \frac{\cancel{9}^{1}}{\cancel{18}_{2}} \times N_A \times 2 = N_A$.

MCQ:

How many $\bar{e}$s / protons / neutrons are present in 9g of ice. H_2O

(neutrons) $n = 0 + 8$

a: N_A b: $4N_A$

ⓒ $5N_A$ ($\bar{e}$s / p^+) d: $N_A/2$

No. of $\bar{e}$s / p^+ = $n \times N_A \times$ Atomic No.

No. of neutron = $n \times N_A \times Z - A$

$= \frac{9}{18} \times N_A \times 8 \Rightarrow 4N_A$

MCQ:

How many neutrons are there is 10g of heavy water? (D_2O)

neutrons $= 2 + 8 = 10$

a: N_A b: $4N_A$

ⓒ: $5N_A$ d: $N_A/2$

$= \frac{\cancel{10}^{1}}{\cancel{20}_{2}} \times N_A \times \cancel{10}^{5} = 5N_A$

MCQ:

How many valance $\bar{e}$s of O is present in 9g of ice?

Valence $\bar{e}$s = $n \times N_A \times$ gp no.

$= \frac{\cancel{9}^{1}}{\cancel{18}_{2}} \times N_A \times \cancel{6}^{3} = 3N_A$.

1 mole of H_2SO_4 = 2 mole of H

= 1 mole of S

= 4 mole of O

1 mole of H_2SO_4 = 2g of H
1 mole of H_2SO_4 = 32g of S
1 mole of H_2SO_4 = 64g of O

0.5 mole of H_2SO_4
= 1g of H
= 16g of S
= 32g of O

1 mole of H_2SO_4 = 2NA atom of H
= NA atom of S
= 4NA atom of O

= 1NA atom of H
$\overset{0.5}{=}$NA atom of S
= 2NA atom of O

Stoichiometry:

→ Relative amount of R and P in balanced equation

→ Stoichometry is only apply on irreversible rxn can't apply on reversible rxns.

Relative amount can be in terms of:

→ mole
→ mass
→ particles
→ volumes (gases.)

e.g.:, $2H_2 + O_2 \longrightarrow 2H_2O$

mole:	2	1	2
mass:	4g	32g	36g
particles:	2NA	NA	2NA
Volume:	2Vm	Vm	2Vm

→ We balance chemical eq to equalize:
atoms and mass

$\cancel{} H_2 + O_2 \longrightarrow H_2O$
✗ 2g 32g 18g
✗ 34g 18g

Stoichiometric Calculations:

Assumptions:

→ All reactants must be converted into products
→ No side reaction
→ Law of conservation of mass
→ Law of definite proporation($\overset{H_2O}{1x:18x}$:1:8

Drawbacks of balance chemical reactions:

→ Doesnot tell us rate of rxn
→ Can't judge order of rxn
→ Can't judge mechonism of rxn.
→ Can't judge fessibility of rxn
→ Can't identify condition of rxn.

MCQ: Equation are balanced to equalize ____ of reactants and products:

a: moles　　b: volume
c: molecules　　[✓ d: atoms.]

Calculations:

- mole to mole
- mole to mass
- mole to volume
- mass to mass

Mole to mole:

MCQ: How many moles of water will produce when 0.25moles of O_2 ~~re~~ completely reacts with hydrogen.

a: 1 mol　　[✓ b: 0.5 mol]
c: 2 mol　　d: 0.2 mol

$\cancel{2}H_2 + 1O_2 \rightarrow 2H_2O$

$1 : 2$
$0.25 : x$ $\Rightarrow$ $x : 2 \times 0.25$
$x : 0.5$

Mole to mass:

MCQ: How much mass of Oxygen will produce when 1 mole of $KClO_3$ is completely decomposed.

a: 96g　　b: 32g
[✓ c: 48g]　　d: 16g

$2KClO_3 \rightarrow 2\cancel{K}Cl + 3O_2$

$2 : 3 \Rightarrow 1 : 1.5 \Rightarrow 1 : 1.5 \times 32 = 48$

Mole to Volume:

MCQ:

How much volume of Oxygen will produce on decomposing 1 moles of $KClO_3$:

a: 22.414 dm^3 b: 11.212 dm^3

[✓ c: 33.626 dm^3] d: 44 dm^3

$2KClO_3 \rightarrow 2KCl + 3O_2$

$KClO_3 : O_2$

2 : 3

1 : 1.5 × 22.414

= 33.626

Mass to Mass:

$4Al + 3O_2 \rightarrow 2Al_2O_3$

How much mass of Al_2O_3 will produce when 54g of Al reacts with excess of O_2.

a: 27g b: 54g

[✓ c: 102g] d: 204g

4 : 2

4×(27) : 2(102)

wt 108 g : 204 g wt.

given 54 g : 102 g

Limiting Reactant:

- earlier consume or control reaction.
- produce less or no. of mole of product.

