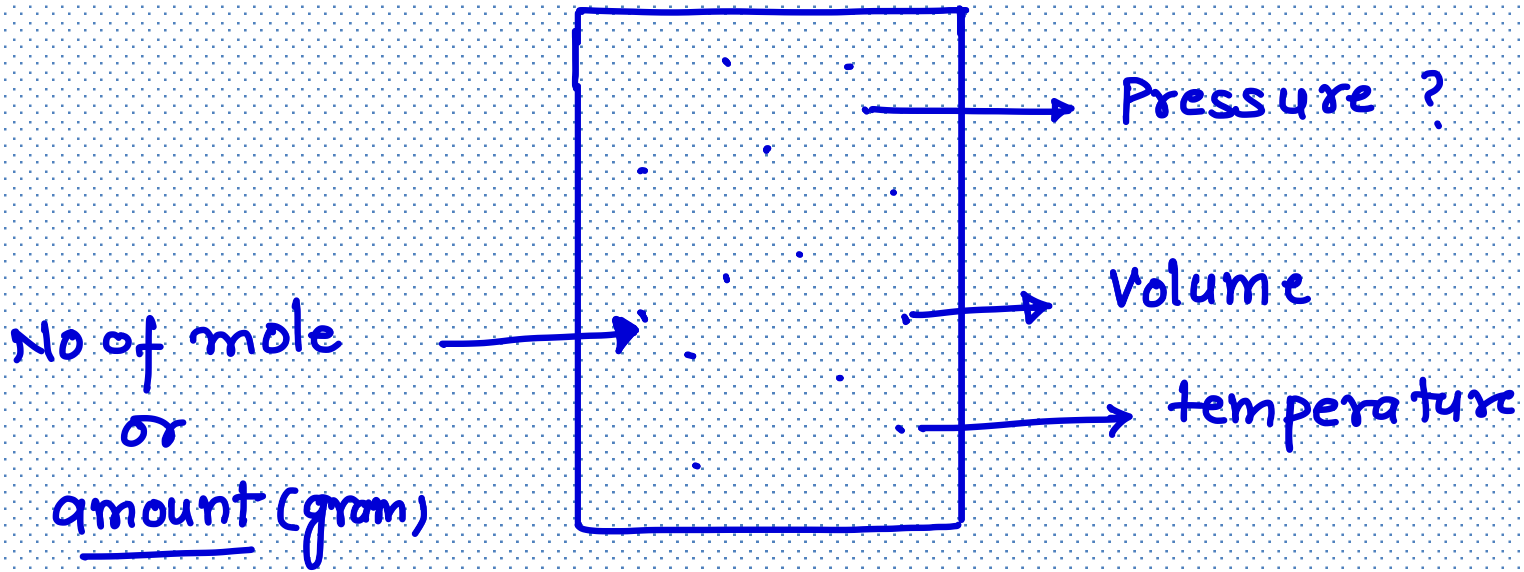
Ideal Gas Equation



SOME IMPORTANT DEFINITIONS

- **Pressure** : force per unit area.

units : Pa, N/m^2, bar, atm, torr, cm of Hg, mm of Hg

$\underbrace{\text{Pa},\ \text{N/m}^2}_{\text{SI unit}}$

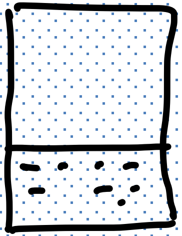
1.01325×10^5 Pa $= 1.01325 \times 10^5$ N/m^2 $= 1.01325$ bar $=$ 1 atm $=$ 760 torr

$=$ 76 cm of Hg

$=$ 760 mm Hg

SOME IMPORTANT DEFINITIONS

- **Volume** : Volume of gas is volume of container.



