» An ideal gas is a hypothetical gas in which intermolecular force is assumed to be zero.

» An ideal gas cannot be liquefied because intermolecular force is 0.

» A real gas behaves as an ideal gas at low pressure (low density) and high temp.

» The temp. at which a gas can be liquified by applying pressure only is called critical temp.

» If the temp of the gas is above its critical temp. then the gas cannot be liquified by ~~applyid~~ applying pressure

» If the temp. of the gas is below its critical temp then the gas can be liquified by applying pressure only. The gas in this condition is called vapour. ∴ a gas below its critical temp is called vapour

» Pressure of a gas in a container is due to collission of gas molecules with the walls of the container

» Atmospheric gases is due to the weight of the gases ⊕nt in the atmosphere. Atmospheric pressure at height h is given as

$$\boxed{P = P_0 e^{-Mgh/RT}}$$

P_0 = Pressure on earth
m = molecular weight of gases

Ideal gas eq^n

a) $\boxed{PV = nRT}$ $\quad \because n = \frac{m}{M_w}$

b) $\therefore PV = \left(\frac{m}{M_w}\right) RT$ $\quad \therefore PM_w = \left(\frac{m}{V}\right) RT \Rightarrow \boxed{PM_w = \rho RT}$

c) $\because n = \frac{N}{N_A}$ $\quad \therefore PV = \left(\frac{N}{N_A}\right) RT$ $\quad \therefore \boxed{PV = NKT}$

$\because K = \frac{R}{N_A} = \frac{8.314}{6.02 \times 10^{23}} = \boxed{1.32 \times 10^{-23} \ J/K}$

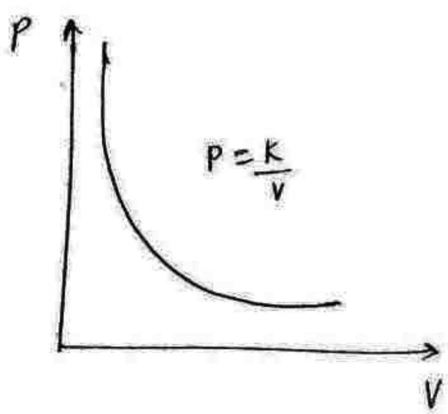
~~***~~ **Important Points:**

» when temp is constant for a given amount,

$PV = nRT \Rightarrow$ constant

$PV = K$

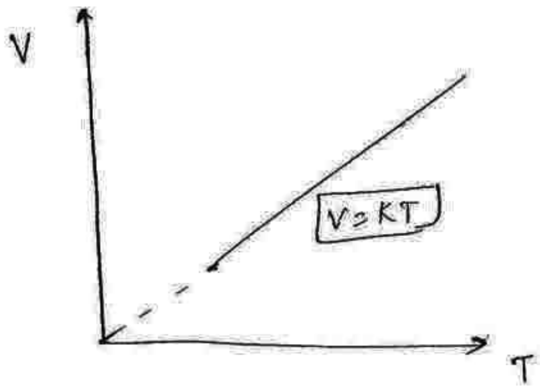
$\therefore P_1V_1 = P_2V_2$ $\quad \therefore \boxed{P \propto \frac{1}{V}}$ Boyle's law



$PV = nRT$ constant

$\therefore V = \frac{nR}{P}T$ $\quad\therefore V = KT$

$\boxed{V \propto T}$ $\boxed{\text{Charles' law}}$ C & P

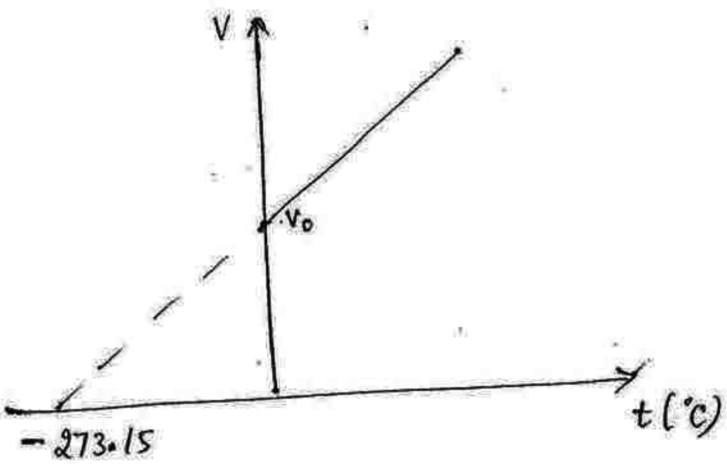


$\therefore \boxed{\frac{V_1}{V_2} = \frac{T_1}{T_2}}$

* $\frac{V_2}{V_1} = \frac{t_2 + 273.15}{t_1 + 273.15}$ (if temp is in celsius)