- When information for all reactants is given.

Note: there is no limiting reactant in balanced chemical reactions. when there is stichiometric equation.

Eq: $2H_2 + 1O_2 \rightarrow 2H_2O$

WOF is limiting?

a: O_2 b: H_2

c: Both [✓ d: None] (b/c equation is balanced)

WOF would be the limiting reactant? when 2 moles of H_2 reacts with 2 mole of O_2.

ⓐ H_2 b: O_2

c: H_2O d: All

$2H_2 + 1O_2 \longrightarrow 2H_2O$

$n_{H_2} = \frac{\cancel{2}\,1}{\cancel{2}\,1}$, $n_{O_2} = \frac{2}{1}$

L.R

$\boxed{n_{H_2} = 1}$, $n_{O_2} = 2$

L.R = $\frac{\text{mole of Element}}{\text{coefficient on B.C.E}}$

When 10 moles of H_2 and 10 moles of O_2?

n_{H_2}

$n_{H_2} = \frac{10}{2}$, $n_{O_2} = \frac{10}{1}$

L.R ← $\boxed{n_{H_2} = 5}$, $n_{O_2} = 10$

WO.F is L.R? When 8g of H_2 and 8g of O_2 reacts completely with each other?

$2H_2 + 1O_2 \longrightarrow 2H_2O$

O₂ is L.R

H_2 · O_2

8g 8g

find moles:

$n_{H_2} = \frac{8g}{2}$, $n_{O_2} = \frac{8g}{32}$

$n_{H_2} = 4$, $n_{O_2} = 0.25$

divide cofficient:

$n_{H_2} = \frac{\cancel{4}\,2}{\cancel{2}\,1}$, $n_{O_2} = \frac{0.25}{1}$

$n_{H_2} = 2$, $\boxed{n_{O_2} = 0.25}$

$2H_2 + 2O_2 \rightarrow 2H_2O$

8g 8g

→ When both ~~ma~~ given masses of reactants are same then the reactant with greater molar mass will be L.R.

11 mole $\frac{\overset{1}{\cancel{8}}}{32}$

When 8g of H_2 and 8g of O_2 reacts completely with each other then L.R and mole of product? mass of H_2O?

a: 1 mole   b: 2 mole H_2 : O_2

✓c: 0.5 mole   d: 0.25 mole.   n=2 , n=0.25

compare L.R to P:

$1O_2 = 2H_2O$

Mole of E.R used: compare reactants, 1 : 2

mass of E.R used: multiply × moles to M.M   0.25 = 0.5 mol ⇒

mole of E.R left: mass:

mass of E.R left: $H_2O = 0.5\text{ mol} \times 18$

$\frac{1}{2} \times 18 = 9g$

Yield:

↳ Ammount of product in reaction

Types:

① Actual Yield:

→ Experimental yield / practical yield → obtain after experiment.

② Theoratical Yield:

→ Expected / calculated yield → obtain using balance chemical reaction.

A.Y < T.Y

→ Reversibility of R   → In expereime

→ Side product   → Mechanical loss

→ Condition T, P, PH.   → (filteration, separation)

③ Percentage Yield.

$$\%\text{age Yield} \propto \frac{A.Y}{T.Y} \times 100$$

A.Y = T.Y → ideal Rxn

Efficiency of Rxn ∝ %age.

MCQ:

$\rightarrow$ A.Y

50g of $CaCO_3$ on complete decomposition produces 7g of CaO. Find % Yield?

[✓ a]: 25%   b: 50%

c: 75%   d: 12.5%

$1CaCO_3 \longrightarrow 1CaO + CO_2$

100g   56g

↓   ↓

50g   28g → T.Y

$= \frac{7}{28} \times 100 = 25\%$

MCQ:

When 25g of $CaCO_3$ decomposes 14g of CaO is produced find % yield?