5L

Volume of air $= 3L$

unit. m^3, cm^3, dm^3, mL, L

$100\,cm = 1\,m$

$1\,cm = 10^{-2}\,m$

$1\,cm = 10^{-1}\,dm$

$$\boxed{1\,cm^3 = 1\,c.c = 1\,mL}$$

$(10^{-2}\,m)^3 = 1\,mL$

$10^{-6}\,m^3 = 1\,mL$

$10^{-6}\,m^3 = 10^{-3}\,L$

$$\boxed{1\,m^3 = 1000\,L}$$

$(10^{-1}\,dm)^3 = 1\,mL$

$10^{-3}\,dm^3 = 1\,mL = 10^{-3}\,L$

$$\boxed{1\,dm^3 = 1\,L}$$

SOME IMPORTANT DEFINITIONS

- Temperature : degree of hotness or coldness.

unit , 0°C, °K , F

$$\boxed{\frac{C}{5} = \frac{F-32}{9} = \frac{K-273}{5}}$$

$K = C + 273$

$C = K - 273$

Amount of gas

$$\text{moles}(n) = \frac{\text{given mass}}{\text{Molar mass}} = \frac{\text{No of particles}}{6.022 \times 10^{23}}$$

Mole Concept

SOME IMPORTANT DEFINITIONS

Ideal Gas Equation :

$$\boxed{PV = nRT}$$

P → Pressure (atm)
V → Volume (L)
R → Universal gas constant
n → Number of moles
T → Temperature (K)

R → Universal gas constant
→ 8.314 $JK^{-1} mol^{-1}$
→ 0.082 L atm $K^{-1} mol^{-1}$
→ 0.083 L bar $K^{-1} mol^{-1}$
→ 2 Cal $K^{-1} mol^{-1}$

NTP ⇒ T = 273 K, P = 1atm
STP ⇒ T = 273 K, P = 1 bar

approx. $\left(\approx \frac{1}{12}\right.$

SOME IMPORTANT DEFINITIONS

- NTP → Normal temperature and pressure

  $t = 0°C$, $T = 273\ K$, $P = 1\ atm$

STP → standard temperature and pressure

$t = 0°C$, $T = 273K$, $P = 1\ bar$.

✓ SATP → Standard Ambient temperature and pressure

Ind. $t = 25°C$, $298K$,

$P = 1\ atm$

MOLE

NTP $\Rightarrow$ T = 273 K, P = 1atm

STP $\Rightarrow$ T = 273 K, P = 1 bar

If n = 1 $\quad$ PV = nRT

At NTP $\Rightarrow$ (1) (V) = 1 (0.082) × 273

$V = 22.4\ L\ mol^{-1}$

- For Calculation purpose STP ≈ NTP
- 1 mole of any gas at STP/NTP occupy same volume i.e. 22.4 L.

Molar volume :

It is the volume of 1 mole of any gas at NTP i.e. 22.4 L

SOME IMPORTANT DEFINITIONS

Ex. Find volume of 1 mole of gas at

1.01325

(i) NTP = $PV = nRT$

$1(V) = 1(0.0821) \times 273$

$V = 22.4L$

(ii) STP = $\left(\frac{1}{1.013125}\right) \cdot V(L) = 1 \times 0.0821 \times 273$

1 bar

$V(L) = (22.4) \times 1.01325$

$V(L) = 22.7\ L$

(iii) SATP ⇒

$1(V) = 1 \times 0.0821 \times 298$

$V = 24.46L$

SOME IMPORTANT DEFINITIONS

Ex. Find the volume of 4.8 g He kept at temperature 127°C and pressure 76 mm of Hg

- mole $= \frac{4.8}{4} = 1.2$
- pressure $= \frac{76}{760} = 0.1$
- temperature $= 127 + 273 = 400K$

$$V = \frac{nRT}{P} = \frac{(1.2) \times 0.0821 \times 400}{0.1}$$

$$\underline{V = 394.08}\ L$$

SOME IMPORTANT DEFINITIONS

Ex: He, O_2, O_3 are kept in containers of same volume at same condⁿ (P, T)