$\therefore \frac{V}{V_0} = \frac{t + 273.15}{0 + 273.15}$

$\therefore V = V_0\left(1 + \frac{t}{273.15}\right)$



* 0 K = absolute 0 = −273.15°C

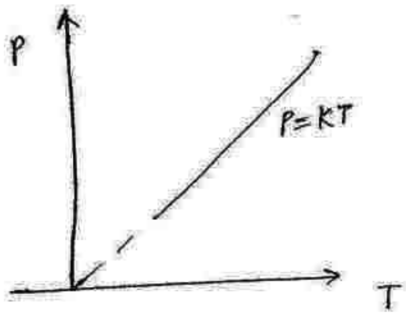
⇒ when vol^m is constant for a given amount

$$PV = nRT$$

$$P = \left(\frac{nR}{V}\right)T$$

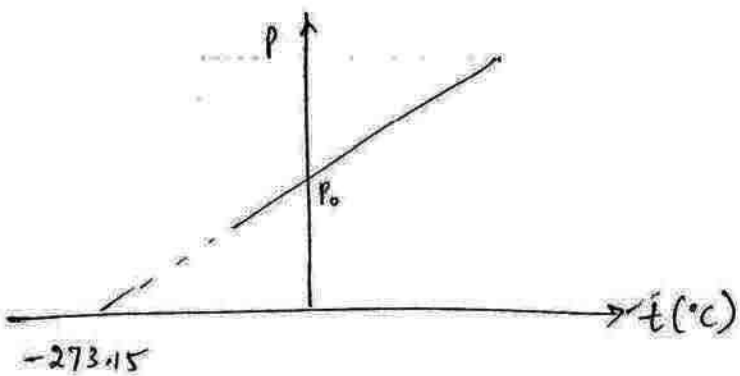
constant

$\boxed{P = KT}$ or $\boxed{P \propto T}$ $\boxed{\text{Gay Lussac Law}}$



$$\boxed{\frac{P_2}{P_1} = \frac{T_2}{T_1}}$$

$$P = P_0\left(1 + \frac{t}{273.15}\right)$$



⇒ Avogadro's Law

At the same temp and pressure, equal ~~no.~~ vol^m of all gases contains equal no. of molecules

$$PV = nRT$$

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

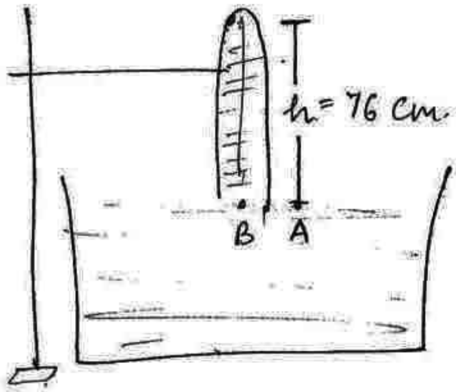
$$\therefore V = Kn \Rightarrow \boxed{V \propto n}$$

* 1 atm ⇒ 760 mm of Hg

⇒ 10.3 m of H_2O

⇒ 101325 N/m^2 (standard value)

⇒ 1.01×10^5 N/m^2 (Pascal)



$\therefore P_A = P_B.$

$P_{atm} = h\rho g$

$= 0.76 \times 13.6 \times 10^3 \times 9.8$

$\simeq 1.01 \times 10^5$ N/m^2

Q) Find the vol^m of 1 mole of an ideal gas at STP

$PV = nRT$

$\therefore V = \frac{nRT}{P} = \frac{1 \times 8.314 \times 273.15}{1.01325 \times 10^5}$

$\Rightarrow 22.4 \times 10^{-3}$ m^3 = 22.7

Q) At constant pressure, when Temp is increased by 10 K vol^m ↑es by 0.40% find T.