$1CaCO_3 \longrightarrow 1CaO + CO_2$

[✓ a]: 100%   b: 25% $= \frac{\cancel{14}}{\cancel{14}} \times 100\%$

c: 50%   d: 12.5% $= 100\%$

100g   56g

50g   28g

$\boxed{25g}$ 14g → T.Y

$CaCO_3 \longrightarrow CaO + CO_2$

100g   56g

10g   x

$100x = 10 \times 56$

$x = \frac{1\cancel{0} \times 56}{10\cancel{0}} = \frac{56}{10} = \boxed{5.6g}$

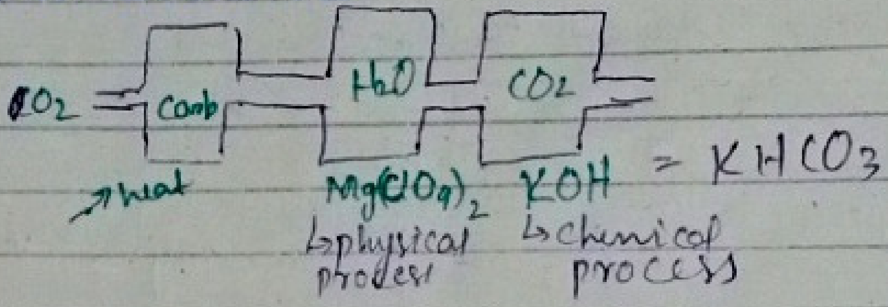
Cumbustion Analysis:

→ C, H, O ✓
→ N, P, S, Cl, X

Cumbustion analysis can't analyze on:

a: Urea b: Amine * b/c it lacks C, H, O
c: R-X (d): All

Procedure:



$$\% \text{ of } C = \frac{\text{Mass of } CO_2}{\text{M.M of O.C}} \times \frac{12}{44} \times 100$$

$$\% \text{ of } H = \frac{\text{mass of } H_2O}{\text{M.M of O.C}} \times \frac{2}{18} \times 100$$

$$\% \text{ of } O = 100 - (\% C + \% H)$$

Steps to Find empirical F:

→ Find % composition

→ mole = $\frac{\% \text{ of } C}{\text{molar mass}}$ $\frac{\% \text{ of } H}{\text{molar mass}}$

C_2 H_1 O_3

→ mole ratio

C : H : O

$\frac{2}{1}$ $\frac{1}{1}$ $\frac{3}{1}$ ⇒ 2 : 1 : 3 → E.F

Benzene.

→ E.F (Fraction)

C : H : O

3.33 : 2.33 : 3.33

∴ multiply it with suitable no. to get value in whole number.

~~xplem~~

3×(3.33 : 2.33 : 3.33)

9.99 : 6.99 : 9.99

10 : 7 : 10

Molecular Formula:

M.F = n × E.F

where;

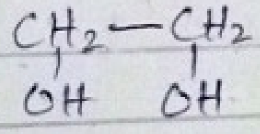
n = 1, 2, 3, 4, 5 ...

$n = \frac{\text{molecular mass}}{\text{E.F mass.}}$

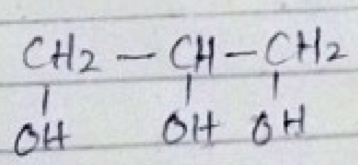
E.F	M.F
→ Simplest ratio of atom	→ Actual No. of atom.
→ % composition	→ M.F = n × E.F
→ Ionic + covalent compound	→ Covalent compounds.

* giant covalent compounds don't have molecular formula they just have empirical formula

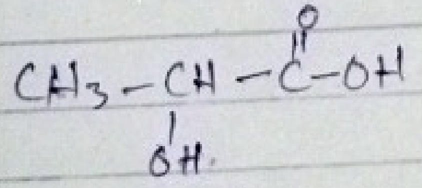
e.g: SiO_2, Diamond, graphite



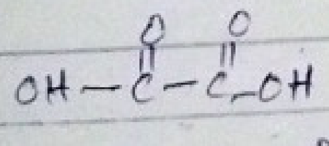
$\underset{OH}{\underset{|}{CH_2}}-\underset{OH}{\underset{|}{CH_2}}$ → ethylene glycol



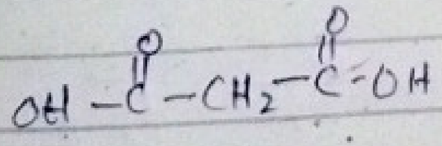
$\underset{OH}{\underset{|}{CH_2}}-\underset{OH}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH_2}}$ → glycerol



$CH_3-\underset{OH}{\underset{|}{CH}}-\overset{O}{\overset{\|}{C}}-OH$ → lactic acid



$OH-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-OH$ → Oxalic acid



$OH-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-OH$ → Malonic acid.