find

(a) Ratio of moles of gas = 1 : 1 : 1

(b) Ratio of molecules = 1 : 1 : 1

(c) Ratio of atoms = 1 : 2 : 3

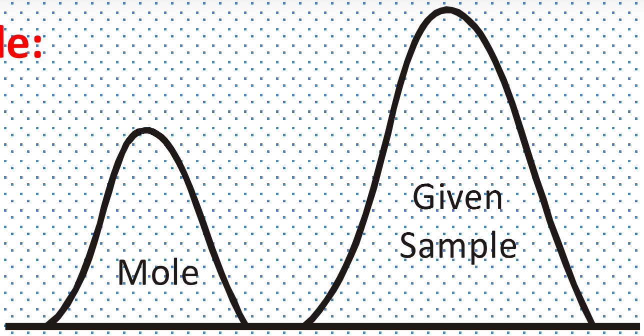
MOLE

Some Important Terms :

- **Gram Atomic Mass (GAM) :** When atomic mass of an element is expressed in grams. i.e. mass of 1 moles.
- **Gram Molecular Mass (GMM) :** When molecular mass is represented in grams. i.e. mass of 1 mole molecules.
- **1 g-atom :** 1 mole atoms
- **1 g-molecule :** 1 mole molecules

MOLE

Calculation of Mole:



$$\text{Mole, } n = \frac{\text{Given weight}}{\text{Weight of 1mole substance}} = \frac{w}{Mw}$$

$$\text{Mole, } n = \frac{\text{Given no. of particles}}{\text{No. of particles in 1mole}} = \frac{N}{N_A}$$

$$\text{Mole, } n = \frac{\text{Given volume}}{\text{Volume of 1mole}} = \frac{V(L)}{22.4} = \frac{V(ml)}{22400}$$ ← Only for Gas at NTP/STP conditions.

Question : How many g-atoms are there in 1 atom?

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Solution : 1g-atom means 1 mole atom

Hence

$$n_{atom} = \frac{1}{6.02 \times 10^{23}} = 1.67 \times 10^{-24} \text{ moles}$$

OR

$$= 1.67 \times 10^{-24} \text{ g-atoms}$$

ILLUSTRATIONS

Question : The dot at the end of this sentence has a mass of about 1 micro gram. Assuming that black stuff is carbon, calculate approximate atoms of carbon needed to make such a dot.

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Solution : Mass of dot = 1×10^{-6} g

$$n_C = \frac{10^{-6}}{12}$$

$$\text{No. of C atoms} = \frac{10^{-6}}{12} \times 6 \times 10^{23}$$

$$= 5 \times 10^{16}$$

Question : Which of the following have maximum number of Cl atoms.

(i) 1 g of Cl

(ii) 1 g of Cl_2

Question : Which of the following have maximum number of Cl atoms.

(i) 1 g of Cl

(ii) 1 g of Cl_2

Solution : (i) No. of moles of Cl, $n_{Cl} = \frac{1}{35.5}$

No. of Cl atoms $= \frac{1}{35.5} \times N_A$

(ii) No. of moles of Cl_2, $n_{Cl_2} = \frac{1}{71}$

No. of moles of Cl, $n_{Cl} = \frac{1}{71} \times 2 = \frac{1}{35.5}$

No. of Cl atoms $= \frac{1}{35.5} \times N_A$

Hence, no. of Cl atoms in both the samples will be same.

Question : Which of the following have maximum number of atoms.

(1) 1 g of O

(2) 1 g of O_2

(3) 1 g of O_3

(4) All have same no. of atoms

Question : Which of the following have maximum number of atoms.

(1) 1 g of O (2) 1 g of O_2

(3) 1 g of O_3 (4) All have same no. of atoms

Solution :

(1) $n_O = \frac{1}{16}$

No. of O atoms $= \frac{1}{16} \times N_A$

(2) $n_{O_2} = \frac{1}{32}$

$n_O = \frac{1}{32} \times 2 = \frac{1}{16}$

No. of O atoms $= \frac{1}{16} \times N_A$

(3) $n_{O_3} = \frac{1}{48}$

$n_O = \frac{1}{48} \times 3 = \frac{1}{16}$

No. of O atoms $= \frac{1}{16} \times N_A$

Hence no. of O atoms will be same.

