DPP – 2 (KTG)

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Q 1. The change in momentum of a molecule moving with momentum p colliding stationary wall of the container can not be

(a) p/2 (b) 2p

(c) 3p (d) p

Q 2. A gas is kept in a closed container, a small hole is made in container and due to hole gas is leaking out (Temperature of sample is constant).

	Column I		Column II
(A)	Pressure of gas	(P)	Increases
(B)	Frequency of collisions of a molecule with wall of container	(q)	Decreases
(C)	Momentum transferred to wall by a molecule per collision	(r)	Remain constant
(D)	Energy of gas sample	(s)	Zero

Q 3. N molecules each of mass (m) of gas (A) and 2N molecules, each of mass (2m) of gas (B) are contained in the same vessel which maintained at a temperature (T). The mean square of the velocity of molecules of (B) type is denoted by (v^2) and the mean square of the (X) component of the velocity of (A) type is denoted by (w^2) then w^2 / v^2 is -

(a) 2 (b) 1

(c) 1/3 (d) 2/3

Q 4. Cooking gas container are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will –

(a) Increase

(b) Decrease

(c) Remain same

(d) Decrease for some, while increase for others

Q 5. The mass of hydrogen molecule is 3.32×10^{-27} kg. If 10^{23} hydrogen molecules strike per second at 2 cm^2 area of a rigid wall at an angle of 45^0 from the normal and rebound back with a speed of 1000 m/s, then the pressure exerted on the wall is

(a) 2.34×10^3 Pascal

(b) 0.23×10^3 Pascal

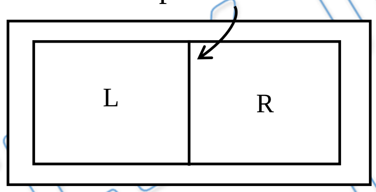
(c) 0.23×10^3 Pascal

(d) 23.4×10^3 Pascal

Q 6. When a gas is forced in a smaller volume without change in temperature, its pressure increases because its molecules –
(a) Strike the unit area of the container walls more often.
(b) Strike the unit area of the container walls at higher speed.
(c) Strike the unit area of the container wall with greater momentum.
(d) Have more energy.

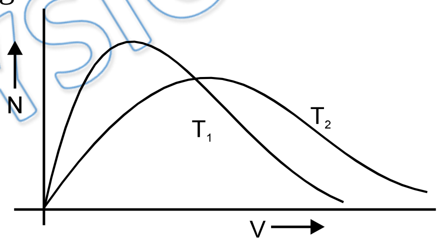
Q 7. A sample of a gas is kept in a closed container and temperature is increased. Which of the following is true?
(a) Pressure is increased because momentum transferred per collision to wall is increased
(b) Pressure is decreased
(c) Pressure is increased because frequency of collision is decreased
(d) Both (1) & (3) are correct

Q 8. A vessel is partitioned in two equal halves by a fixed diathermic separator. Two different ideal gases are filled in left (L) and right (R) halves. The rms speed of the molecules in L part is equal to the mean speed of molecules in the R part. Then the ratio of the mass of a molecules in L part to that of a molecules in R part is



(a) $\frac{3}{2}$ (b) $\frac{\pi}{4}$
(c) $\frac{2}{3}$ (d) $\frac{3\pi}{8}$

Q 9. Maxwell's velocity distribution curve is given for the same quantity two different temperatures. For the given curves.



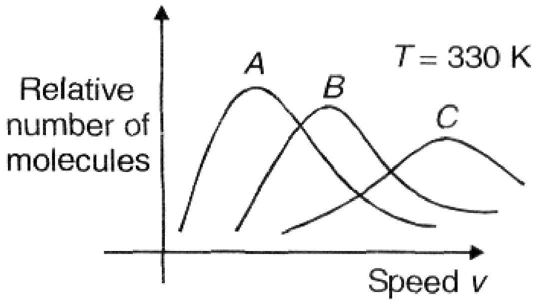
(a) $T_1 > T_2$ (b) $T_1 < T_2$
(c) T_1 £ T_2 (d) $T_1 = T_2$

Q 10. The ratio of r.m.s. speed to the r.ms. angular speed of a diatomic gas at certain temperature is: (assume m = mass of one molecule, M = molecular mass, I = moment of inertia of the molecules)
(a) $\sqrt{\frac{3}{2}}$ (b) $\sqrt{\frac{3I}{2M}}$ (c) $\sqrt{\frac{3I}{2m}}$ (d) 1

