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Some Basic Concepts of Chemistry.

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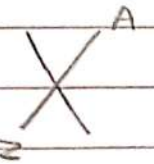
Mole Concept:

* atoms ⟶ molecules ⟶ compound

$H \longrightarrow H_2O$

$H_2O \longrightarrow H_2O$.

* Representation of element:



X = element / atom

A = mass no. (no. of p^+ + no. of n°)

Z = atomic no. = (no. of p^+) = (no. of e^-)

eg: ${}_{6}C^{12}$ X = C A = 2 Z = 6

NOTE: proton, neutron and electron are subatomic particle for an element.

NOTE: conversion of volume into mole & vice versa is applicable only for gaseous substance.

1 mole = N_A (avogadro no.)

↳ 6.022×10^{23} N

★

H_2SO_4

- No. of hydrogen gas ('H' molecule) = 01 NOS
- No. of hydrogen atom = 2 NOS.
- No. of sulphur atom = 1 NOS.
- No. of oxygen atom = 4 NOS
- No. of proton = 50.
- No. of electron = 50.
- No. of neutron = 48.

★

2 mole H_2SO_4.

- Mole of hydrogen gas = 2 mole = 4 gm.
- Mole of hydrogen atom = 4 mole = 4 gm.
- Mole of sulphur atom = 2 mole = 64 gm
- Mole of oxygen atom = 8 mole = 128 gm

★

2.5 mole PO_4^{3-} ion.

- No. of phosphorous atom = 2.5 N_A
- No. of oxygen atoms = 10 N_A
- No. of protons = 117.5 N_A
- No. of electron = 125 N_A

NOTE:

2.5 gm atom of Nitrogen means → 2.5 mole of nitrogen atom.

2.5 gm molecule of Nitrogen means → 2.5 mole of nitrogen molecu

★ Unit of pressure:

1 atm = 1.01 bar = 760 mm Hg = 76 cm Hg = 760 ~~for~~ torr

★ Unit of volume:

1 l = 1000 ml = 1000 cm^3 = 1000 cc = 1 dm

Molecular mass for molecules:

molecule	molecular mass
H_2	2
N_2	28
O_2	32
H_2O	18
CH_4	16
CO_2	44
NH_3	17
$C_6H_{12}O_6$	180
H_2SO_4	98
HCl	~~3010~~ 36.5
HNO_3	63
$CaCO_3$	100
NaOH	40
N_2O	

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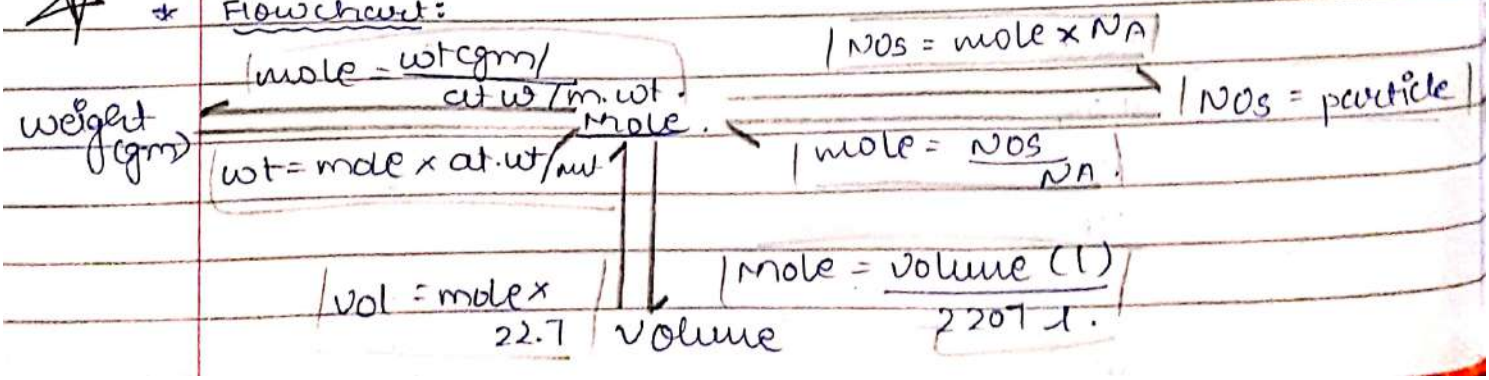
Molecular mass of diff. atoms:

ATOM	ATOM. NO.	E^-	P^+	N^0	ATOMIC WT. ($P^+ + N^0$)
H	1	1	1	0	2
He	2	2	2	2	4
C	6	6	6	6	12
N	7	7	7	7	14
O	8	8	8	8	16
F	9	9	9	10	19
Na	11	11	11	12	23
Mg	12	12	12	12	24
Al	13	13	13	14	27
P	15	15	15	16	31
S	16	16	16	16	32
Cl	17	17	17		35.5
Ca	20	20	20	20	40

Mole:

- The mole, symbol 'mol' is SI unit of amount of substance, One mole contain exactly 6.022 *4076×10^23 elementary entities this number is fixed numerical value of Avogadro constant (N_A) when expressed in unit called Avogadro no.