$PV = nRT$

$P\Delta V = nR\Delta T$

$$\frac{\Delta V}{V} = \frac{\Delta T}{T}$$

$$\frac{0.4}{100} = \frac{10}{T} \qquad \therefore T = 2500\,K$$

$$PV_1 = nRT_1$$

$$PV_2 = nRT_2$$

$$\therefore P(V_2 - V_1) = nR(T_2 - T_1)$$

Q)) At constant temp, vol^m is increased by 1%. find % change in P

$$PV = nRT = K$$

$$\therefore \frac{\Delta P}{P} + \frac{\Delta V}{V} = 0$$

$$\frac{\Delta P}{P} = -\left(\frac{\Delta V}{V}\right) = -1\%$$

i.e decreases by 1%.

Q)) At constant temp, vol^m is $\uparrow$ed by 100% Find % change in pressure

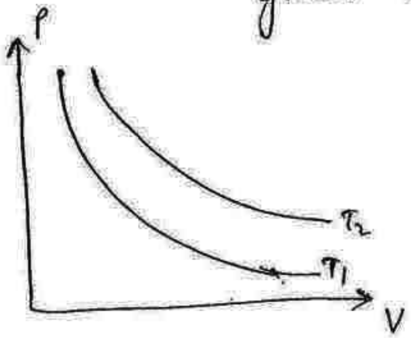
$$V_2 = V_1 + 100\% \text{ of } V_1$$

$$V_2 = 2V_1$$

$$\therefore P_1V_1 = P_2V_2 \qquad \therefore P_2 = \frac{P_1}{2}$$

i.e decreases by 50%.

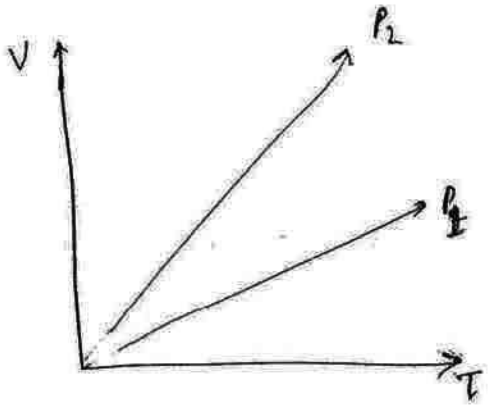
Q) Select the correct option in the following. given T_1 and T_2 = constant



a) $T_1 = T_2$ b) $T_1 > T_2$

c) $T_1 < T_2$ d) none

Q)



a) $P_1 = P_2$ b) $P_1 < P_2$

c) $P_1 > P_2$ d) none

$PV = nRT$

$$V = \left(\frac{nR}{P}\right) T$$

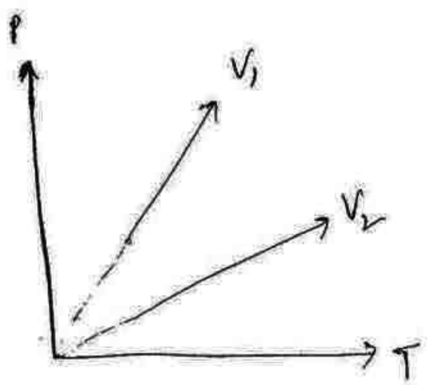
$$y = m x$$

$$\text{slope} = \frac{nR}{P}$$

$$\therefore (\text{slope})_1 < (\text{slope})_2$$

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

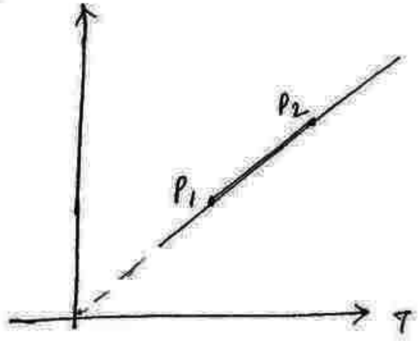
Q)



a) $V_1 = V_2$ b) $V_1 > V_2$

c) $V_2 > V_1$ d) none

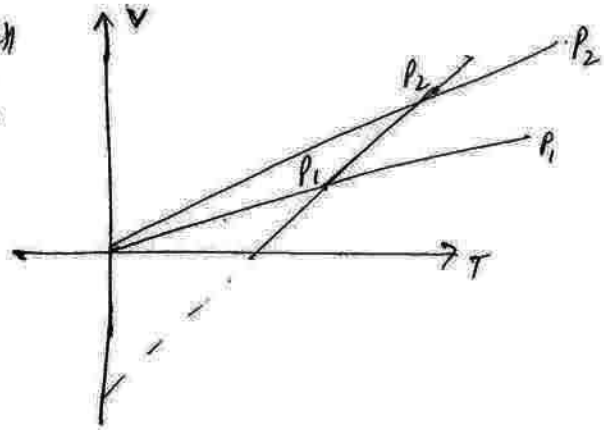
Q)



