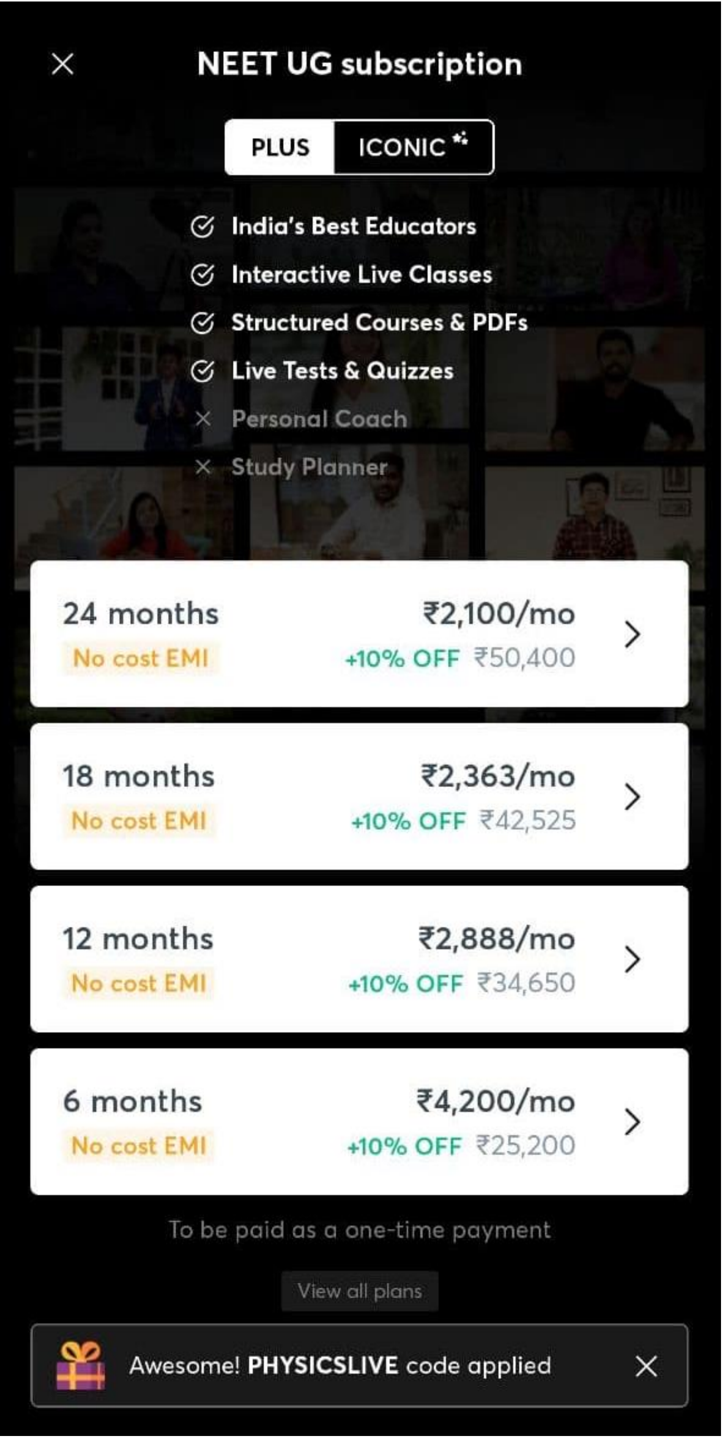
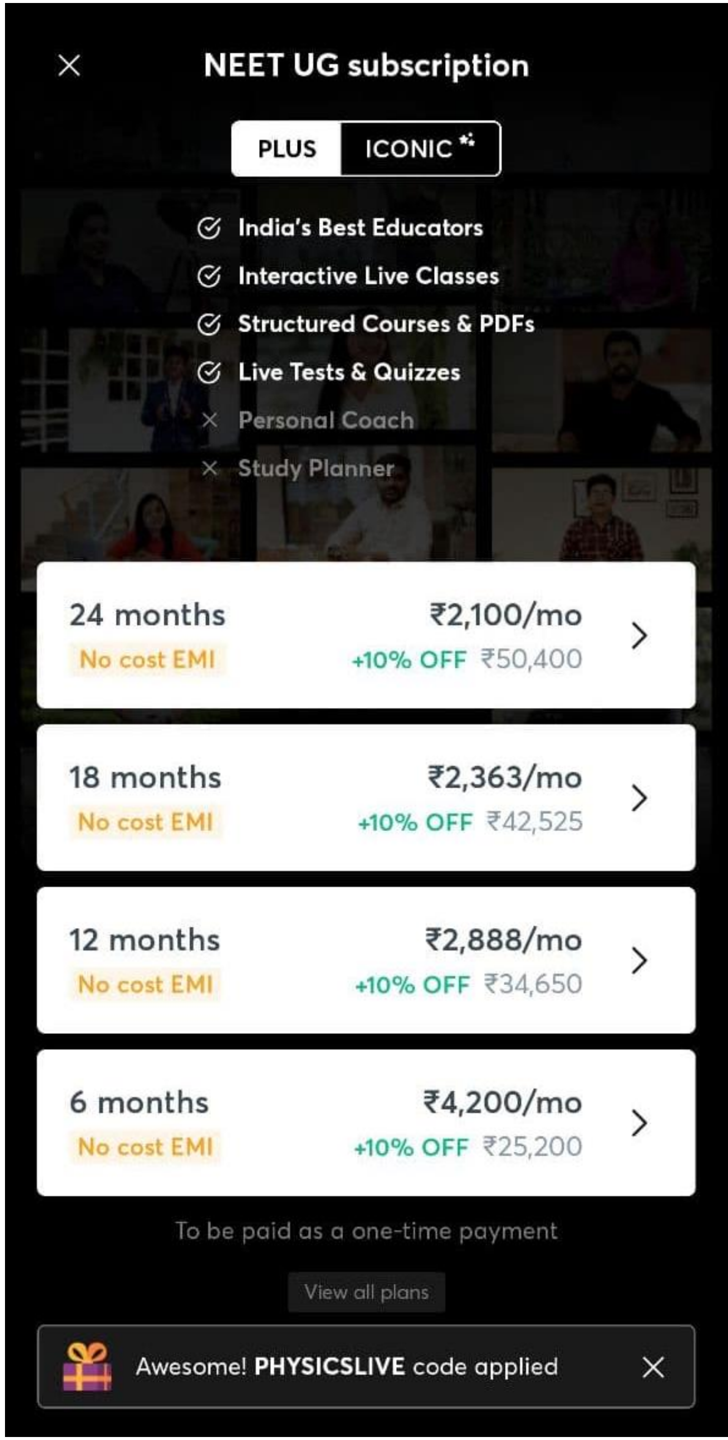
SIR PRATEEK JAIN

