ARJUNA NEET BATCH

States of Matter

LECTURE - 3 {Structure of Atom}

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Objective of today's class

Gas Laws

HONEST

Google

NEET

20 June → 180

BACKLOG

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Volume (V)

The volume of the container is the volume of the gas sample as gases occupy the entire space available to them.

→ SI unit = m^3

→ C.G.S. unit = cm^3

Commonly used unit = L (Litre)

$1L = 1000\ ml$

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

$1m^3 = 1000L = 10^3\ dm^3$

$= 10^3 L$

$= 10^6\ cm^3$

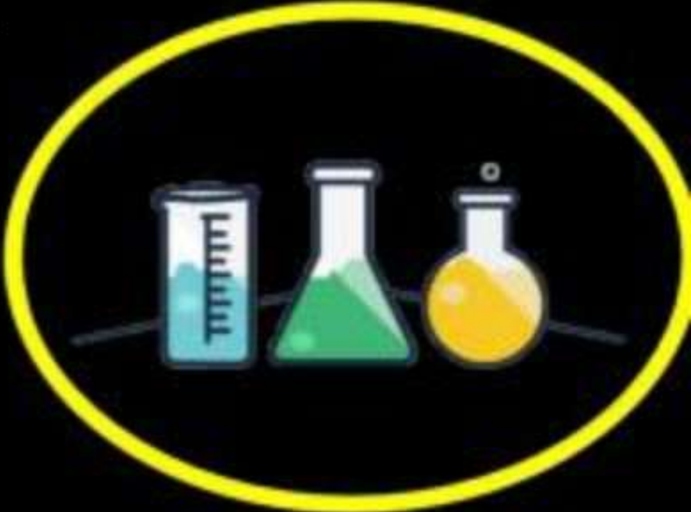
$= 10^6\ ml$

$1\ L = 1000\ cm^3$

$= 1000\ cc$

$= 1000\ ml$

P, V, T, n

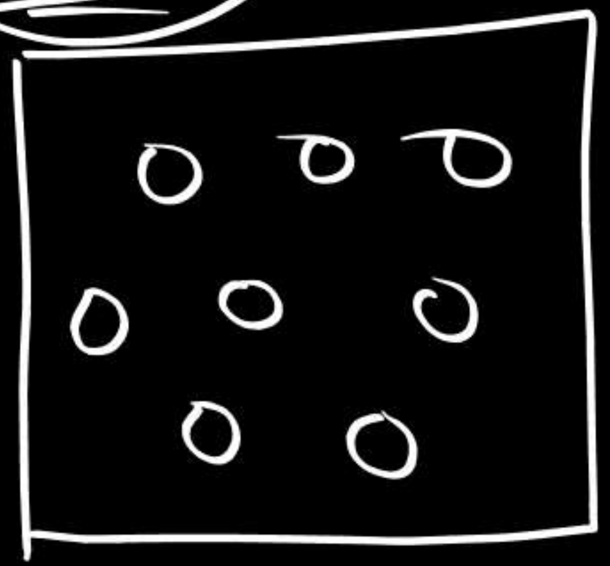


Pressure (P)

Pressure of the gas is the force exerted by the gas per unit area on the walls of the container in all directions.

$$\boxed{P = \frac{F}{A}} \quad F \rightarrow N,\; A \rightarrow m^2$$

KTG



S.I. unit = pascal (Pa)

1 Pa ⟶ $= 1\ Nm^{-2}$

1 atm ⟶ $= 1.013 \times 10^5$ Pa (Pascal)

Conversions

1 bar ⟶ $= 10^5$ Pa

⟶ $= 0.987$ atm (1 atm ≈ 1 bar)

1 atm ⟶ $= 760$ mm Hg (milli metre of mercury (Hg))

⟶ $= 760$ torr

⟶ $= 1.013 \times 10^5$ Pa

Temperature

It is the measure of hotness of the system and energy of the system.

S.I. unit = kelvin (K)

$\boxed{K = {}^\circ C + 273}$

°C → centigrade degree or Celsius degree

→ Change in temperature Either in °C or in Kelvin is always remains same.

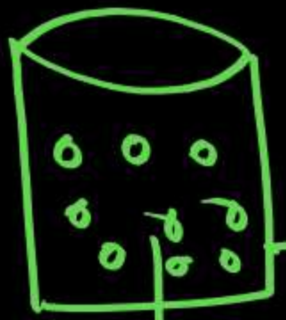
273.15

273 → Calculation easy

Mass

The mass of a gas can be determined by weighing the container in which the gas is enclosed and again weighing the container after removing the gas. The mass of the gas is related to the number of moles of the gas i.e.

$$\text{Moles of gas (n)} = \frac{\text{Mass in grams}}{\text{Molar Mass}} = \frac{m}{M}$$

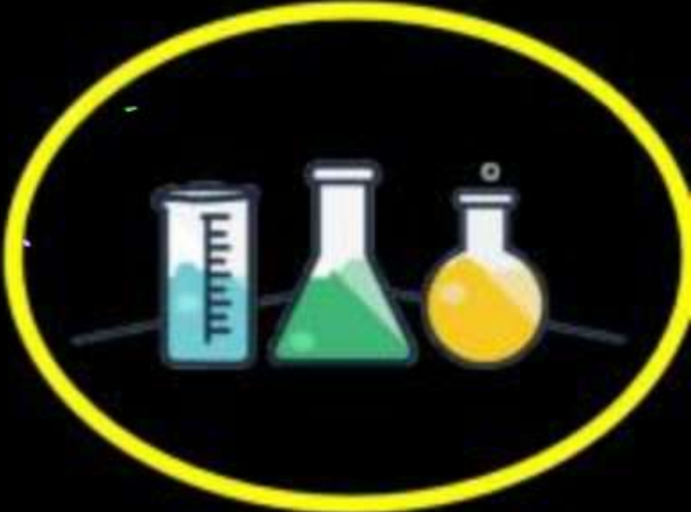


$\rightarrow w'$ → mass of container

mass of gas $\leftarrow w$

Amount of gas $= (w' + w) - w'$

w – ?