~~a)~~ $P_1 = P_2$ b) $P_1 > P_2$

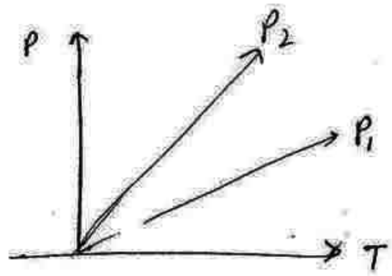
c) $P_2 > P_1$ d) none

Q)
*

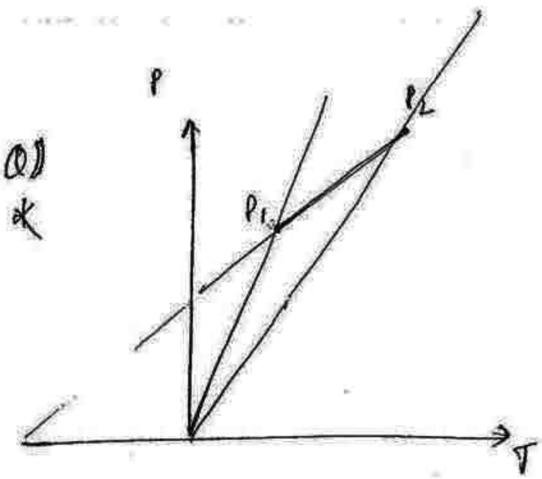


a) $P_1 = P_2$ b) $P_1 > P_2$

c) $P_2 > P_1$ d) none



Q)
*



a) $P_1 = P_2$ b) $P_1 > P_2$

~~c)~~ $P_2 > P_1$ d) none

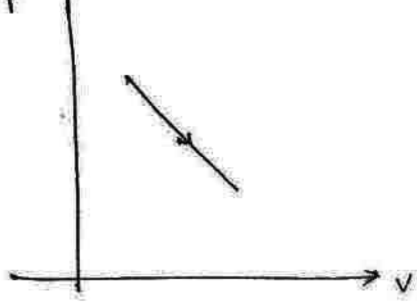
$y = mx + C$

$V = KT - C \quad \text{—(1)}$

$PV = nRT$

$P = \frac{nRT}{V} = \frac{nRT}{KT - C} \quad \therefore P = \frac{nR}{K - \frac{C}{T}}$

$T\uparrow, \ \frac{C}{T}\downarrow, \ \left(K - \frac{C}{T}\right)\uparrow \quad \therefore P\downarrow$



i) T is constant

ii) T ↓

iii) T ↑

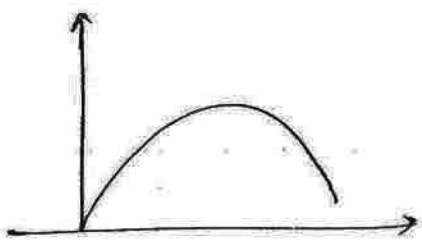
~~iv)~~ T first ↑ then ↓es

$y = mx + c$

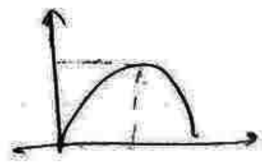
$P = -KV + C$ — (1)

$\because PV = nRT$

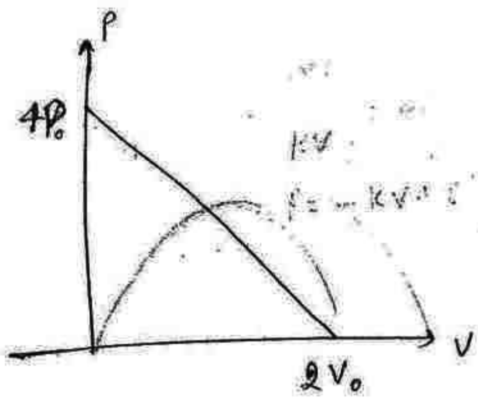
$\therefore T = \frac{PV}{nR} = \frac{-KV^2 + CV}{nR} = -aV^2 + bV$