Q 11. The average velocity of molecules of a gas of molecular weight M at temperature T is:
(a) 0 (b) $\sqrt{\frac{3RT}{M}}$ (c) $\sqrt{\frac{8RT}{\pi M}}$ (d) $\sqrt{\frac{2RT}{M}}$

Q 12. The velocities of three molecules are 3v, 4v and 12v respectively. Their rms speed will be
(a) 3.1v
(b) 17 v
(c) 7.5 v
(d) Cannot say temperature is not provide

Q 13. Maxwell distribution function is shown in figure from different gases, which of the following is correct matching?



(a) A → Ne, B → O_2, C →He
(b) A → Ne, B → He, C → O_2
(c) A → O_2, B → He, C → Ne
(d) A → O_2, B→ Ne, C → He

Q 14. The root mean square (rms) speed of hydrogen molecules at a certain temperature is 300 m/s. If temperature is doubled and hydrogen gas dissociates into atomic hydrogen the r.m.s. speed will become :
(a) 424.26 m/s (b) 300 m/s
(c) 600 m/s (d) 150 m/s.

Q 15. Let v, v_{rms} and v_p respectively denote the mean speed, root mean square speed and most probable speed of the molecules of an ideal monoatomic gas at absolute temperature T. Mass of a gas molecule is m. Then :
(a) no molecule can have a speed greater than $\sqrt{2}v_{rms}$
(b) no molecule can have speed less than $v_p/\sqrt{2}$
(c) $v_p < v < v_{rms}$
(d) the average kinetic energy of a molecule is $\frac{3}{4}mv_p^2$.

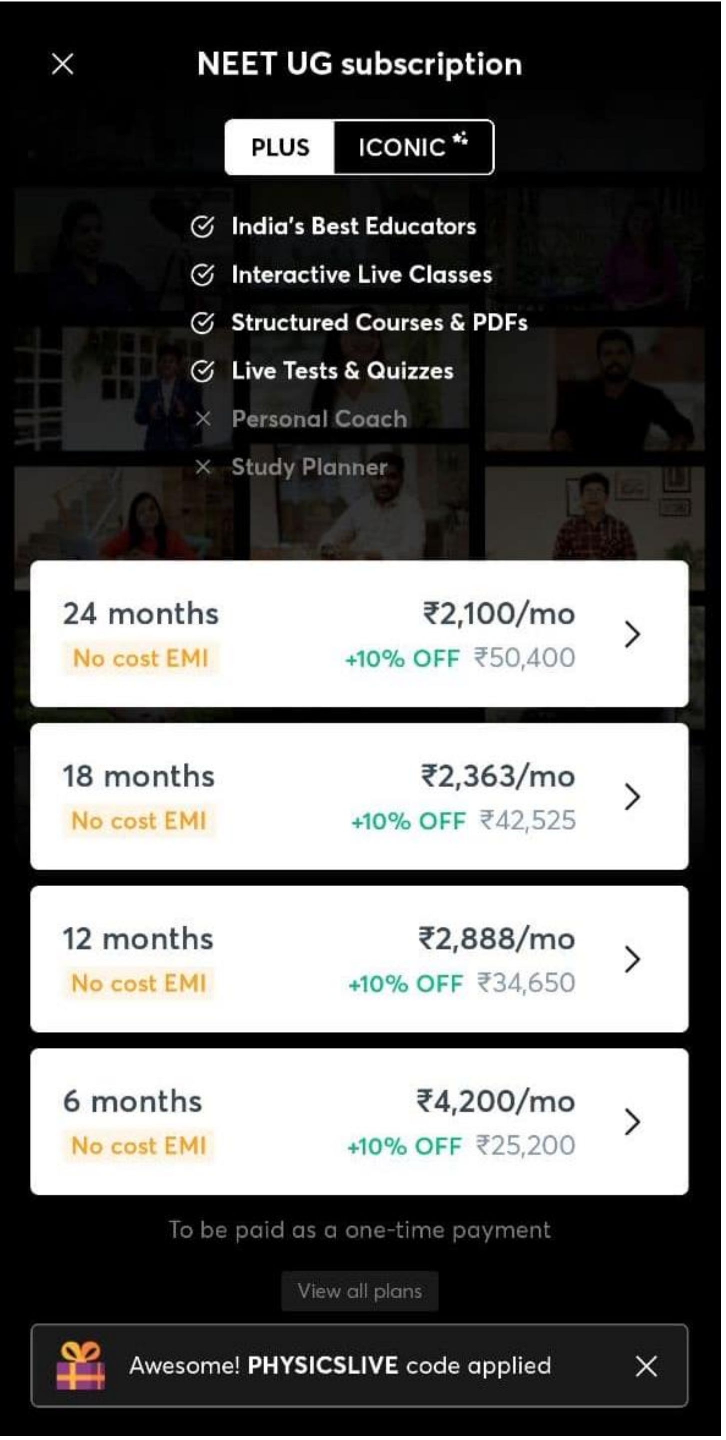
Q 16. On increasing temperature area under maxwells speed distribution curve of a gas sample
(a) increases (b) decreases
(c) Remains same (d) none of these