BOYLE'S LAW

- 'Robert Boyle' in 1662 gave the pressure-volume relationship of a gas.
- "At constant temperature, the pressure of a fixed amount of a gas varies inversely with the volume of the gas."

$$\boxed{P \propto \frac{1}{V}}$$

n, T = constant

$$PV = \boxed{\text{Constant } (K)}$$

(K) → Boyle's constant

$$\boxed{P_1V_1 = P_2V_2}$$

P_1 → Initial Pressure

V_1 → Initial Volume

P_2 → Final Pressure

V_2 → Final Volume

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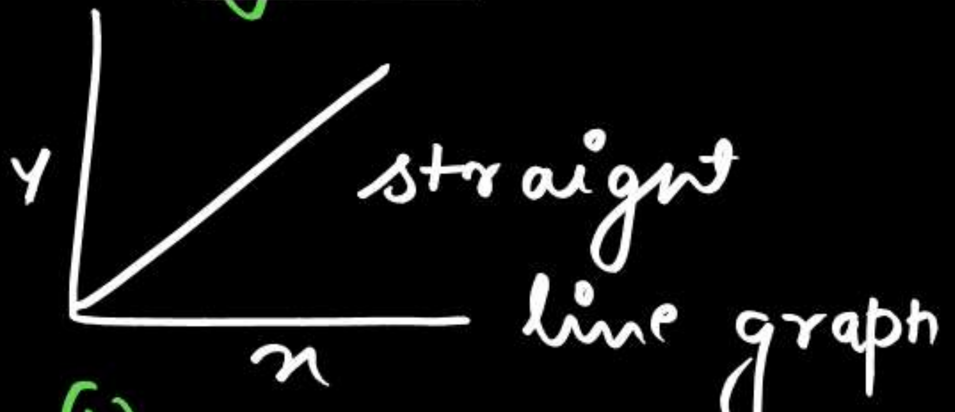
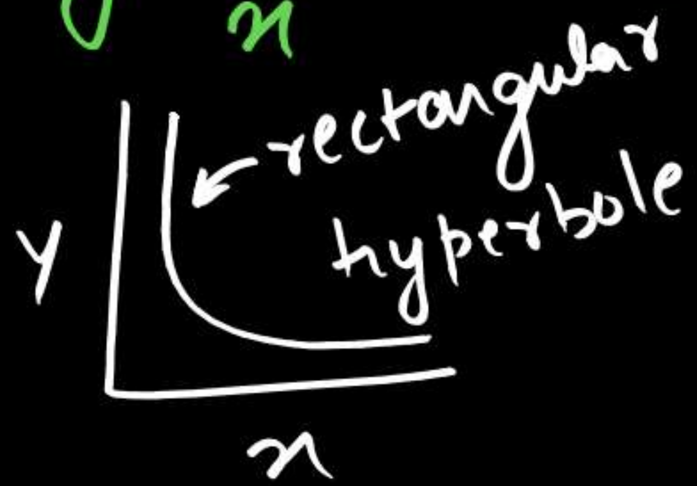
Graphical Representation