Question : Which of the following have maximum number of atoms?

(1) 8g of H_2

(2) 32 g of O_2

(3) 28 g of N_2

(4) 18 g of H_2O

Question : Which of the following have maximum number of atoms?

(1) 8g of H_2 (2) 32 g of O_2

(3) 28 g of N_2 (4) 18 g of H_2O

Solution :

(1) $n_{H_2} = \frac{8}{2} = 4$

$n_H = 4 \times 2 = 8$

atoms $= 8 \times N_A$

(2) $n_{O_2} = \frac{32}{32} = 1$

$n_O = 1 \times 2 = 2$

atoms $= 2 \times N_A$

(3) $n_{N_2} = \frac{28}{28} = 1$

$n_N = 1 \times 2 = 2$

atoms $= 2 \times N_A$

(4) $n_{H_2O} = \frac{18}{18} = 1$

$n_{atoms} = 1 \times 3$

atoms $= 3 \times N_A$

Question : Calculate number of Hydrogen atoms in 2.8 L of H_2 at STP?

ILLUSTRATIONS

Question : Calculate number of Hydrogen atoms in 2.8 L of H_2 at STP?

Solution :

$$n_{H_2} = \frac{2.8}{22.4} = \frac{1}{8}$$

$$n_H = \frac{1}{8} \times 2 = 0.25$$

atoms = $0.25 \times N_A$

Question : Find the sum of electrons protons and neutrons in 16 g of O atom ?

ILLUSTRATIONS

Question : Find the sum of electrons protons and neutrons in 16 g of O atom ?

Solution : In 1 atom of O

8 electrons, 8 protons and 8 neutrons are present.

Total = 24

$$n_O = \frac{16}{16} = 1$$

No. of O atoms = $1 \times N_A$

Total no. of protons, neutrons and electrons = $24 \times N_A$

Question : For 4.4×10^{-19} g of CO_2

Calculate :

(1) Number of molecules

(2) Volume at STP

ILLUSTRATIONS

Question : For 4.4×10^{-19} g of CO_2

Calculate :

(1) Number of molecules

(2) Volume at STP

Solution :

$$n_{CO_2} = \frac{4.4 \times 10^{-19}}{44} = 10^{-20}$$

(1) No. of CO_2 molecules $= 10^{-20} \times 6 \times 10^{23}$

$= 6 \times 10^{3}$

(2) Volume at STP $= 10^{-20} \times 22.4$ L

ILLUSTRATIONS

Question : For 3.01×10^{19} atoms of He

Calculate :

(1) Mass

(2) Volume at STP in mL

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Calculate :

(1) Mass

(2) Volume at STP in mL

Solution :

$$n_{He} = \frac{3.01 \times 10^{19}}{6.02 \times 10^{-23}} = 5 \times 10^{-5}$$

(1) Mass = $5 \times 10^{-5} \times 4 = 2 \times 10^{-4}$ g

(2) Volume at STP in ml = $5 \times 10^{-5} \times 22400$

= 1.12 ml

Question : 6.4 g of unknown gas occupies 2.24 L volume at STP, then find the unknown gas ?

(1) O_2 (2) H_2

(3) CO_2 (4) SO_2

ILLUSTRATIONS

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(1) O_2 (2) H_2

(3) CO_2 (4) SO_2

Solution :

$$n_{gas} = \frac{6.4}{MW} = \frac{2.24}{22.4}$$

$MW_{gas} = 64$

Hence the gas should be SO_2 having molecular weight 64.

Question : If 3×10^{20} molecules are removed from 63 mg of HNO_3, then remaining number of moles of HNO_3 are ?

ILLUSTRATIONS

Question : If 3×10^{20} molecules are removed from 63 mg of HNO_3, then remaining number of moles of HNO_3 are ?