Q 17. Three closed vessels A, B and C are at the same temperature and contain gases which obey the Maxwellian distribution of velocities. Vessel A contain only O_2, B only N_2 and C a mixture of equal quantities of O_2 and N_2. If the average speed of O_2 molecules in vessel A is v_1, that of the N_2 molecules in vessel B is v_2, the average speed of the O_2 molecules in vessel C is –

(a) $(v_1 + v_2)/2$ (b) v_1
(c) $(v_1v_2)^{½}$ (d) $\sqrt{(3kT/M)}$

Answer Key

Q.1 c	Q.2 A(q), B(r), C(r), D(q)	Q.3 d	Q.4 c	Q.5 a
Q.6 a	Q.7 a	Q.8 d	Q.9 b	Q.10 c
Q.11 a	Q.12 a	Q.13 d	Q.14 c	Q.15 c,d
Q.16 c	Q.17 b			



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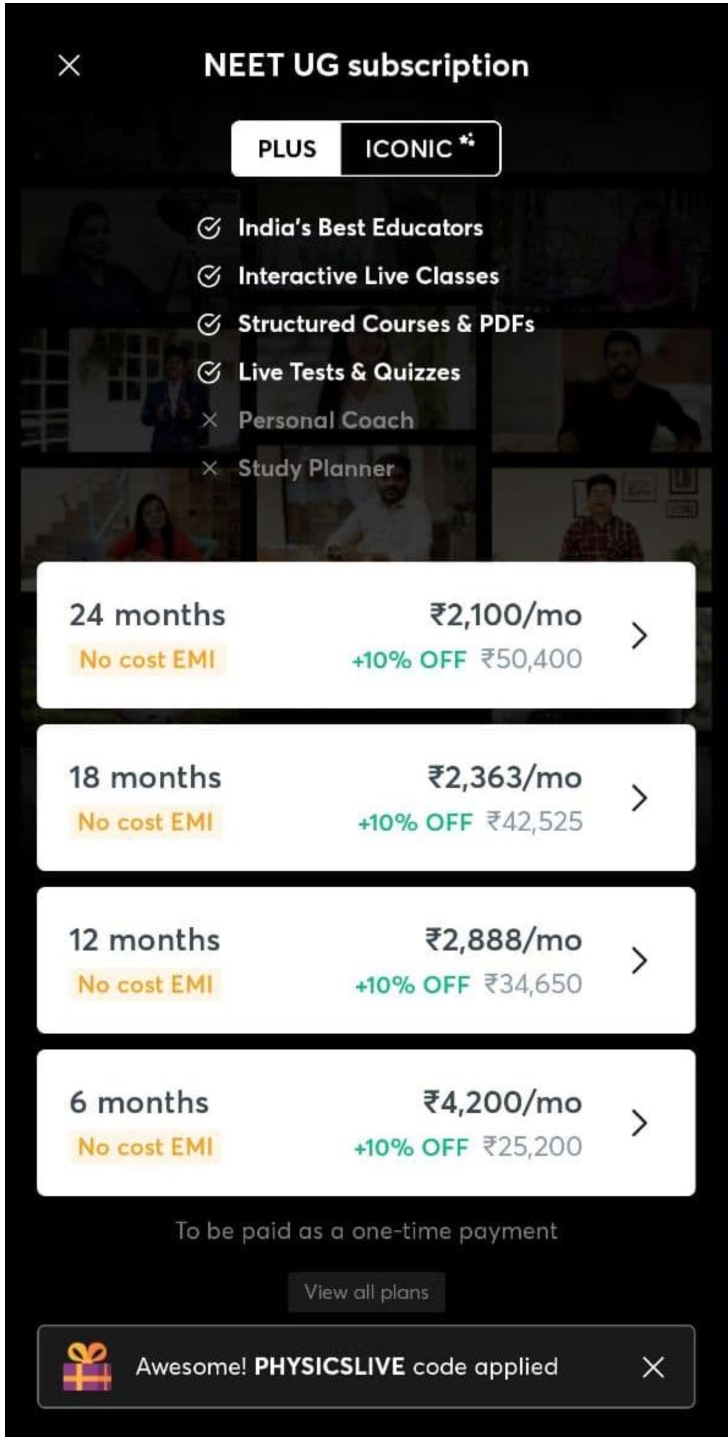