* $y = ax - bx^2$



Q)



find:

i) Vol^m when temp is max

ii) Pressure when temp is max

iii) Max. Temp

Temp will be max at mid point.

i) $V_{Max} = V_0$

ii) $P_{Max} = 2P_0$

iii) $PV = nRT \quad \therefore T = \frac{PV}{nR} \quad \therefore T_{Max} = \frac{2P_0V_0}{nR}$

Q) A gas follows the process $PV^2 = K$ and its
* initial state is P_0, V_0 and T_0. find:

i) Pressure when vol^m is $2V_0$

ii) Temperature when vol^m is $4V_0$

iii) Pressure when temp is $2T_0$

i) $PV^2 = K$

$$\therefore P_1 V_1^2 = P_2 V_2^2$$

$$\therefore P_0 V_0^2 = P_2 (2V_0)^2 = 4 P_2 V_0^2$$

$$\therefore P_2 = \frac{P_0 V_0^2}{4 V_0^2} \Rightarrow \frac{P_0}{4}$$

ii) ~~nRT~~ $PV^2 = K$

$$\left(\frac{nRT}{V}\right) V^2 = K$$

$$\therefore TV = \frac{K}{nR} = K_1 \rightarrow \text{new constant}$$

$$\therefore T_1 V_1 = T_2 V_2$$

$$T_0 V_0 = T_2 \, 4V_0 \qquad \therefore T_2 = \frac{T_0}{4}$$

iii) $PV^2 = K$

$$P\left(\frac{nRT}{P}\right)^2 = K$$

$$\frac{T^2}{P} = \frac{K}{n^2 R^2} = K_2 \text{ is new constant}$$

$$\therefore \frac{T_1^2}{P_1} = \frac{T_2^2}{P_2} \qquad \therefore \frac{T_0^2}{P_0^2} = \frac{4T_0^2}{P_2^2}$$

$$\therefore P_2 = 4P_0$$

* $1+\left(\frac{V}{V_0}\right)^2$

find change in temp of the gas when vol^m ↑es from V_0 to $2V_0$

$V = V_0 \qquad P_1 = \frac{P_0}{2}$

$V = 2V_0 \qquad P_2 = \frac{P_0}{5}$

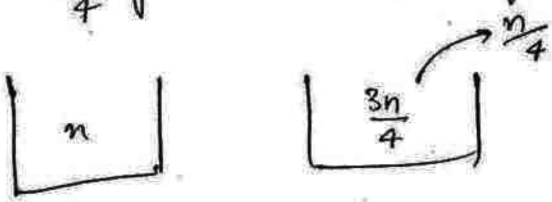
$\therefore \Delta T = T_2 - T_1$

$= \frac{P_2 V_2}{nR} - \frac{P_1 V_1}{nR}$

$\therefore \Delta T = \frac{1}{nR}\left[\frac{P_0}{5}(2V_0) - \frac{P_0}{2}V_0\right]$

$\therefore \Delta T = \frac{1}{nR}\left(\frac{4P_0V_0 - 5P_0V_0}{10}\right) = \boxed{\frac{-P_0V_0}{10nR}}$

Q) An open container is at 27°c find the temp
* at which $\frac{1}{4}$ of air escaped from the container