① $\boxed{y \propto x}$

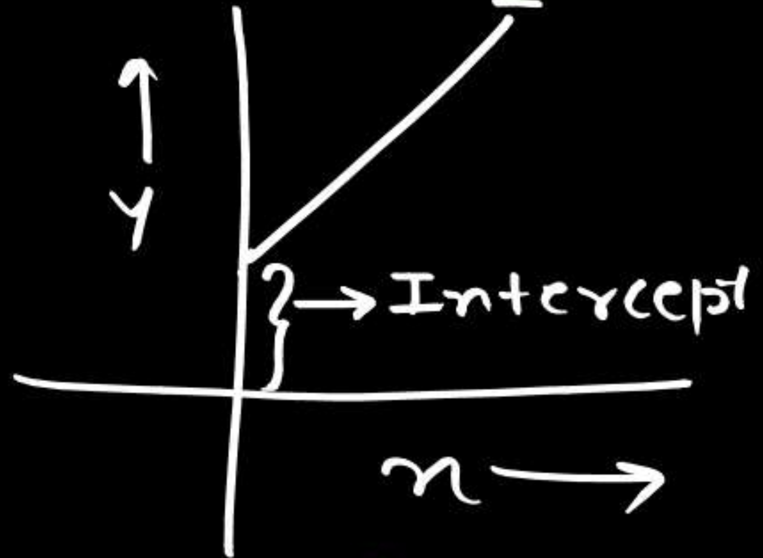


② $y \propto \frac{1}{x}$



③ $Y = mx + C \longrightarrow$ slope → +ive

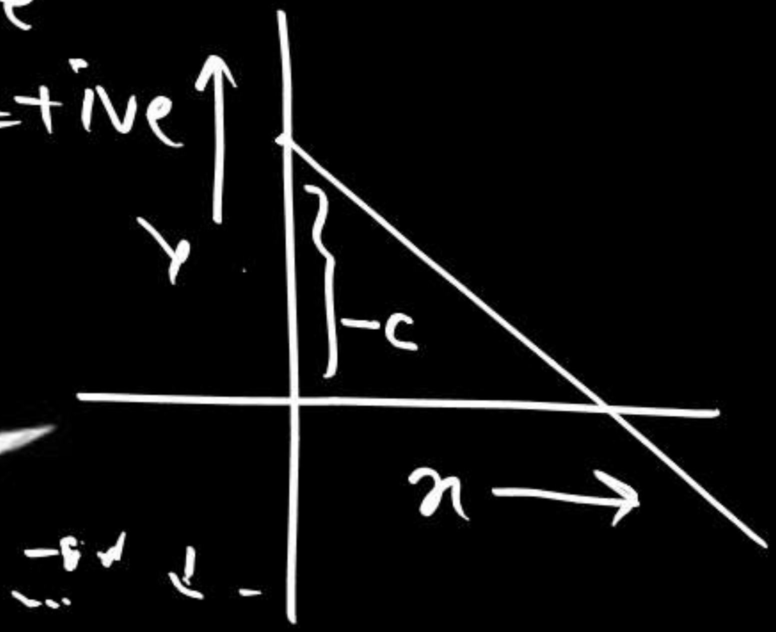
C → Intercept ⇒ +ive



④ $Y = -mx + c$

Slope = -ive

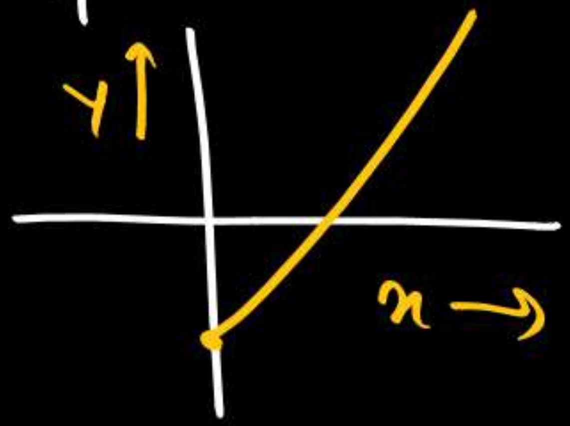
intercept = +ive



⑤ $Y = mx - c$

Slope → +ive

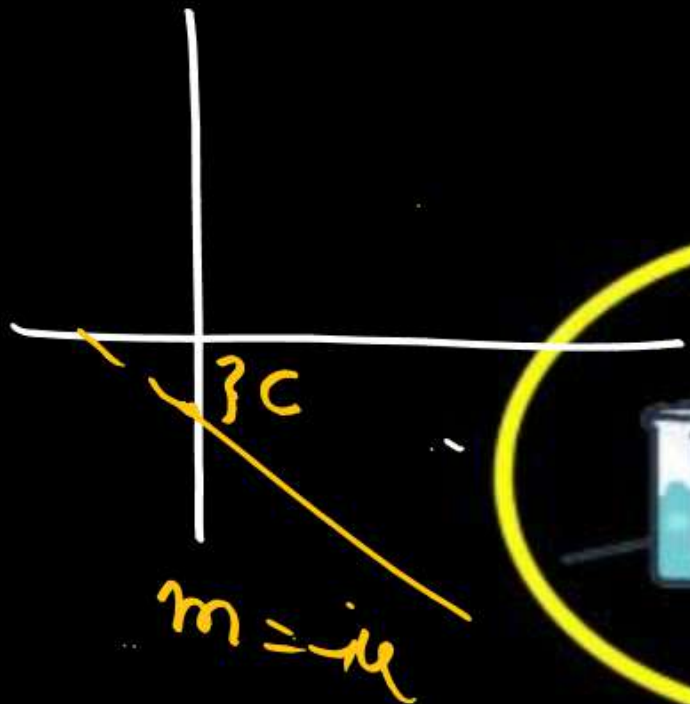
Intercept → -ive



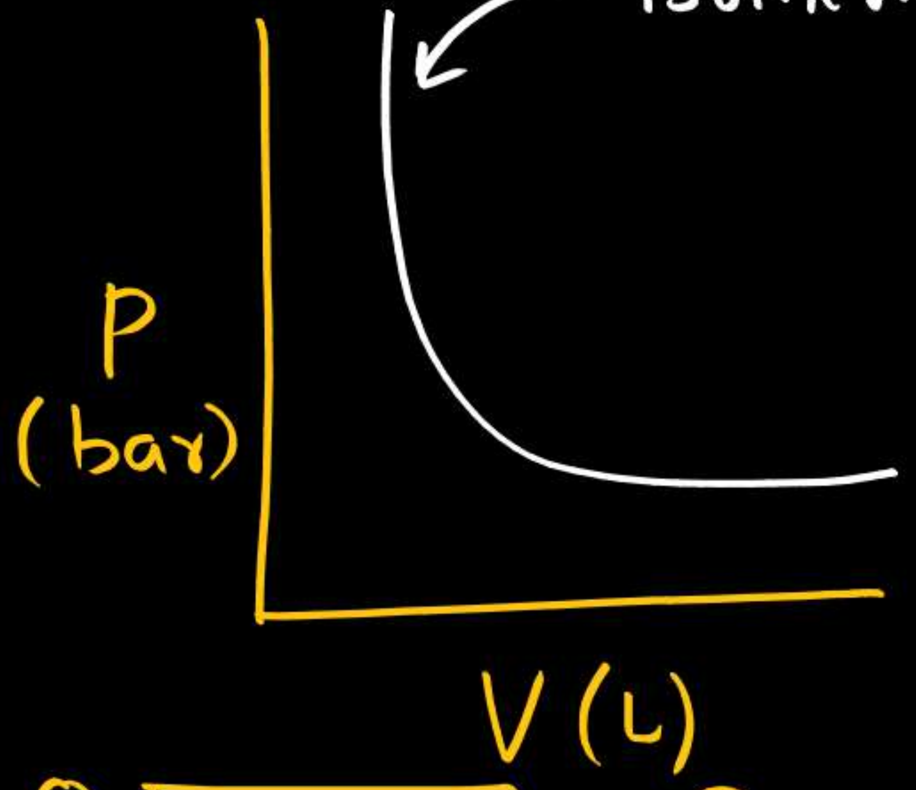
⑥ $Y = -mx - C$

slope = -ive

int = -



isotherm (the curved lines represented in the graph at const. TEMPERATURE.