Written Solution

DPP-2 KTG: Momentum Transfer, Different type of Velocity and speed of gas molecules

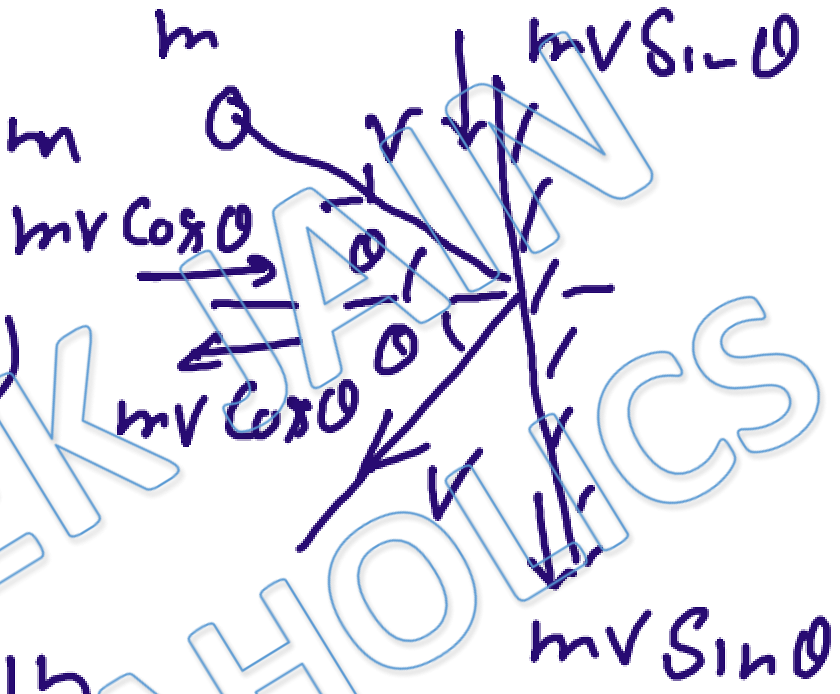
By Physicsaholics Team

Solution: 1

change in momentum

$= (mv\cos\theta) - (mv\cos\theta)$

$= 2mv\cos\theta$



maximum change in momentum $= 2mv$ at $\theta = 0^\circ$

change in momentum can not be 3P.

ANS (C)

Solution:2

(A) $P \propto n$, as n decreases

Pressure also decreases

(B) frequency of collision of a molecule with wall of Container $= \frac{V_x}{2l} \Rightarrow$ same as before

Since V_x depends on temperature which is constant.

(C) momentum transferred to wall by a molecule per Collision $= 2mV_x$

$\Rightarrow$ same as before

(d) Energy of gas $\propto nT$

as n decreases, Energy also decreases.

Ans. A(q) B(r) D(q)

Solution:3

$$v_{rms}^2 = \frac{3RT}{M}$$

$$v_{x\,rms}^2 = \frac{1}{3} \times v_{rms}^2 = \frac{RT}{M}$$

$$w^2 = \frac{RT}{M_A}$$

$$v^2 = \frac{3RT}{M_B}$$

$$\frac{w^2}{v^2} = \frac{M_B}{3M_A} = \frac{2}{3}$$

Ans. (D)

Solution:4

Temperature depends on velocity of gas molecules w.r.t. Container.

⇒ Temperature will remain same.

