ARJUNA NEET BATCH

States of Matter

LECTURE - 5

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⇒ Ideal gas Equation

$$\boxed{PV = nRT}$$

- P → Pressure
- V → Volume
- n → no. of mole
- R → gas constant
- T → Temp.

$$\boxed{\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}}$$

Combined gas Eq^n

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

d → density
P → Pressure
T → Temp.
M = Molarmass
R = gas const

$$d_1 = \frac{P_1M}{RT_1} \quad \text{—(1)}$$

$$d_2 = \frac{P_2M}{RT_2} \quad \text{—(2)}$$

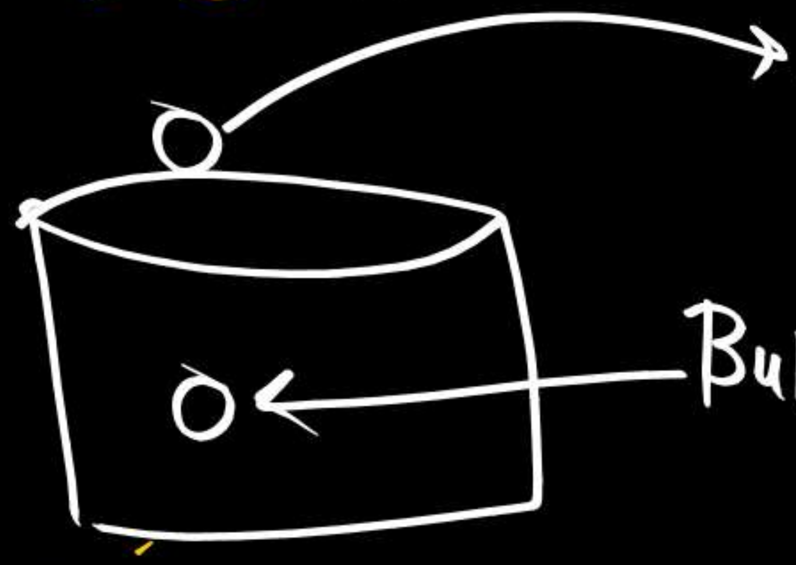
(1) = (2)

$$\boxed{\frac{d_1T_1}{P_1} = \frac{d_2T_2}{P_2}}$$

Case-I when % ↑ or % ↓ is considered in terms Pressure & Volume then always assume initial Pressure or initial Volume as 100%.

Case-II Change in temperature, either in °C or in Kelvin remains same

Case-III

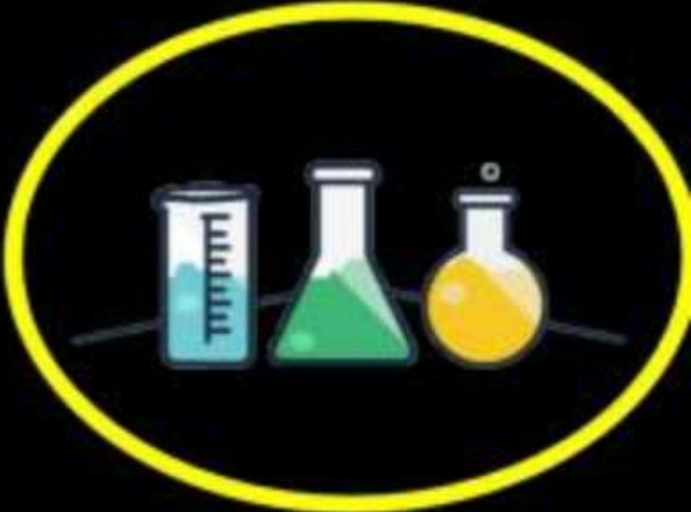


Bubble $T_1 =$
$P_1 =$
$V_1 =$

surface (bubble) → STP $T_1 = 0°C$
$P_1 = 1\,atm$
$V_1 = ?$

Objective of today's class

Gas Laws



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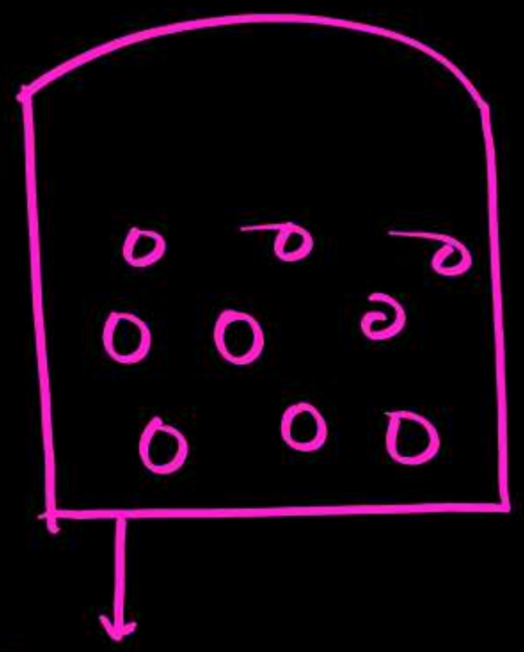
Dalton's Law of Partial Pressure

$$\boxed{P_T = P_1 + P_2 + P_3 - - - \_\_}$$

Non-reacting gas at Room temp.