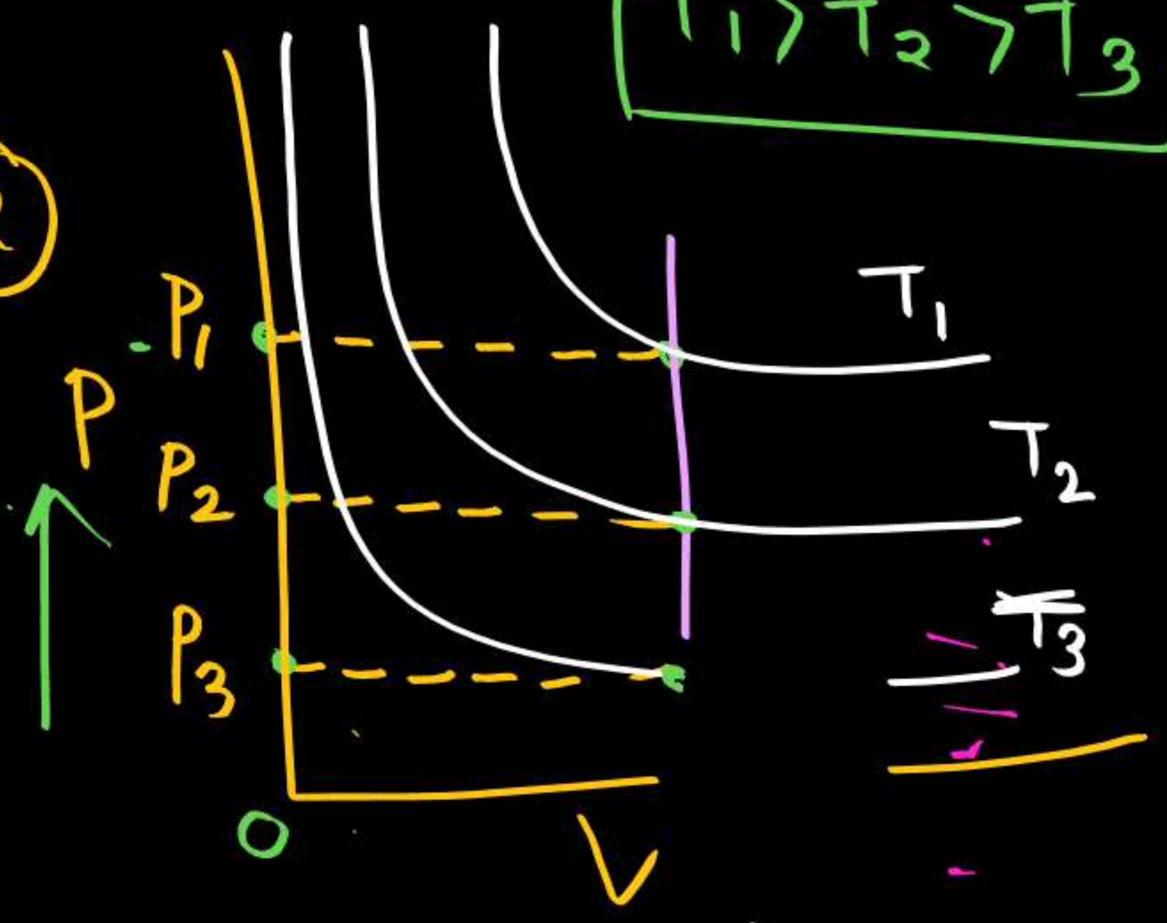


① $\boxed{P \propto \frac{1}{V}}$

②

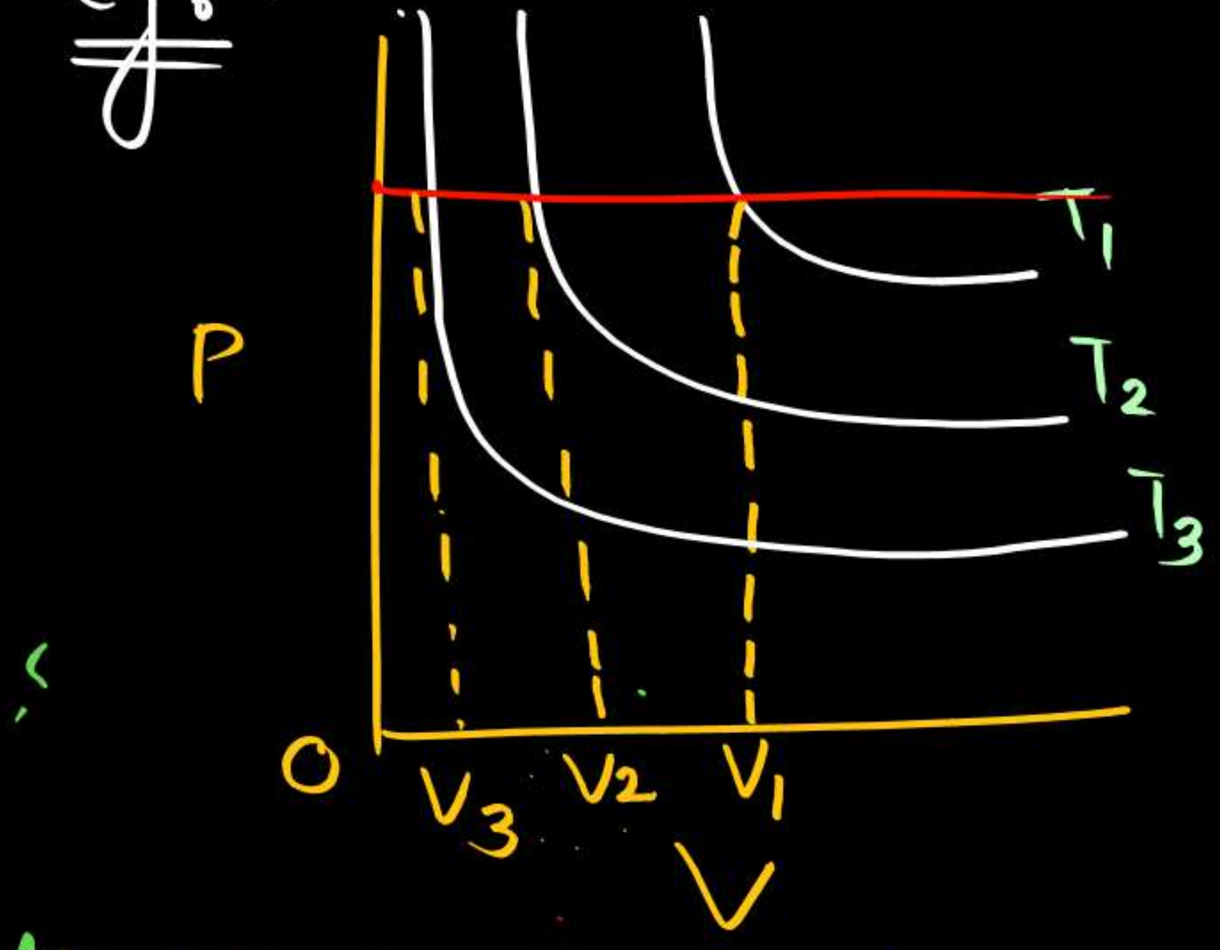
$P_1 > P_2 > P_3$

$\boxed{T_1 > T_2 > T_3}$



$PV = nRT$

Eg:-



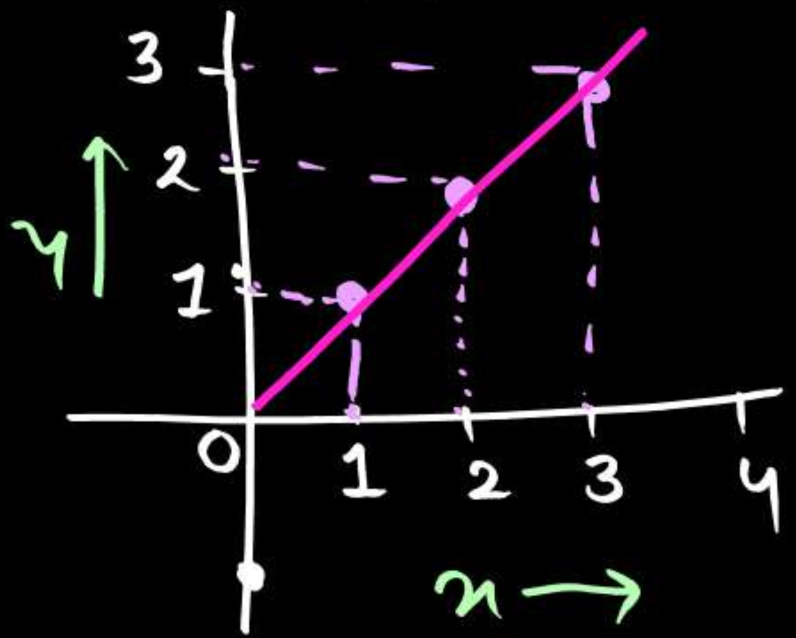
$V_1 > V_2 > V_3$

$\boxed{T_1 > T_2 > T_3}$

Rough

① $\Rightarrow \boxed{y \propto x} \Rightarrow Y = mx$ → straight line

m ↓ slope

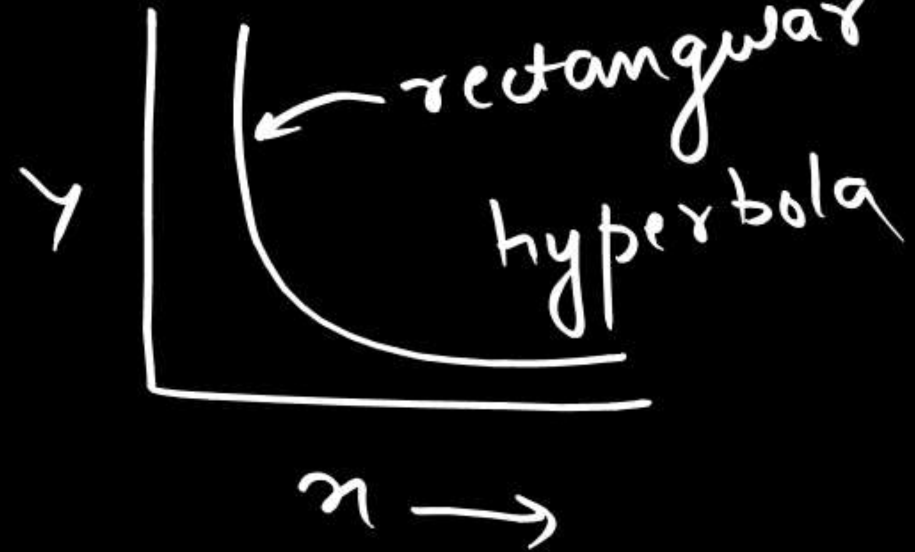


Y	1	2	3
x	1	2	3

② $y \propto \frac{1}{x}$

$xY = \text{const}$

x			
Y			

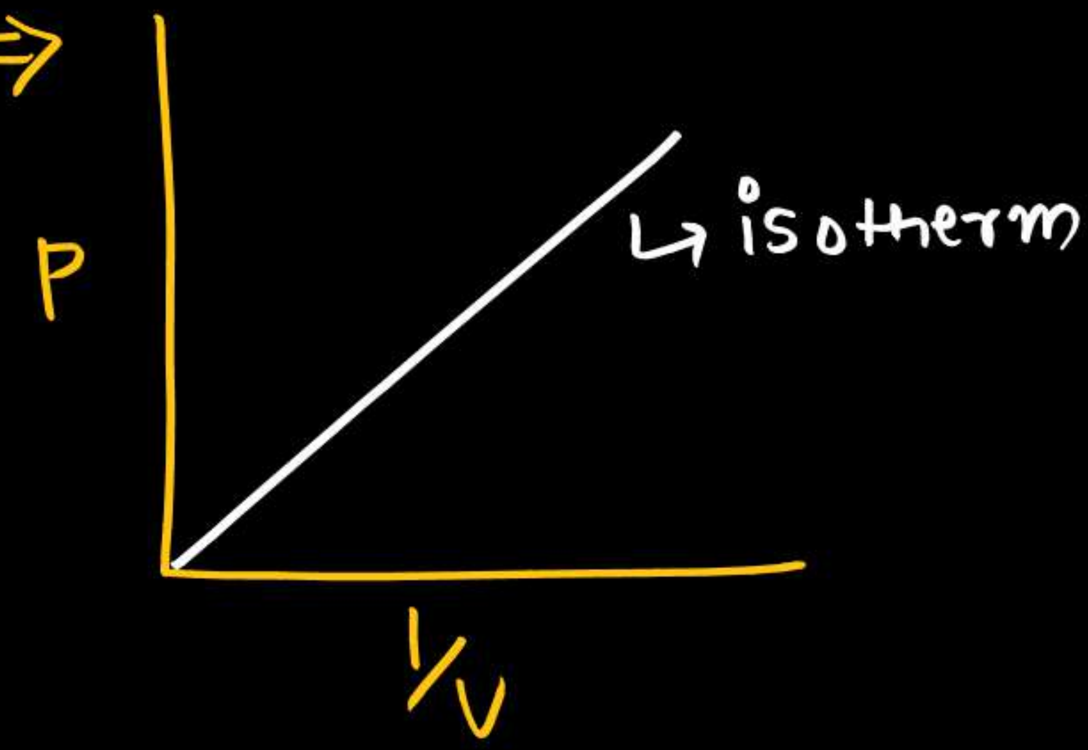


③ $Y = mx + c$

m ↓ Slope

c ↓ Intercept

⇒

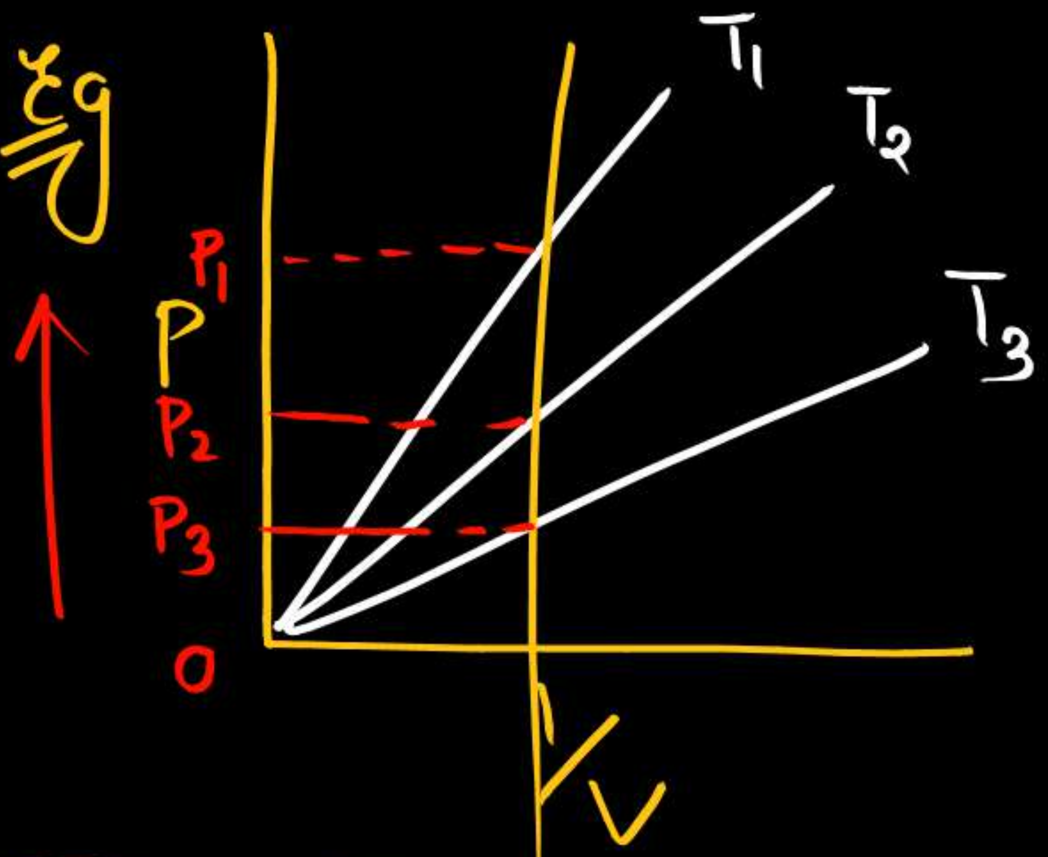