. Founder @Physicsaholics
. Top Physics Faculty on Unacademy (IIT JEE & NEET)
. 8+ years of teaching experience in top institutes
like FIITJEE (Delhi, Indore) , CP (KOTA) etc.
. Produced multiple Top ranks.
. Research work with HC Verma sir at
IIT Kanpur
. Interviewed by International media.



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS and learn from India's Top Faculties.



For Video Solution of this DPP, Click on below link

Video Solution on Website:-

https://physicsaholics.com/home/courseDetails/58

Video Solution on YouTube:-

https://youtu.be/uUgK5PMvkDo

JEE Main & Advanced, NSEP, INPhO, IPhO

Physics DPP

DPP- 3 KTG: Kinetic Energy of Gas, Degree of freedom of gas molecules

By Physicsaholics Team

Q) A gas mixture consists of 2 moles of oxygen and 4 moles of argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is:

(a) 4 R T

(b) 5 R T

(c) 15 R T

(d) 11 R T

Ans. d

Solution:

Internal energy of a gas $U = \frac{f}{2} nRT$

$$U_{oxygen} = \frac{5}{2} \times 2RT = 5RT$$

$$U_{organ} = \frac{3}{2} \times 4RT = 6RT$$

$$U_{total} = 11RT$$

ANS (d)

unacademy

Q) The molecules of an ideal gas have 6 degrees of freedom. The temperature of the gas is T. The average translational kinetic energy of its molecules is:

(a) $\frac{3}{2}$k T

(b) $\frac{6}{2}$ k T

(c) k T

(d) $\frac{1}{2}$ k T

Ans. a

Solution:

Av. energy associated with each degree of freedom $= \frac{1}{2}KT$

degree of freedom of K.E. $= 3$

average translational KE $= \frac{3}{2}KT$

ANS (a)

unacademy

Q) The average translational kinetic energy of O_2 (molar mass 32) molecules at a particular temperature is 0.048 eV. The translational kinetic energy of N_2 (molar mass 28) molecules in eV at the same temperature is –

(a) 0.0015
(b) 0.003
(c) 0.048
(d) 0.768

Ans. c

Solution:

Average translational KE of a molecule does not depend on molar mass. At same temperature It is same for all gases.