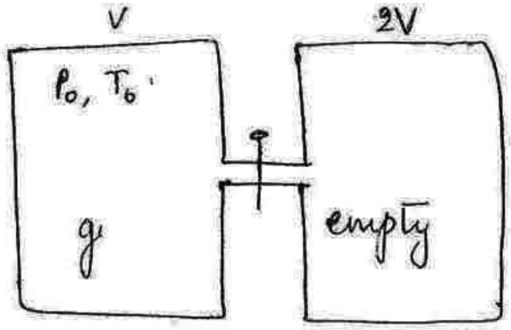
$PV = nRT$

$\therefore n_1T_1 = n_2T_2$

$\therefore n \times 300 = \frac{3n}{4} T_2$

$\therefore T_2 = 400\,K \Rightarrow 127°C$

Q) *



Find the pressure of the gas when value is open

$n_i = n_f$

$\therefore \dfrac{P_0 V}{RT_0} = \dfrac{PV}{RT_0} + \dfrac{P(2V)}{RT_0}$ OR

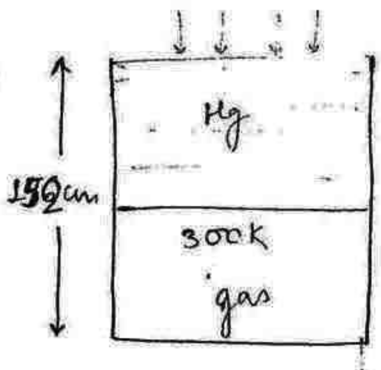
$\therefore \boxed{P = \dfrac{P_0}{3}}$

$P = \dfrac{nRT}{V}$

$\therefore \dfrac{P_1}{P_2} = \dfrac{V_2}{V_1}$

$\dfrac{P_0}{P_2} = \dfrac{3V}{V} \quad \therefore P_2 = \dfrac{P_0}{3}$

Q) **



Find the temp at which half of mercury overflows

$P_1 = P_{Hg} + P_{atm} = 1 + 1 = 2\,atm$

$\therefore V_1 = 76A \quad T_1 = 300\,K$

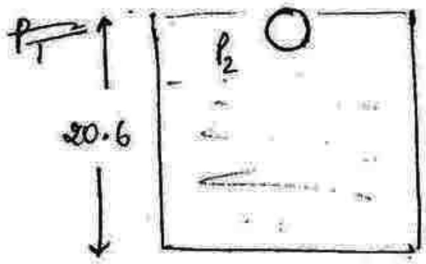
$P_2 = P_{Hg} + P_{atm} = \dfrac{1}{2} + 1 = \dfrac{3}{2}\,atm$

$V_2 = 114\,A, \; T_2 = ?$

$\therefore \dfrac{P_1 V_1}{T_1} = \dfrac{P_2 V_2}{T_2} \Rightarrow \dfrac{2 \times 76A}{300} = \dfrac{3}{2} \times \dfrac{114A}{T_2}$

$\therefore T_2 = 337.5$

Q) An air bubble of vol ... the depth of 20.6 m in a lake. Find its vol^m as it reaches on the surface.



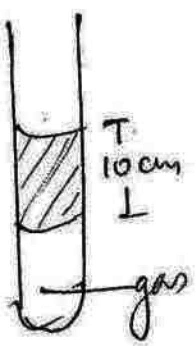
$$P_1 = P_w + P_{atm} = 2 + 1 = 3 \text{ atm.}$$

$$P_2 = P_a = 1 \text{ atm}$$

$$P_1 V_1 = P_2 V_2$$

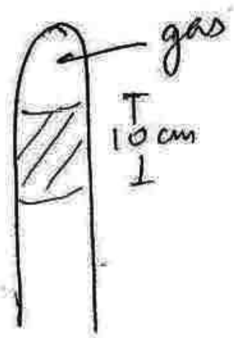
Q) Find pressure of the gas, length of mercury col^m is 10 cm

i)



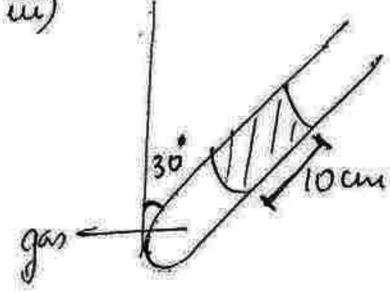
$$P = P_{Hg} + P_{atm}$$
$$= (10 + 76) \text{ cm of Hg}$$
$$= 86 \text{ cm of Hg}$$

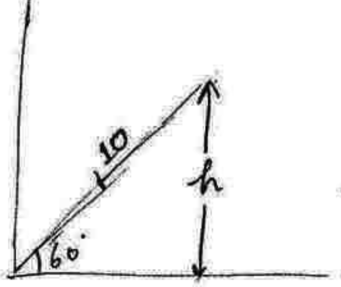
ii)



$$P_a = P_{Hg} + P$$
$$\therefore P = P_a - Hg$$
$$= 76 - 10 = 66 \text{ cm of Hg}$$

iii)