* Flowchart:



Here;

STP (Standard Temperature Pressure)

or

NTP (Normal Temperature Pressure).

Phy. State	Temperature	Pressure
Gas	0°C or 273.15K	1atom or 1bar
Liquid	15°C or 298.15K	1atom or 1bar

Questions:

1. Find out number of molecule present in 4.25 gm of ammonia.

NH_3 : 14, 3 $\rightarrow$ 17

$\Rightarrow$ mass of ammonia = 17.

$\therefore$ mole $= \frac{4.25}{4.00 \times 17} = \frac{1}{4}$ mole.

NOS = mole $\times N_A$

$= \frac{1}{4} \times 6.02 \times 10^{23}$

$= 0.25 \times 6.02 \times 10^{23}$

$= \boxed{1.5050 \times 10^{23}}$

2. Find out number of neutron in 4.4 gm of CO_2 gas.

$\Rightarrow$ CO_2 mass = 44.

C = 12

O = 16 } 32
O = 16 }

$\frac{4.4}{44} = 0.1$ mole.

no. of neutron in CO_2 = 22 N°

$\therefore$ in 0.1 mole = $0.1 \times 22 \times N_A$

$= 2.2\ N_A$ neutron.

3. Find out weight of 1 hydrogen atom in gm.

⟹ particles = 1

mole = $1/N_A$

weight of 1 hydrogen = 1gm

∴, mass = mole × at. mass

$= \frac{1}{N_A} \times 1 \longrightarrow \frac{1}{N_A}$ gm.

6.022×10^{23}

4. Find out weight of in amu (u).

(a) Nitrogen gas (b) Cl_2 (c) He

⟹ (a) 28 amu (b) 71 amu (c) 4 amu.

5. Find out no. of protons and neutrons in 5 mole of hydrogen gas.

⟹ proton in hydrogen gas (H_2) = 2

∴, in 5 mole = $2N_A \times 5$

$= \boxed{10 N_A}$

neutron in on hydrogen gas = 0

∴, in 5 mole = $2N_A \times 0$

$= \boxed{0}$

6. Calculate number of atoms in 0.5 gm atom of 'N'.

⟹ 0.5 gm atom = 0.5 mole

$\boxed{0.5 N_A}$

7. Calculate number of oxygen atoms at STP, If volume of oxygen at STP is 5.6 ltrs.

(cas at STP. it is oxyg giv.)

⟹ V = 5.6 l ∴, mole $= \frac{56 \times 10}{10 \times 224} = \frac{1}{4} = 0.25$ mole

∴, Oxygen atoms = $1.2 \times 0.25 \times N_A$

$= 0.5\, N_A \longrightarrow \boxed{3.01 \times 10^{23}}$.

8. Find out height of one molecule of CH_4 gas in gm and amu.

$\Rightarrow$ P = 1 molecule. $\quad$ Mole = $\frac{1}{N_A}$ $\left(\frac{P}{N_A}\right)$

wt $\begin{cases} gm = \frac{1}{N_A} \times 16 = \boxed{\frac{16}{N_A}\ gm} \\ amu = 16\left(\frac{1}{N_A}\right) = \boxed{16\ amu} \end{cases}$

$\left(1/N_A = amu\right)$

9. If V ml of vapour substance at NTP weight wg. Then molecular wt. of substance.

$\Rightarrow$ $\frac{V}{22.4}$ = mole

$\frac{V}{22400}$ = mole

$\frac{W}{M\ wt.}$ = mole.

M wt = $\frac{W}{\text{mole.}} \longrightarrow \boxed{\frac{W}{V} = 22400}$

(element)

$\Rightarrow$ %. mass of atom in molecule.

$$= \frac{\text{atomic mass}}{\text{molecular mass of molecular compound}} \times 100.$$

10. Find out % mass of atoms in $CaCO_3$ molecule.

⟹ M. wt $CaCO_3$ = 100.