Solution :

Initial moles of HNO_3 $= \dfrac{63 \times 10^{-3}}{63} = 1 \times 10^{-3}$

Removed moles of HNO_3 $= \dfrac{3 \times 10^{20}}{6 \times 10^{23}} = 0.5 \times 10^{-3}$

Remaining moles of HNO_3 $= 1 \times 10^{-3} - 0.05 \times 10^{-3}$

$= 0.5 \times 10^{-3}$

Question : In 4.2 mg of N^{3-} ion calculate

(i) Number of ions

(ii) Number of electrons & protons

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(i) Number of ions

(ii) Number of electrons & protons

Solution : In 1 N^{3-} ion

Electrons = 7 + 3 = 10, Protons = 7, Neutrons = 7

$$n_{N^{3-}} = \frac{4.2 \times 10^{-3}}{14} = 3 \times 10^{-4}$$

(1) No. of ions = $3 \times 10^{-4} \times 6 \times 10^{23} = 1.8 \times 10^{20}$

(2) No. of electrons = $1.8 \times 10^{20} \times 10 = 1.8 \times 10^{21}$

No. of protons = $1.8 \times 10^{20} \times 7 = 1.26 \times 10^{21}$

Question : Two elements X and Y combine together to form two different compounds XY_2 and X_2Y_3. If 0.05 mole of XY_2 has a mass of 5g and 3.01×10^{23} molecules of X_2Y_3 has a mass of 85 g. Then calculate the atomic mass of X and Y.

ILLUSTRATIONS

Question : Two elements X and Y combine together to form two different compounds XY_2 and X_2Y_3. If 0.05 mole of XY_2 has a mass of 5g and 3.01×10^{23} molecules of X_2Y_3 has a mass of 85 g. Then calculate the atomic mass of X and Y.

Solution : 0.05 mole of $XY_2 \Rightarrow 5\text{g}$

$$1 \text{ mole of } XY_2 \Rightarrow \frac{5}{0.05} \Rightarrow 100 \text{ g}$$

and 3.01×10^{23} molecules of $X_2Y_3 \Rightarrow 85$ g

6.02×10^{23} molecules of $X_2Y_3 \Rightarrow 170 \text{ g} = 1$ mole X_2Y_3

Hence $Mw_x + 2Mw_y = 100$ g ....(i)

$2Mw_x + 3Mw_y = 170$ g ....(ii)

From (i) & (ii)

$Mw_x = 30,\ Mw_y = 40$

Question : Find number of g-atoms of oxygen in 1120 cm^3 CO_2 at STP.

ILLUSTRATIONS

Question : Find number of g-atoms of oxygen in 1120 cm^3 CO_2 at STP.

Solution :

$$n_{O_2} = \frac{1120}{22400} = 0.05$$

$$n_O = 0.05 \times 2 = 0.1$$

Hence no. of g-atoms of O = 0.1

ILLUSTRATIONS

Question : Equal masses of O_2, H_2 and CH_4 will have mole ratio of

(1) 16 : 1 : 8

(2) 1: 16 : 2

(3) 1 : 16 : 1

(4) 16 : 1 : 16

Question : Equal masses of O_2, H_2 and CH_4 will have mole ratio of

(1) 16 : 1 : 8 (2) 1: 16 : 2

(3) 1 : 16 : 1 (4) 16 : 1 : 16

Solution : Let the masses be x g

	O_2		H_2		CH_4
mass	x	:	x	:	x
moles	$\frac{x}{32}$	:	$\frac{x}{2}$	:	$\frac{x}{16}$
Mole Ratio	1	:	16	:	2

Question : Calculate number of atoms in the following cases

(i) 4 amu of He

(ii) 4g of He

(iii) 4 g-atom of He

ILLUSTRATIONS

Question : Calculate number of atoms in the following cases

(i) 4 amu of He

(ii) 4g of He

(iii) 4 g-atom of He

Solution :

(i) No. of atoms = $\frac{4}{4} = 1$

(ii) $n_{He} = \frac{4}{4} = 1$

No. of atoms = $1 \times N_A$

(iii) $n_{He} = 4$

No. of atoms = $4 \times N_A$

ILLUSTRATIONS

Question : Calculate the number of atoms in 5.6 L of a
(i) Monoatomic gas
(ii) Diatomic (at NTP)