$\boxed{P} \propto \boxed{\frac{1}{V}}$

$y \qquad x$

$y \propto x$

Eg



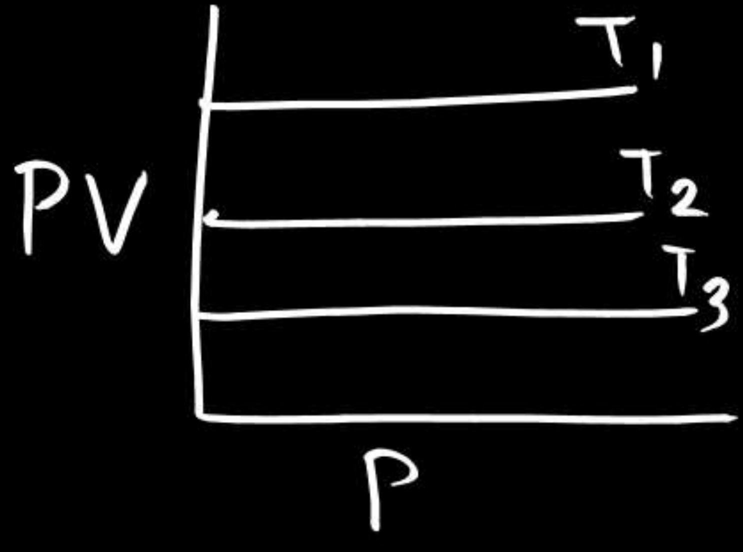
$y \propto x$

$\boxed{P_1 > P_2 > P_3}$

$P \propto T$

** $\boxed{T_1 > T_2 > T_3}$

Eg. PV v/s P



$\boxed{T_1 > T_2 > T_3}$

Relation of density with P

$P \propto \frac{1}{V}$

$P = \frac{K}{V}$

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

$V \Rightarrow \frac{M}{d}$

$$\boxed{P = \frac{K \times d}{M}}$$

$P \rightarrow$ Pressure of gas

$M \rightarrow$ Mass of gas

$d \rightarrow$ density of gas

$K \rightarrow$ Constant

Physical significant of BOYLE'S LAW

- On increasing pressure, the density of the air increases at constant temperature.

$P \uparrow, V \downarrow, d \uparrow$

$\uparrow d = \frac{w}{V \downarrow}$ $d \propto \frac{1}{V}$

- This indicates that gases are compressible.
- Air is denser at the sea level and as the altitude increases air pressure decreases, which means air now becomes less denser. So, less oxygen molecules occupy the same volume.
- Therefore oxygen in air becomes insufficient for normal breathing. Out of the result altitude sickness occurs with symptoms like headache, uneasiness.
- That is why mountaineers have to carry oxygen cylinders with them in case of emergency to restore normal breathing.