ANS (c)

Q) A gas sample is enclosed in a closed container, temperature of gas is continuously increasing. Match the correct options in column-ll corresponding to column-l

Column I		Column II
(a)Internal energy of gas	(P)	Increases
(b)Average momentum of gas molecules	(q)	Decreases
(c)Number of molecules moving with most probable speed	(r)	Zero
(d) $\frac{V_{avg}}{V_{rms}}$	(s)	Remains constant

Ans. a(p) , b(r, s) , c(q) , d(s)

Solution:

(a) $U = \frac{f}{2} nRT \rightarrow$ U increases on increasing T

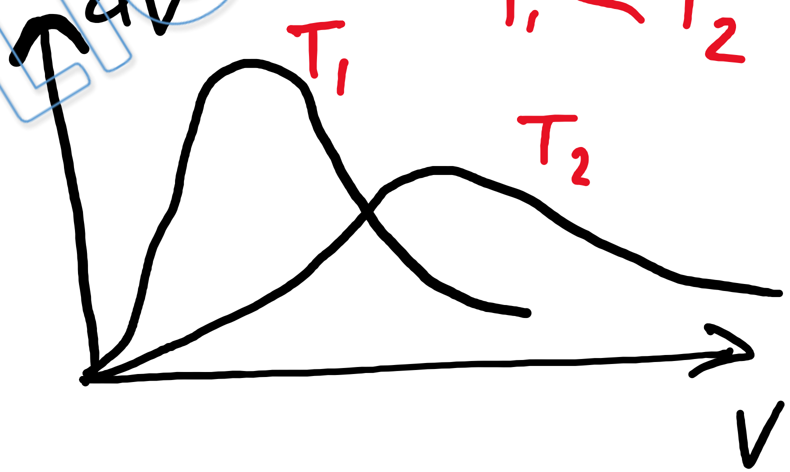
$a \rightarrow p$

(b) Since $\overrightarrow{V_{av}} = \vec{0} \Rightarrow \overrightarrow{P_{av}} = \vec{0}$

$b \rightarrow r, s$

(c) maxima of graph shows no of molecules having most probable velocity.

It decreases on increasing temperature



$c \rightarrow q$

(d) $\dfrac{V_{av}}{V_{rms}} = \dfrac{\sqrt{8RT/\pi M}}{\sqrt{3RT/M}} = \sqrt{\dfrac{8}{3\pi}}$

$= \text{Constant}$

$d \rightarrow s$

Q) Temperature of an ideal gas is 300 K. The change in temperature of the gas when its volume changes from V to 2V in the process $P = aV$ (Here, a is a positive constant) is:

(a) 900 K
(b)1200 K
(c) 600 K
(d) 300 K

Ans. a

Solution:

$$T = \frac{PV}{nR} = \frac{aV^2}{nR} \propto V^2$$

$V \rightarrow 2$ times

$\Rightarrow T \rightarrow 4$ times

final temperature $= 300 \times 4$

$= 1200\ K$

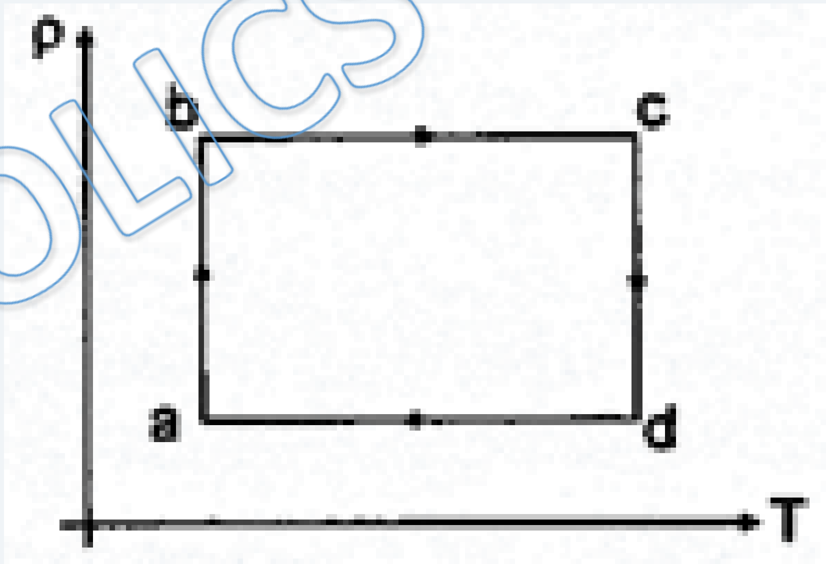
change in temperature $= 900\ K$

ANS (a)

unacademy

Q) In the ρ-T graph shown in figure, match the following:

Table-1		Table-2	
(a)	Process a-b	(p)	Constant volume
(b)	Process b-c	(q)	$\Delta U = 0$
(c)	Process c-d	(r)	P increasing
(d)	Process d-a	(s)	P decreasing



Ans. a(q, r) , b(p, r) , c(q, s) , d(p, s)

Solution:

(a) $T = \text{Constant} \Rightarrow \Delta U = 0$; ρ is increasing

$$\rho = \frac{PM}{RT} \Rightarrow P = \frac{\rho RT}{M} \Rightarrow P \text{ is increasing}$$

$a \rightarrow q, r$

(b) $\rho = \text{Constant}$, T is increasing

$$P = \frac{\rho RT}{M} \Rightarrow P \text{ is increasing}$$

$$\rho = \text{Constant} \Rightarrow \frac{P}{T} = \text{Constant} \Rightarrow V = \text{Constant}$$

$b \rightarrow p, r$

(c) ρ is decreasing , T is Constant

$\Downarrow$ $\qquad\qquad$ $\Downarrow$

P is decreasing $\qquad$ $\Delta U = 0$

$c \rightarrow q, s$

(d) ρ is Constant , T is decreasing

$\Downarrow$ $\qquad\qquad$ $\Downarrow$

V is Constant $\qquad$ $\Delta U \neq 0$ & $P = \dfrac{\rho RT}{M}$

$\Downarrow$

P is decreasing

$d \rightarrow p, s$

Q) One mole of an ideal gas undergoes a process $P = \frac{P_0}{1+\left(\frac{V_0}{V}\right)^2}$. Here, P_0 and V_0 are constants. Change in temperature of the gas when volume is changed from $V = V_0$ to $V = 2V_0$ is :

(a) $-\frac{2P_0V_0}{5R}$ (b) $\frac{11P_0V_0}{10R}$ (c) $-\frac{5P_0V_0}{4R}$ (d) P_0V_0

Ans. b

Solution:

$$P = \frac{P_0}{1+\left(\frac{V_0}{V}\right)^2}$$

at $V = V_0$, $P = \frac{P_0}{1+1} = \frac{P_0}{2} \Rightarrow T_1 = \frac{P_0V_0}{2R}$

at $V = 2V_0$, $P = \frac{P_0}{1+\frac{1}{4}} = \frac{4P_0}{5} \Rightarrow T_2 = \frac{4P_0 \times 2V_0}{5R}$

change in temperature

$$\Delta T = \frac{P_0V_0}{R}\left[\frac{8}{5} - \frac{1}{2}\right] = \frac{11 P_0 V_0}{10 R}$$

ANS (b)

unacademy

Q) Two containers of equal volume contain the same gas at pressures p_1 and p_2 and absolute temperatures T_1 and T_2 respectively. On joining the vessels, the gas reaches a common pressure p and a common temperature T. The ratio P/T is equal to

(a) $\frac{p_1}{T_1} + \frac{p_2}{T_2}$

(b) $\frac{1}{2}\left[\frac{p_1}{T_1} + \frac{p_2}{T_2}\right]$

(c) $\frac{p_1 T_2 + p_2 T_1}{T_1 + T_2}$

(d) $\frac{p_1 T_2 - p_2 T_1}{T_1 - T_2}$

Ans. b

Solution:

$V \rightarrow$ volume of one container

n_1 & n_2 are no of moles in containers.

$$n_1 = \frac{P_1 V}{R T_1} \quad , \quad n_2 = \frac{P_2 V}{R T_2}$$

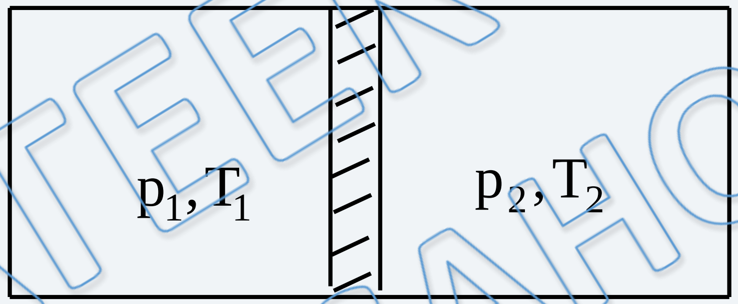
$$\frac{P}{T} = \frac{nR}{2V} = \frac{(n_1 + n_2)R}{2V} = \frac{n_1 R}{2V} + \frac{n_2 R}{2V}$$

$$= \frac{P_1}{2T_1} + \frac{P_2}{2T_2}$$

ANS (b)

COMPREHENSION –

Figure shows a cylindrical tube of volume V with adiabatic walls containing an ideal gas. The internal energy of this gas is given by 1.5 nRT. The tube is divided into two equal parts by a fixed diathermic wall.