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(i) Monoatomic gas
(ii) Diatomic (at NTP)

Solution :

(i) $n_{gas} = \dfrac{5.6}{22.4} = \dfrac{1}{4}$

No. of atoms = $0.25 \times N_A = 1.5 \times 10^{23}$

(ii) $n_{gas} = \dfrac{5.6}{22.4} = \dfrac{1}{4}$

No. of atoms = $\dfrac{1}{4} \times 2 \times N_A = 3 \times 10^{23}$

Question : Which of the following have least number of atoms :

(1) 5.6 L NH_3

(2) 4g O_2

(3) 3.01×10^{22} moles of H_2SO_4

(4) 2.24 g of H_2 gas

Question : Which of the following have least number of atoms :

(1) 5.6 L NH_3

(2) 4g O_2

(3) 3.01×10^{22} moles of H_2SO_4

(4) 2.24 g of H_2 gas

Solution :

(1) $$n_{NH_3} = \frac{5.6}{22.4} = \frac{1}{4}$$

$$n_{atoms} = \frac{1}{4} \times 4 = 1$$

(2) $$n_{O_2} = \frac{4}{32} = \frac{1}{8}$$

$$n_{atoms} = \frac{1}{8} \times 2 = \frac{1}{4} = 0.25$$

(3) $$n_{H_2SO_4} = \frac{3.01 \times 10^{22}}{6.02 \times 10^{23}} = 0.05$$

$$n_{atoms} = 0.05 \times 7 = 0.35$$

(4) $$n_{H_2} = \frac{2.24}{2}$$

$$n_{atoms} = \frac{2.24}{2} \times 2 = 2.24$$

SOME IMPORTANT DEFINITIONS

$d \rightarrow$ density

$$PV = nRT$$

$$PV = \frac{w}{M_{wt}} RT$$

M_{wt} = molar mass of gas

$$P \cdot M_{wt} = \frac{W}{V} RT$$

$$P \cdot M_{wt} = d \, RT$$

$$\boxed{d = \frac{PM}{RT}}$$

$$d_A = \frac{P_A M_A}{RT_A}$$

$$d_B = \frac{P_B M_B}{RT_B}$$

A: T_A, P_A, M_A

B: T_B, M_B, P_B

SOME IMPORTANT DEFINITIONS

$$\frac{d_A}{d_B} = \left(\frac{P_A}{P_B}\right)\left(\frac{M_A}{M_B}\right)\left(\frac{T_B}{T_A}\right)$$

if both gase are same cond^n ($P_A = P_B$, $T_A = T_B$)

Relative density of A w.r.t B $= \boxed{\frac{d_A}{d_B} = \frac{M_A}{M_B}}$

Vapour density (V.D) → It is Relative density of gas w.r.t hydrogen.

$$V.D = \frac{d_{gas}}{d_{H_2}} = \frac{M_{gas}}{M_{H_2}}$$

SOME IMPORTANT DEFINITIONS

$$V.D \times M_{H_2} = M_{gas}$$

$$\boxed{M_{gas} = V.D \times 2}$$

Ex. the vapour density of SO_2 w.r.t methane is 4 find molecular mass of SO_2.

$$(V.D) \cdot M_{CH_4} = M_{SO_2}$$

$$4 \times 16 = M_{SO_2}$$

$$M_{SO_2} = 64 \text{ g/mol.}$$

VAPOUR DENSITY (V.D.)