$\therefore$ % of Ca = $\frac{40}{100} \times 100$ | 40% |

$\therefore$ % of C = $\frac{12}{100} \times 100$ | 12% |

$\therefore$ % of O_3 = $\frac{48}{100} \times 100$ | 48% |

11. Find out mass ratio for following:

(a) $C_6H_{12}O_6$ (b) NH_3 (c) H_2SO_4

⟹ (a) C : H : O

$6 \times 12 : 1 \times 12 : 16 \times 6$

12 : 12 : 96

| 6 : 1 : 8 |

(b) NH_3

N : H

| 14 : 3 |

(c) H_2SO_4

H : S : O

2 : 34 : 64

| 1 : 16 : 32 |

* H_2O:

	H : O
(a) mass ratio of atom	1 : 8
(b) mole ratio of atom	2 : 1
(c) mass ratio of molecules	1 : 8
(d) mole ratio of molecules	2 : 1
(e) volume ratio of molecules.	2 : 1

12. Find out mole ratio for following molecules:

⇒ (a) $K_2Cr_2O_7$ (K : Cr : O)

2 : 2 : 7

(b) CH_3COOH (C : H : O)

2 : 4 : 2

1 : 2 : 1

(c) Na_2SO_4 (Na : S : O)

2 : 1 : 4

13. Insulin contains 3.4%. sulphur. Minimum mol. wt. of insulin is.

⇒ $\frac{\text{at. wt.}}{\text{m. wt.}} \times 100$

$\Rightarrow \frac{32}{\text{M. wt.}} \times 100 = 3.4$.

$\text{M. wt.} = \frac{32000}{34}$

$= \boxed{941.176}$

Density:

Density.

- Absolute density
- Relative density.
  - specific gravity
  - vapour density

Absolute density

$d = \frac{\text{mass (grm)}}{\text{volume (ml)}}$

#=> Specific gravity:

- it is relative density for liquid substances in respect with water.
- at 4°C temperature, specific gravity of water is equal to 1.

#=> Vapour density:

- it is also relative density of gaseous substances with respect to hydrogen gas.

$\text{vapour density} = \frac{\text{Density of any gas}}{\text{density of } H_2 \text{ gas}}$ (T & P are same)

$\text{vapour density} = \frac{Pm/Rt \text{ any gas}}{Pm/Rt \ H_2 \text{ gas}}$

here m = molecular gas.

$VD = \frac{(P/Rt) \times m.\text{gas}}{(P/Rt) \times m.\ H_2 \text{ gas}}$

$VD = \frac{\text{molecular weight}}{2}$

molecular weight = VD × 2

$PV = nRT$ (ideal gas eq)

$n = wt/m$

$PV = \frac{wt}{m} \times Rt$ $\quad \frac{wt}{v} = d$

$Pm = \frac{wt}{v} \times Rt$

$\frac{Pm}{Rt} = d$

$\therefore, \boxed{d = \frac{Pm}{Rt}}$ universal gas constant

$\boxed{R = 0.0821}$

14. Vapour density of gas is 11.2, volume occupied by 2.4gm of this gas at STP will be.

$\Rightarrow$ Mol. = V.D. × 2

M. wt. = 11.2 × 2

= 22.4 gm

$\rightarrow$ mole = $\frac{2.4}{22.4}$ $\Longrightarrow$ $\frac{V}{22.4}$ = mole.

$\frac{V}{22.4} = \frac{2.4}{22.4}$ $\Longrightarrow$ $\boxed{V = 2.4\ L}$

Empirical formulae & molecular formulae:

- empirical formulae of compound represents simplest whole number ratio of various element present in one molecule

molecular formulae	C_6H_6	C_2H_6	CH_3COOH $C_2H_4O_2$	NH_3	$C_6H_{12}O_6$
Emp. formula	CH	CH_3	CH_2O	NH_3	CH_2O
n	6	2	2	1	6.

$n = \frac{\text{molecular formulae}}{\text{empirical formulae.}}$

15. Phosgene gas contain 12.1% carbon, 16.2% oxygen atom and 71.7% chlorine by mass. Find out its empirical formulae.

⟹ C = 12.1% O = 16.2% Cl = 71.7%

12.1gm 16.2gm 71.7gm.

$\frac{12.1}{12}$ = 1.01 mole $\frac{16.2}{16}$ = 1.01 mol $\frac{71.7}{35.5}$ = 2.02 mol

⟶ $\frac{1.01}{1.01}$ = 1 mole $\frac{1.01}{1.01}$ = 1 mole $\frac{2.02}{2.02}$ = 2 mole.

∴ Emp. form = $\boxed{COCl_2}$

16. Find out empirical formulae for hydrocarbon containing 80% C & 20% H. If molecules weight of hydrocarbon is 30.

⟹ C H

80% 20%

80x 20x

80x + 20x = 30

100x = 30

x = 0.3

∴ C = 80 × 0.3 (24)

H = 20 × 0.3 (6)

80 gm 20gm

$\frac{80}{12}$ = 6.6 $\frac{20}{1}$ = 20

$\frac{6.6}{6.6}$ = 1 $\frac{20}{6.6}$ = 3.