$N_2 + O_2 \rightarrow$



Room temp.

$F = P \times A$

$P = \frac{F}{A}$

DALTON'S LAW OF PARTIAL PRESSURES

- Total pressure exerted by the mixture of non-reactive gases is equal to the sum of the partial pressures of the individual gases.
- Same volume and under same conditions of temperature.
- Three non-reacting constituting gases 1,2 and 3 whose partial pressures are P_1, P_2 and P_3 respectively. Then mathematically, Dalton's Law of partial pressure can be written as
- $\boxed{P_{total} = P_1 + P_2 + P_3}$ (at constant T, V)
- This law is only applicable for mixture of non-reacting gases.

$PV = nRT$

$$P_1 = \frac{n_1 RT}{V} \quad \text{--- (1)}$$

$$P_2 = \frac{n_2 RT}{V} \quad \text{--- (2)}$$

$$P_3 = \frac{n_3 RT}{V} \quad \text{--- (3)}$$

(1) + (2) + (3)

$$P_{Total} = P_1 + P_2 + P_3$$

$$= \frac{n_1 RT}{V} + \frac{n_2 RT}{V} + \frac{n_3 RT}{V}$$

$$P_T = (n_1 + n_2 + n_3)\frac{RT}{V} \quad \text{--- (4)}$$

(1) / (4)

$$\Rightarrow \frac{P_1}{P_T} = \frac{n_1 \cancel{\left(\frac{RT}{V}\right)}}{(n_1 + n_2 + n_3)\cancel{\left(\frac{RT}{V}\right)}}$$

$$\Rightarrow \boxed{P_1 = X_1 P_T}$$

$$\boxed{P_1 = X_1 P_T}$$

$P_1 \rightarrow$ Partial pressure of 1^{st} gas

$X_1 \rightarrow$ Mole fraction of 1^{st} gas

$P_T \rightarrow$ Total pressure

CH_4	He	H_2
w_1	w_1	w_1
P_T	P_T	P_T

$$\boxed{n = n_{gas} = \frac{w}{MM}}$$

$$P_{H_2} = X_{H_2} P_T = \frac{n_{H_2}}{\cancel{\text{Total moles}}} \times \cancel{P_T}$$

$$p_{CH_4} = X_{CH_4} P_T = \frac{n_{CH_4}}{n_{CH_4} + \cancel{n_{He}} + n_{H_2}} \cdot \cancel{P_T}$$