CHARLES' LAW

❖ Charles' Law states that the volume of a given mass of a gas increases or, decreases by $\boxed{\frac{1}{273.15}}$ of the volume at 0°C for each degree rise or fall in temperature respectively, provided pressure is kept constant.

$\boxed{V \propto T(K)}$

$n, P =$ constant

$\Rightarrow V_0 \Rightarrow$ Volume of gas at 0°C (Initial Volume)

$V_t \Rightarrow$ Volume of gas at t°C

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→ For $1°C$ rise in temperature, Volume increases $= \frac{1}{273.15} \times 1° \times V_0$

→ For $2°C$ rise in temperature, Volume increases $= \frac{1}{273.15} \times 2° \times V_0$

→ For $\underline{\underline{t°C}}$ rise in temperature, Volume increases $\boxed{= \frac{1}{273.15} \times \underline{\underline{t°_C}} \times V_0}$

⇒ Volume of gas at $t°C$ = Initial Volume + increase in Volume at $t°C$

$$\Rightarrow V_t = V_0 + \frac{V_0 \times t°(c)}{273.15} \Rightarrow V_0\left[1 + \frac{t°(c)}{273.17}\right]$$

$$V_{t^\circ C} = V_{0^\circ C}\left[1 + \frac{t^\circ (C)}{273.15}\right]$$

$$\Rightarrow \frac{V_{t^\circ C}}{V_{0^\circ C}} = \frac{[273.15 + t(C)]}{[273.15]}$$

→ absolute temperature

or

temperature in Kelvin scale

↓

Temperature at which Volume of gas becomes zero

$$\boxed{V \propto T(K)}$$

⇒ $V \propto T$

⇒ $\frac{V}{T}$ = Constant

⇒ $\boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$

V_1 → Initial Volume

V_2 → Final volume (

T_1 → Initial temp (K)

T_2 → Final temp (K)

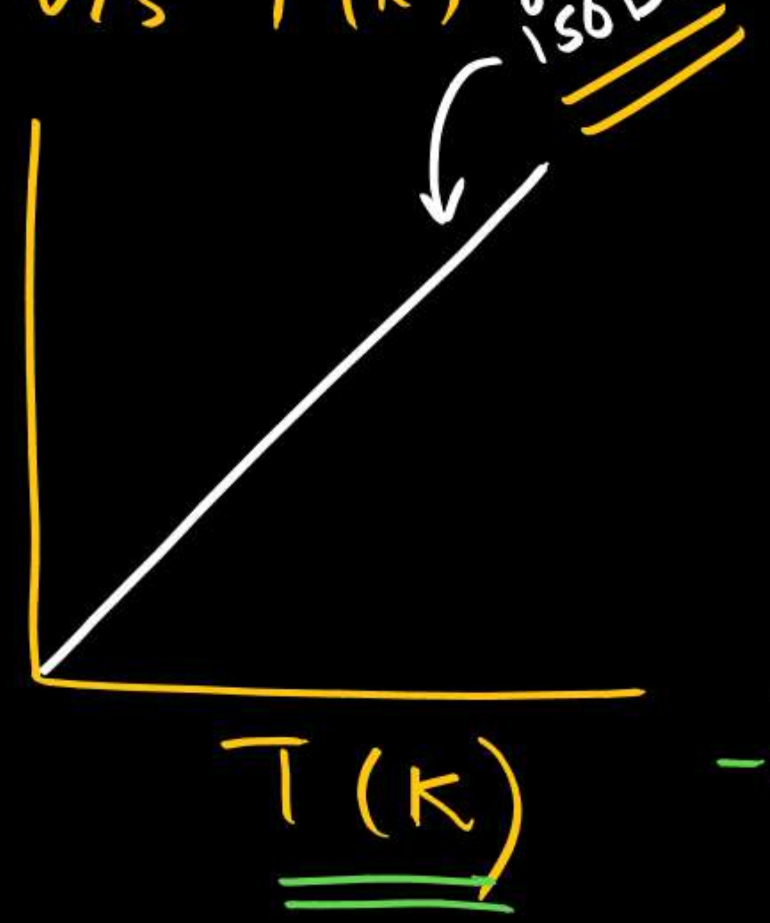
Graph

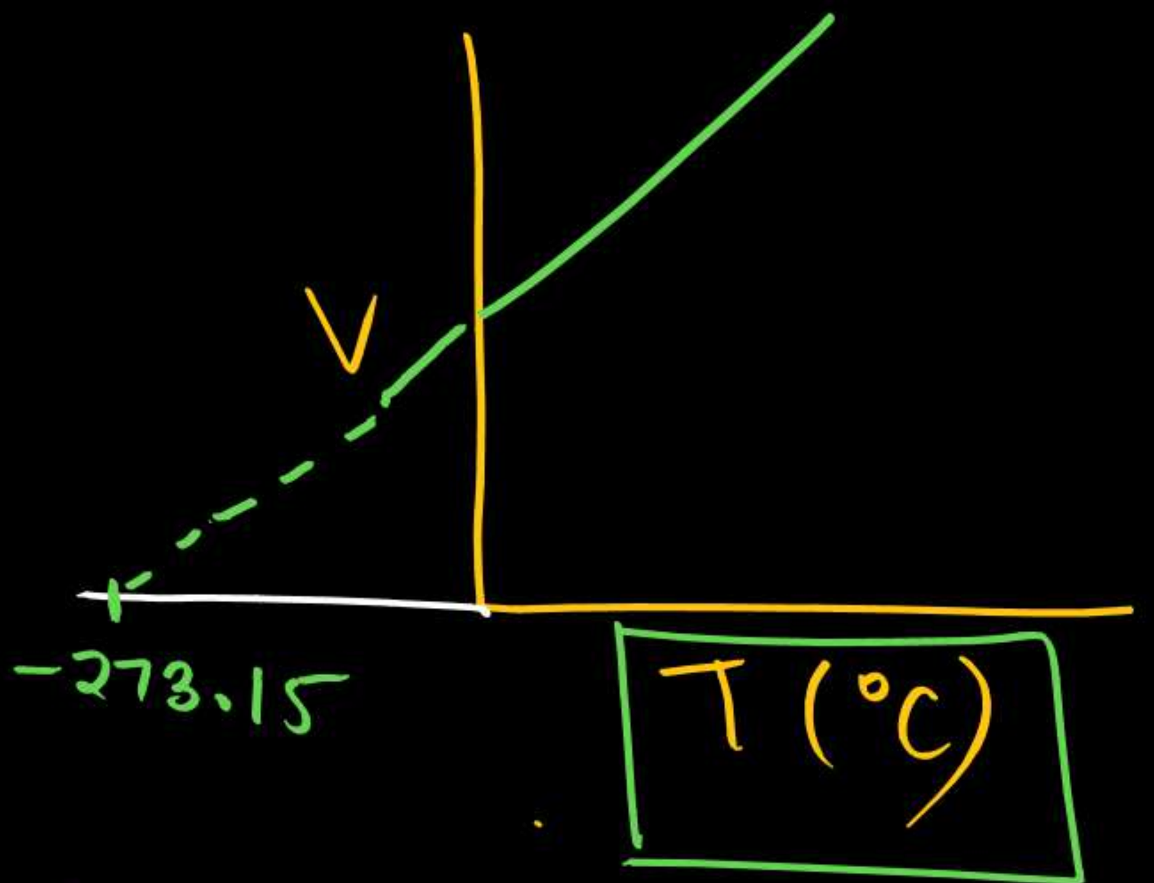
→ the curve of volume at const pressure)