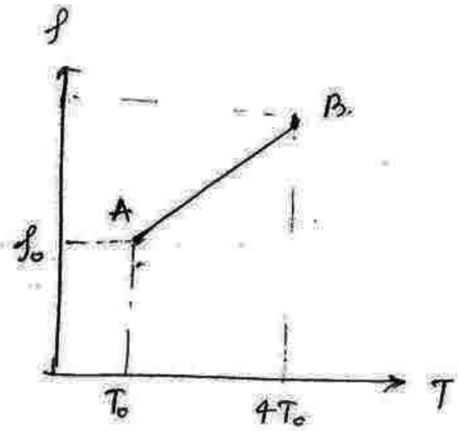
$\sin 60° = \frac{h}{10}$

$h = 10 \cos 30 = (5\sqrt{3})$

$\therefore P = P_{Hg} + P_{atm}$

$= (5\sqrt{3} + 76)$ cm.

Q)



Find density of the gas at B

$P_A M_w = \rho_A R T_A$

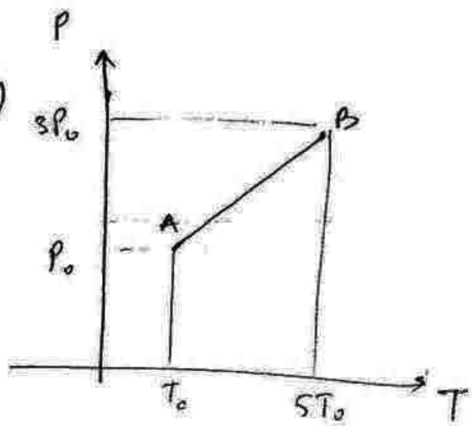
$P_B M_w = \rho_B R T_B$

$\therefore \frac{P_B}{P_A} = \frac{\rho_B}{\rho_A}\left(\frac{T_B}{T_A}\right)$

$\therefore \frac{P_B}{P_A} = \frac{\rho_B}{\rho_0}\left(\frac{4\cancel{T_0}}{\cancel{T_0}}\right)$

$\therefore \rho_B = \left(\frac{P_B}{4P_A}\right)\rho_0.$

Q)

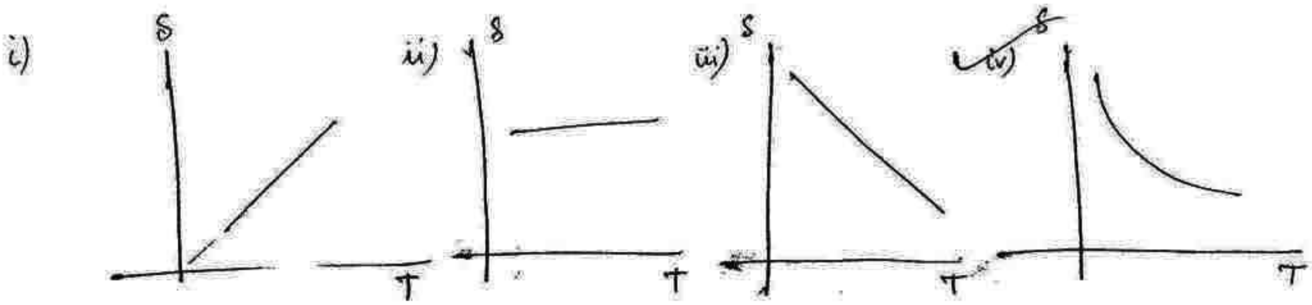


If $\rho_A = \rho_0$, then find density at B

$$\therefore \frac{P_B}{P_A} = \frac{\rho_B}{\rho_A}\left(\frac{T_B}{T_A}\right) \Rightarrow \frac{3P_0}{P_0} = \frac{\rho_B}{\rho_0}\left(\frac{5T_0}{T_0}\right)$$

$$\therefore \rho_B = \frac{3}{5}\rho_0$$

Q) The pressure of the gas is constant and $\delta = \frac{\Delta V}{V \Delta T}$, then select the correct option



$$PV = nRT$$

$$P \cdot \Delta V = nR\Delta T$$

$$\therefore \frac{\Delta V}{V} = \frac{\Delta T}{T}$$

$$\therefore \frac{\Delta V}{V\Delta T} = \frac{1}{T} \quad \text{i.e} \quad \boxed{\delta = \frac{1}{T}}$$