$$P_{He} = X_{He} P_T$$

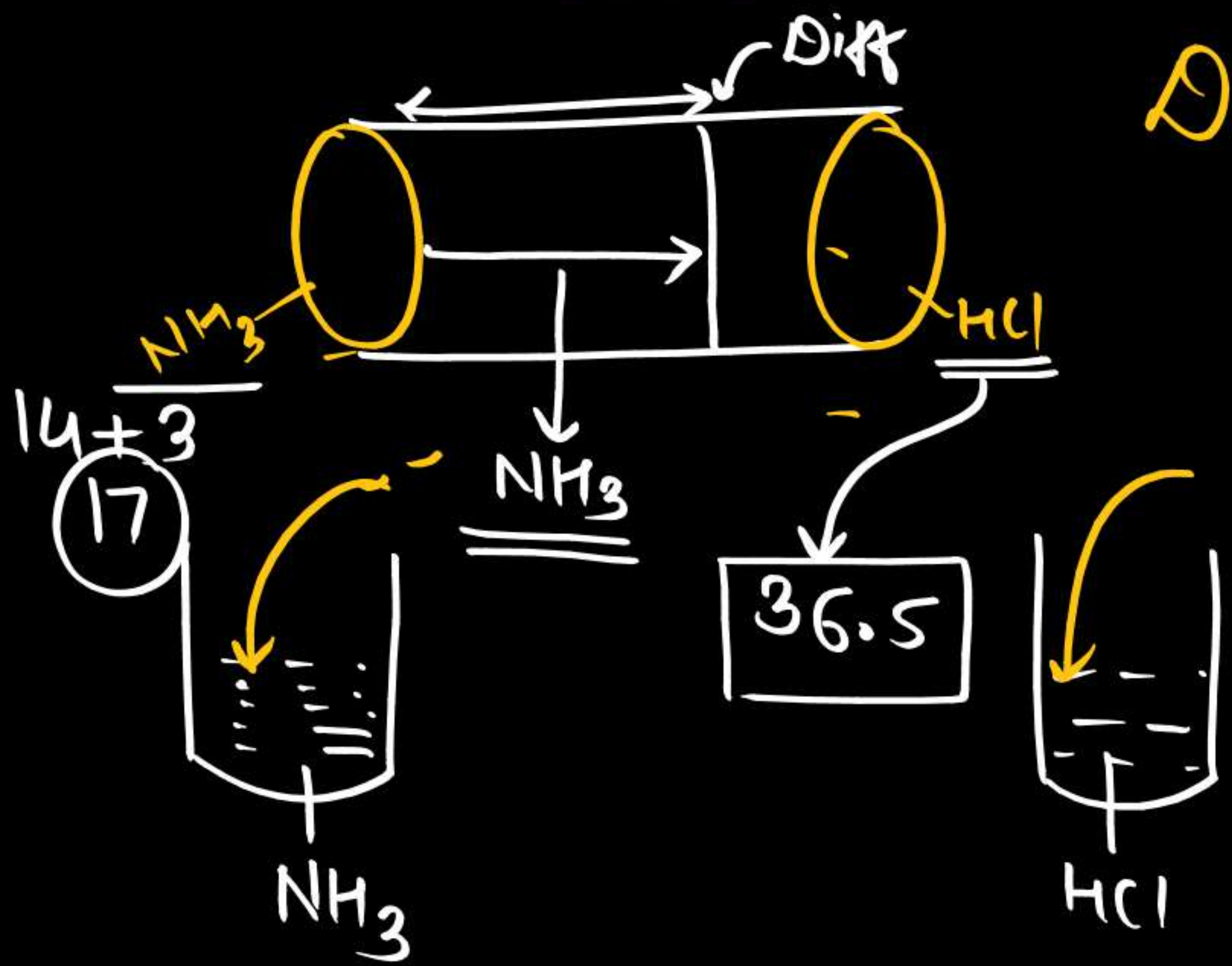
$$P_{He} = \frac{n_{He}}{\cancel{\text{Tot Mo}}} \times \cancel{P_T}$$

NOTE → The Partial pressure of lightest gas is maximum & the partial pressure of heaviest gas is minimum.

$$\boxed{\text{Pressure of dry gas} = \text{Pressure of moist gas} - \text{Aqueous tension}}$$

Aqueous tension → Pressure of Water vapours

GRAHAM'S LAW OF DIFFUSION



Diffusion → Intermining of gases without influence of any External agency.

$$\boxed{\text{Rate of Diffusion (R)} = \frac{\text{Volume diffused (V)}}{\text{Time taken}(t)}}$$

$$(R) \propto \frac{V}{t}$$

$$\frac{R_2}{R_1} = \frac{V_2}{V_1} = \frac{t_1}{t_2} = \frac{\sqrt{M_1}}{\sqrt{M_2}} = \frac{\sqrt{T_2}}{\sqrt{T_1}} = \frac{\sqrt{d_1}}{\sqrt{d_2}}$$

$$= \frac{P_2}{P_1} \qquad = \frac{n_1}{n_2}$$

$$R \propto \frac{1}{\sqrt{M}} \propto \text{Pressure} \propto \sqrt{\text{Temp.}}$$

$d \rightarrow$ density

$t \rightarrow$ time

$M \rightarrow$ Molecular mass

$n \rightarrow$ mole

$P \rightarrow$ Pressure

Effusion

Q. A sample of gas occupies 10 L under a pressure of 1 atm. What will be its volume if the pressure is increased to 2 atm? Assuming that temperature of the gas sample does not change?