∴ Ef = CH_3

∴ moles of C = $\frac{24}{12}$ 2 mole

moles of H = $\frac{6}{1}$ 6 mole

→ molecular formula = C_2H_6

17. Compound contain 38.8% C, 16% Hydrogen & 45.2% Nitrogen. Find E.F.

⇒

C	H	N
38.8%	16%	45.2%

$\frac{38.8}{12} = 3.2$ mole $\quad \frac{16}{1} = 16$ mole $\quad \frac{45.2}{14} = 3.27$ mole,

→ ÷ by 3.2 mole.

$\frac{3.2}{3.2} = 1$ mole $\quad \frac{16}{3.2} = 5$ mole $\quad \frac{3.27}{3.2} = 1$ mole.

∴ Ef = CH_5N.

18. 5.325 gm methyl benzoate contain 3.758 gm of carbon, 0.316 hydrogen and 1.251 gm oxygen. Find Ef.

⇒

C	H	O
3.758	0.316	1.251

$\frac{3.758}{5.325} \times 100 = 70.57\%$ $\quad \frac{0.316}{5.325} \times 100 = 5.93\%$ $\quad \frac{1.251}{5.325} \times 100 = 23.5\%$

⇒ $\frac{70.57}{12} = 5.88$ $\quad \frac{5.93}{1} = 5.93$ $\quad \frac{23.5}{16} = 1.46$

$\frac{5.88}{1.46} = 4$ mole $\quad \frac{5.93}{1.46} = 4$ mole $\quad \frac{1.46}{1.46} = 1$ mole.

Ef: C_4H_4O

19. In above question molecular weight of methyl benzoate is 136, then find its mole. form.

→ Ef = C_4H_4O

= 12(4) + 4(1) + 16

= 48 + 4 + 16

= 68gm

∴, $n = \frac{mf}{Ef.} = 2$.

∴, $Mf = C_8H_8O_2$

20. Compound contains 4.07% hydrogen, 24.27% carbon and 71.65% Cl. Molar mass 98.96 gm. Ef & Mf?

⇒

H	C	Cl
4.07%	24.27%	71.65%

$\frac{4.07}{1}$ $\frac{24.27}{12}$ $\frac{71.65}{35.5}$

= 4.07 mole = 2 mole. = 2.02 mole

⇒ $\frac{4.07}{2.01}$ ⇒ $\frac{2.02}{2.02}$ ⇒ $\frac{2.02}{2.02}$ = 1 mole

≈ 2 ≈ 1 mole

∴, Ef = H_2CCl

CH_2Cl

E. wt = 12 + 2 + 35.5

= 49.5 gm

m. wt. = 98.96 ≈ 2.
e. wt. = 49.5

∴ $M_f = C_2H_4Cl_2$

21. Molecular formulae of oxide of Iron in which mass % of Fe & O are 69.9% and 30.1%.

⇒

Fe	O
69.9%	30.1%
$\frac{69.9}{55.8}$	$\frac{30.1}{16}$
= 1.25 mole	= 1.88 mole.
÷1.25	
= 1 mole.	= 1.51 ≈ 1.5.
= 1 mole	= $\frac{3}{2}$ mole.
÷2	
= 2 mole	= 3 mole.

∴ $E_f = Fe_2O_3$.

22.

P (weight)	n	e^-
1 amu	1 amu	$\frac{1}{1837}$ ≈ $\frac{1}{2000}$ amu.

22. Find out total no. of mole of 'O' atom in 3 l O_3 gas at 27°C temp. and 8.21 atm. pressure?

$\Rightarrow$ $t = 27°C \longrightarrow 273 + 27$

$P = 8.21$ (300 K)

$R = 0.0821$

$\Rightarrow PV = nRT$

$n = \frac{PV}{RT}$

$\Rightarrow \frac{\cancel{821}}{100} \times \frac{3}{\cancel{300}} \times \frac{\cancel{10000}}{\cancel{821}}$

$= 1$ mole

$\therefore$ no. of moles O_3 gas

$= 3 \times 1$ mole (3 moles)

23. Mole of oxygen atom in 175 amu of H_2SO_4.

$\Rightarrow \frac{175}{98} = 1.71$ molecule

$\text{mole} = \frac{1.7}{N_A}$

$\therefore$ mole O. atom $\Rightarrow \frac{1.7}{N_A} \times 4$

$= \frac{5.8}{N_A}$