Initially the pressure and temperature on the two sides are p_1, T_1 and p_2, T_2 respectively. The system is left for sufficient time so that the temperature becomes equal on the two sides.

Q) What is the ratio of pressures on the left and right sides?

(a) p_2T_2/p_1T_1

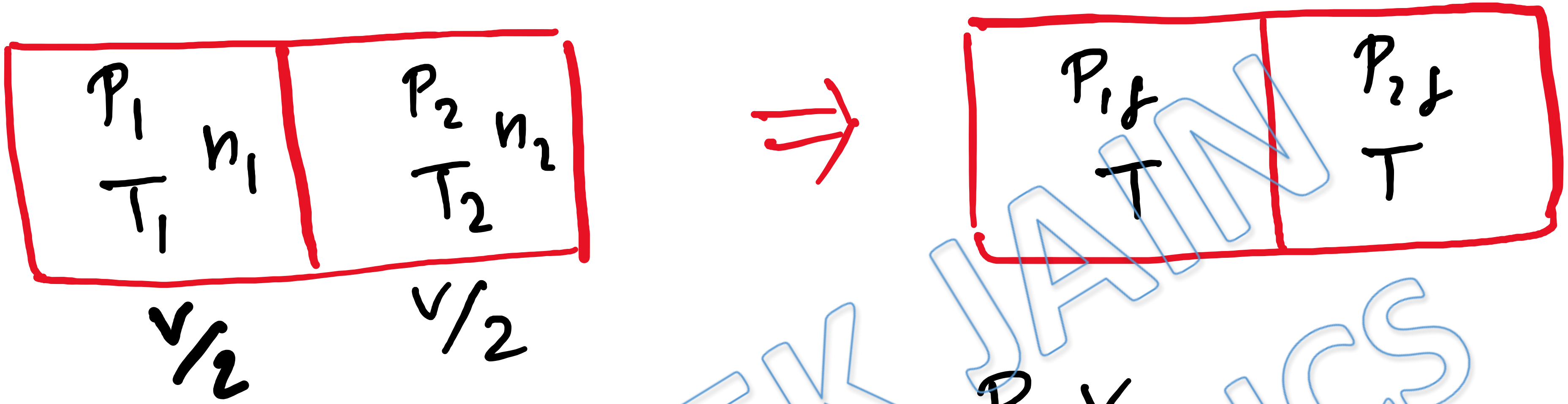
(b) p_1T_2/p_2T_1

(c) $\frac{p_1+p_2}{T_1+T_2}$

(d) $\frac{p_1T_1}{p_2T_2}$

Ans. b

Solution:



$$n_1 = \frac{P_1 V}{2RT_1}, \quad n_2 = \frac{P_2 V}{2RT_2}$$

$$\frac{P_{1f}}{P_{2f}} = \frac{n_1 RT/\cancel{V/2}}{n_2 RT/\cancel{V/2}} = \frac{n_1}{n_2} = \frac{P_1 T_2}{P_2 T_1}$$

Ans (b)

Q) What is the final equilibrium temperature?

(a) $\dfrac{T_1T_2(p_1+p_2)}{p_1T_2+p_2T_1}$

(b) $\dfrac{p_1p_2(T_1+T_2)}{p_1T_2+p_2T_1}$

(c) $\dfrac{T_1T_2(p_1+p_2)}{p_1T_1+p_2T_2}$

(d) $\dfrac{T_1^2p_2^2}{p_1T_2+p_2T_1}$

Ans. a

Solution:

Internal energy loss by left + Internal energy gain by right = 0

$$\Rightarrow \frac{f}{2} n_1 R (T-T_1) + \frac{f}{2} n_2 R (T-T_2) = 0$$

$$\Rightarrow \frac{n_1}{n_2}(T-T_1) + (T-T_2) = 0$$

$$\Rightarrow \frac{P_1 T_2}{P_2 T_1}(T-T_1) + (T-T_2) = 0$$

$$\Rightarrow T(P_1 T_2 + P_2 T_1) = P_1 T_1 T_2 + P_2 T_1 T_2$$

$$\Rightarrow T = \frac{(P_1 + P_2) T_1 T_2}{P_1 T_2 + P_2 T_1}$$

Ans (a)

For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/58

Video Solution on YouTube:- https://youtu.be/uUgK5PMvkDo

Chalo Niklo