(a) 2 L
(b) 5 L
(c) 10 L
(d) 1 L

$$\boxed{\frac{P_1V_1}{\cancel{n_1}\cancel{T_1}} = \frac{P_2V_2}{\cancel{n_2}\cancel{T_2}}}$$

$V_1 = 10\,L$ $\quad$ $V_2 = ?$

$P_1 - 1\ atm$ $\quad$ $P_2 = 2\ atm$

$P_1V_1 = P_2V_2$

$1 \times 10 = 2 \times V_2$

** $\boxed{V_2 = 5\,L}$

Q. How much should the pressure be increased in order to decrease the volume of a gas by 5% at a constant temperature?

(a) 5% (b) 5.26%

(c) 10% (d) 4.26%

$P_1V_1 = P_2V_2$

$P_1 = 100$ atm

$P_2 = ?$

$V_1 = 100\,L$

$V_2 = 95\,L$

$100 \times 100 = P_2 \times 95$

$P_2 = \dfrac{10000}{95}$

$\Rightarrow 105.26$

$\uparrow$ in Pressure $\Rightarrow P_2 - P_1 \Rightarrow 105.26 - 100$

$\Rightarrow 5.26\%$

$\dfrac{P_1V_1}{\cancel{n_1}\cancel{T_1}} = \dfrac{P_2V_2}{\cancel{n_2}\cancel{T_2}}$

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Q. If the density of a certain gas at 30°C and 768 torr is 1.35 kg/m^3 its density at STP would be

(a) 1.48 kg/m^3 (b) 1.58 kg/m^3

(c) 1.25 kg/m^3 (d) 1.4 kg/m^3

$d_1 = 1.35\ \text{kg/m}^3$

$T_1 = 30^\circ C \rightarrow 303\ K$

$P_1 = \underline{\underline{768\ \text{torr}}}$

$d_2 = ?$ at STP

$T_2 = 0^\circ C \rightarrow 273\ K$

$P_2 = 1\ \text{atm} = 760\ \text{torr}$

$$\Rightarrow \frac{d_1 T_1}{P_1} = \frac{d_2 T_2}{P_2} \Rightarrow \frac{1.35 \times 303}{768} = \frac{d_2 \times 273}{760}$$

$$d_2 = \frac{1.35 \times 303 \times 760}{768 \times 273}$$

$$\Rightarrow \underline{\underline{1.48\ \text{kg/m}^3}}$$

Q. The two bulbs of volume 5 litre and 10 litre containing an ideal gas at 9 atm and 6 atm respectively are connected. What is the final pressure in the two bulbs if the temperature remains constant?

(a) 15 atm (b) 7 atm

(c) 12 atm (d) 21 atm

h.w.

Q. The density of neon will be highest at

(a) STP
(b) 0°C and 2 atm
(c) 273°C and 1 atm
(d) 273°C and 2 atm

Q. A vessel has 6 g of oxygen at a pressure P and temperature 400 K. A small hole is made in it so that O_2 leaks out. How much O_2 leaks out if the pressure is P/2 and temperature 300K?

(a) 5 g
(b) 4 g
(c) 2 g
(d) 3 g

Q. Two non-reactive gases A and B are present in a container with partial pressure 200 and 180 mm of Hg. When a third non-reactive gas C is added then total pressure becomes 1 atm then mole fraction of C will be

(a) 0.75

(b) 0.5

(c) 0.25

(d) Cannot be calculated

Q. **Which of the following relation is correct for an ideal gas?**

(a) $\frac{V}{n} = \frac{P}{RT}$

(b) $\frac{MV}{m} = \frac{P}{RT}$

(c) $\frac{d}{M} = \frac{P}{RT}$

(d) *All of these*

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Q. The partial pressure of hydrogen in a flask containing 2g H_2 and 32g SO_2 is

(a) $1/16^{th}$ of total pressure

(b) $1/9^{th}$ of total pressure

(c) $2/3^{rd}$ of total pressure

(d) $1/8^{th}$ of total pressure

Q. What percent of a sample of nitrogen must be allowed to escape if its temperature, pressure and volume are to be changed from 220° C, 3 atm and 1.65 litre to 110° C, 0.7 atm and 1.00 litre respectively?

(a) 81.8%

(b) 71.8%

(c) 76.8%

(d) 86.8%

Q. 4g argon (Atomic mass = 40) in a bulb at a temperature of TK has a pressure P atm. When the bulb was placed in hot bath at a temperature 50°C more than the first one. 0.8g of gas had to be removed to get the original pressure. T is equal to

(a) 510 K
(b) 200 K
(c) 100 K
(d) 73 K

Q. A flask containing air (open to atmosphere) is heated from 300 K to 500 K. Then percentage of air escaped to the atmosphere is

(a) 20 (b) 40

(c) 60 (d) 80

Q. Air contains 23% oxygen and 77% nitrogen by weight. The percentage of O_2 by volume is

(a) 28.1

(b) 20.7

(c) 21.8

(d) 23.0

Q. When the temperature of certain sample of a gas is changed from 30°C to 606 K and its pressure is reduced to half, the volume of gas changed from V to V^2. The value of V is

(a) $2\ dm^3$ (b) $4\ dm^3$

(c) $8\ dm^3$ (d) Unpredictable

thanks
for watching

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