V v/s T (K)

V v/s T (°C)

⇒





⇒ 0 Kelvin → Absolute temp

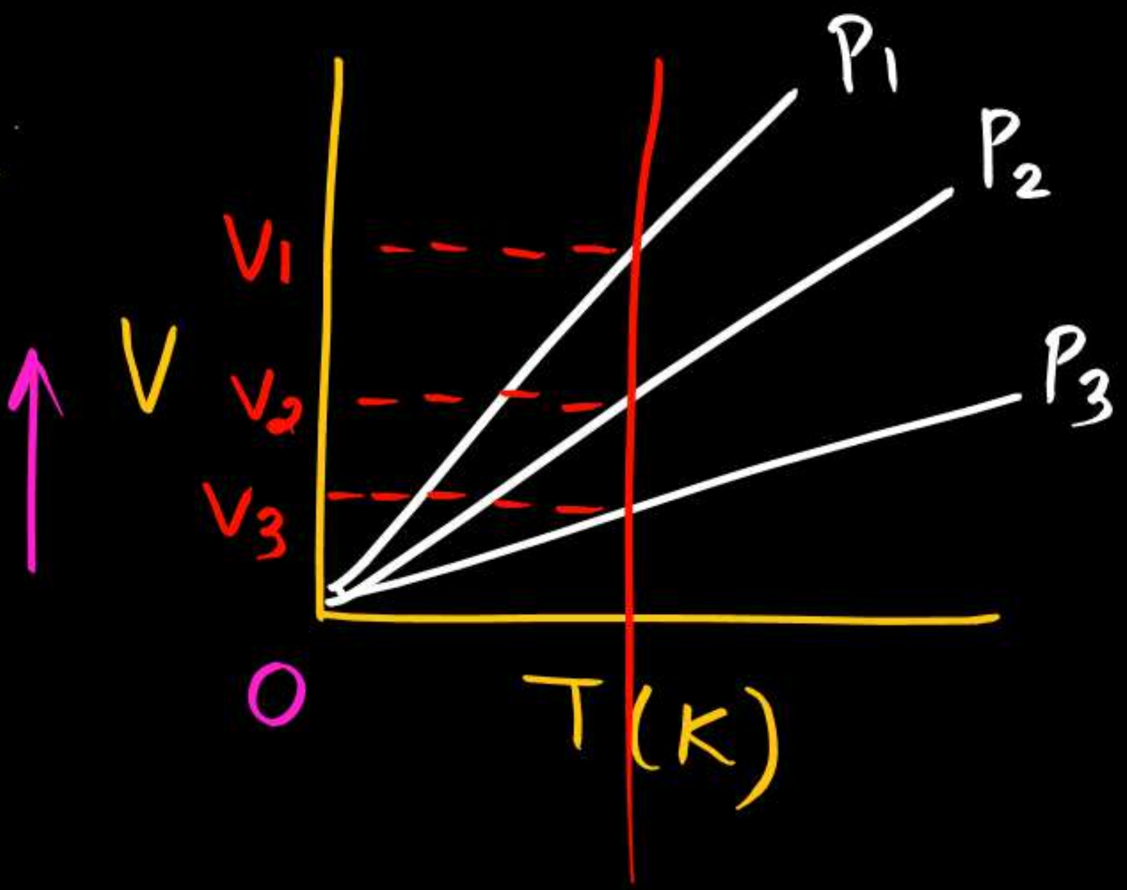
⇒ -273.15°C

0 K → ? °C

∴ ⇒ 0 − 273.15

⇒ -273.15°C

Eg



$V_1 > V_2 > V_3$ $\quad$ $P \propto \frac{1}{V}$

$$\boxed{P_3 > P_2 > P_1}$$

Physical significant of CHARLES' LAW

- Hot air balloon technology is based on $\boxed{\text{Charles Law.}}$
- On increase in temperature air expands.
- So, density of air decreases.
- The hot air in the balloon is less dense and lighter than the atmospheric air. Therefore the balloons filled with hot air rise up for meteorological observations.

$T\uparrow \; V\uparrow, \; d\downarrow$

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Q. 5L of a gas is compressed from 2 atm to 5 atm. Find decrease in volume and % decrease in volume.

H.W.

Q. The pressure of gas A (P_A) is 3.0 atm when is occupies 5 L of the volume. Calculate the final pressure when it is compressed to 3L volume at constant temperature.

(a) 5 atm (b) 2 atm

(c) 4 atm (d) 3 atm

h.w.

Q. At what temperature 25 dm^3 of oxygen at 283 K is heated to make its volume 30 dm^3 ?

(a) 339.6 K
(b) 448 K
(c) 298 K
(d) 473 K

H.W.

thanks
for watching

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