Vapour Density (V.D.) :

Vapour density of a gas is the ratio of density of gas and hydrogen at the same temperature and pressure.
i.e. relative density of a gas w.r.t. density of hydrogen gas at same temperature and pressure condition.

$$V.D. = \frac{d_{gas}}{dH_2} \qquad \because d = \frac{m}{V} \qquad \text{If at STP } n = 1,\ m = Mw,\ V = 22.4\text{ L}$$

$$d_{gas} = \frac{Mw_{gas}}{22.4\text{L}} \qquad d_{H_2} = \frac{Mw_{H_2}}{22.4\text{L}}$$

$$V.D. = \frac{d_{gas}}{d_{H_2}} = \frac{Mw_{gas}}{Mw_{H_2}} = \frac{Mw_{gas}}{2}$$

$$\boxed{Mw_{gas} = 2 \times V.D._{gas}}$$

VAPOUR DENSITY (V.D.)

Some Important Points:

- Vapour density is unitless term.

- At NTP, the density of hydrogen gas $= 0.000089$ g/ml
  $= 9.0 \times 10^{-5}$ g/ml

- Relative density $= \dfrac{\text{Density of gas A}}{\text{Density of gas B}}$

- Specific gravity $= \dfrac{\text{Density of solution}}{\text{Density of water}}$

Question : The formula of a hypothetical gas is $(N_2)_x$ and its vapour density is 70. Find x.

Question : The formula of a hypothetical gas is $(N_2)_x$ and its vapour density is 70. Find x.

Solution :

$$Mw_{gas} = 2 \times \text{Vapour density}$$

$$= 2 \times 70 = 140$$

Hence $140 = x\,(28)$

$$x = 5$$

Question : Calculate the number of moles of H_2SO_4 that contains 0.08 mole of O atoms.

ILLUSTRATIONS

Question : Calculate the number of moles of H_2SO_4 that contains 0.08 mole of O atoms.

Solution :

$$4 \text{ mole O} \rightarrow 1 \text{ mole } H_2SO_4$$

$$1 \text{ mole O} \rightarrow \frac{1}{4} \text{ mole } H_2SO_4$$

$$0.08 \text{ mole O} \rightarrow \frac{1}{4} \times 0.08 \text{ mole } H_2SO_4$$

$$\rightarrow 0.02 \text{ mole } H_2SO_4$$

Question : A hydrocarbon C_nH_{2n+2} has V.D. 29. What is the value of n.

Question : A hydrocarbon C_nH_{2n+2} has V.D. 29. What is the value of n.

Solution : $Mw = 2 \times V.D.$

$= 2 \times 29 = 58$

Hence

$58 = n(12) + (2n + 2)\,1$

$58 = 12n + 2n + 2$

$n = 4$

ILLUSTRATIONS

Question : Vapour density of a gas is 11.2. The volume occupied by 11.2 g of this gas at STP is

(1) 22.4 L
(2) 11.2 L
(3) 1 L
(4) 2.25 L

Question : Vapour density of a gas is 11.2. The volume occupied by 11.2 g of this gas at STP is

(1) 22.4 L (2) 11.2 L

(3) 1 L (4) 2.25 L

Solution : $Mw = 2 \times V.D.$

$$= 2 \times 11.2 = 22.4$$

$$n_{gas} = \frac{11.2}{22.4} = \frac{1}{2}$$

$$\text{Volume occupied by gas at STP} = \frac{1}{2} \times 22.4 = 11.2 \text{ L}$$

ILLUSTRATIONS

Question : Calculate the volume of 1 molecule of $H_2O(\ell)$.

Question : Calculate the volume of 1 molecule of $H_2O(\ell)$.

Solution :

$$n_{H_2O} = \frac{1}{6 \times 10^{23}}$$

$$\text{mass of } H_2O = \frac{1}{6 \times 10^{23}} \times 18\text{ g} = 3 \times 10^{-23}$$

$$d_{H_2O} = 1\text{ g mL}^{-1}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Volume} = \frac{\text{mass}}{\text{density}} = \frac{3 \times 10^{-23}}{1} = 3 \times 10^{-23}\text{ ml}$$

Question : Calculate the vapour density of a gas whose 5g occupies a volume of 2.8 L at STP.

ILLUSTRATIONS

Question : Calculate the vapour density of a gas whose 5g occupies a volume of 2.8 L at STP.

Solution :

$$n_{gas} = \frac{5}{Mw} = \frac{2.8}{22.4}$$

$$Mw_{gas} = 40$$

$$V.D. = \frac{Mw_{gas}}{2} = \frac{40}{2} = 20$$

Question : Calculate the density of 1 mole of N_2 at NTP.

Question : Calculate the density of 1 mole of N_2 at NTP.

Solution :

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{28\,g}{22.4\,L} = 1.25\ g/L$$

Question : Calculate number of atoms present in 1 drop of water having volume 3.6 ml.

SOME IMPORTANT DEFINITIONS

% Composition

H_2O

mass % H = $\frac{1 \times 2}{18} \times 100$

mass % O = $\frac{16}{18} \times 100$

mole % of H = $\frac{2}{3} \times 100$

moles % O = $\frac{1}{3} \times 100$

$$\boxed{\% \text{ composition} = \frac{\text{Atomic mass} \times \text{Atomicity}}{\text{Molecular mass}} \times 100}$$

SOME IMPORTANT DEFINITIONS

Ex: SO_2

(i) $\% S = \frac{32 \times 1}{64} \times 100$

$= 50\%$

ii) $\% O = \frac{16 \times 2}{64} \times 100$

$= 50\%$

SOME IMPORTANT DEFINITIONS

Find the % H_2O in gypsum salt

$CaSO_4 \cdot 2H_2O$

$40+32+64+2\times18=$

$136+36=172$

$$\%\,H_2O = \frac{18\times2}{172}\times100$$

Ex. if epsum salt ($MgSO_4 \cdot xH_2O$) has %H_2O is 60% mass find no of hydrated water.

$$\cancel{60\%} = \frac{\overset{3}{\cancel{18}}\cdot x}{120+18x}\times\cancel{100} \Rightarrow 30x = 120+18x$$

$12x = 120$

$x = 10$

Question : Calculate number of atoms present in 1 drop of water having volume 3.6 ml.

Solution :

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Mass} = \text{volume} \times \text{density} = 3.6\ \text{g}$$

$$n_{H_2O} = \frac{3.6}{18} = 0.2$$

$$n_{atom} = 0.2 \times 3 = 0.6$$

$$\text{No. of atoms} = 0.6 \times 6 \times 10^{23} = 3.6 \times 10^{23}$$

Percentage Composition:

1 mole CH_4

$$\text{Mass \% of C} = \frac{12}{16} \times 100 = \frac{1 \times 12}{16} \times 100$$

$$\text{Mass \% of H} = \frac{4}{16} \times 100 = \frac{4 \times 1}{16} \times 100$$

Mass % of element in compound

$$= \left(\frac{\text{Atomicity} \times \text{Atomic weight}}{\text{Molecular wt.}} \times 100 \right)$$

MOLE

If minimum molecular mass is asked, then assuming at least 1 atom per molecule of the element.

Mass % of element in compound

$$= \frac{1 \times \text{At. wt. of element}}{\text{Min. molecule wt.}} \times 100$$

Question : Determine the mass % of each element in $Fe_2(SO_4)_3$.

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Solution :

$$\text{Mass \% of Fe} = \frac{2 \times 56}{400} \times 100 = 28\%$$

$$\text{Mass \% of S} = \frac{3 \times 32}{400} \times 100 = 24\%$$

$$\text{Mass \% of O} = \frac{12 \times 16}{400} \times 100 = 48\%$$

Question : A metal M forms a metal carbonate M_2CO_3, if the carbonate contains 48% oxygen by mass, then determine the atomic wt. of metal.

Mole Concept

ILLUSTRATIONS

Question : A metal M forms a metal carbonate M_2CO_3, if the carbonate contains 48% oxygen by mass, then determine the atomic wt. of metal.

Solution : % weight of element = $\dfrac{\text{Atomicity} \times \text{Atomic weight}}{\text{Molecular weight}} \times 100$

$$48 = \frac{3 \times 16}{\text{Mw}} \times 100$$

$$\text{Mw} = 100$$

$$2M + 12 + 48 = 100$$

$$M = 20$$