Ans.c

Solution:5

momentum change of one molecule during collision

$$= 2P\cos\theta = 2\times 3.32\times 10^{-27}\times 1000\times \cos 45$$

net change in momentum of all molecules

$$= N(2P\cos\theta)$$

$$\text{Pressure} = \frac{N(2P\cos\theta)}{A}$$

$$= \frac{10^{23}\times 2\times 3.32\times 10^{-27}\times 10^{3}\times 1/\sqrt{2}}{2\times 10^{-4}}$$

$$= 2.34\times 10^{3}\ Pa$$

Ans.a

Solution:6

When a gas is forced in smaller volume at constant temperature, momentum of gas particles remains same but molecules collide with wall more frequently due to which P increases

ANS (a

Solution:7

Pressure in a container depends on

1) Collision frequency with wall

11) momentum transfer per Collision

on increasing temperature both will increase.

Ans. (a)

Solution:8

Since piston is diathermic, both sides have equal temperature.

rms speed of L part = mean speed of R part

$$\Rightarrow \sqrt{\frac{3RT}{M_1}} = \sqrt{\frac{8RT}{\pi M_2}}$$

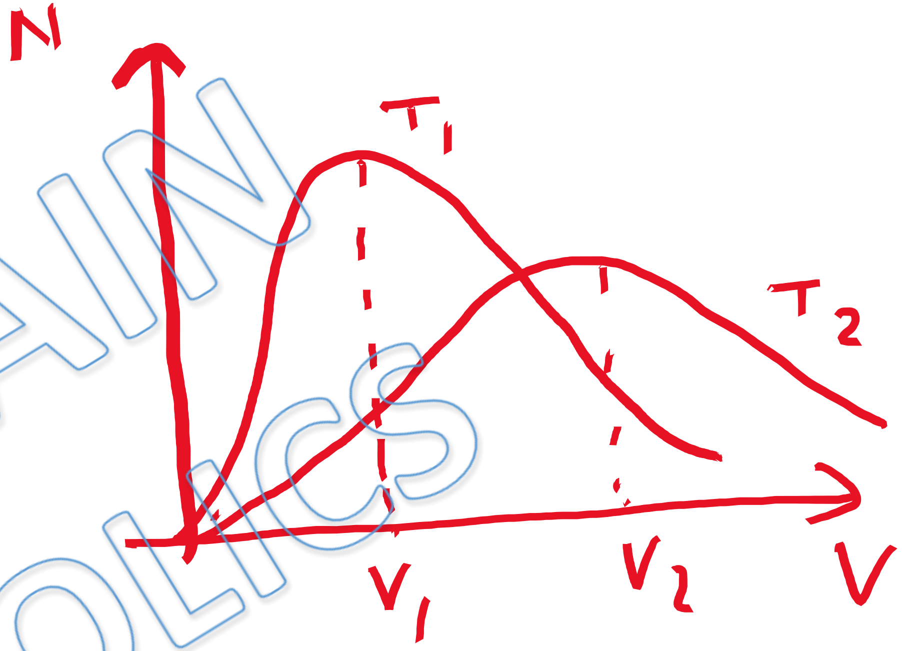
$$\Rightarrow \frac{3}{M_1} = \frac{8}{\pi M_2}$$

$$\Rightarrow \frac{M_1}{M_2} = \frac{3\pi}{8}$$

Ans.d

Solution:9

V_1 & V_2 are most probable velocity.



most probable velocity $\propto \sqrt{T}$

Since $V_1 < V_2$

$\Rightarrow T_1 < T_2$

ANS (b)

Solution:10

If v is rms speed & ω is rms angular speed of diatomic molecule.

$$\frac{1}{2}mv^2 = \frac{3}{2}KT \Rightarrow \frac{mv^2}{I\omega^2} = \frac{3}{2}$$

$$\frac{1}{2}I\omega^2 = \frac{2}{2}KT$$

$$\Rightarrow \frac{v}{\omega} = \sqrt{\frac{3I}{2m}}$$

ANS (C)

Solution:11

$$\vec{V}_{av} = \frac{\vec{V_1} + \vec{V_2} + \ldots}{N} = \frac{m\vec{V_1} + m\vec{V_2} + \ldots}{mN}$$

$$= \frac{\vec{P}_{net}}{mN}$$

If container is stationary, net momentum of gas $= 0$

$$\Rightarrow \vec{V}_{av} = 0$$

ANS (a)

Solution:12

$$V_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2}{3}} = \sqrt{\frac{(3v)^2 + (4v)^2 + (12v)^2}{3}}$$

$$= \frac{\sqrt{169V}}{3} = \frac{13V}{\sqrt{3}}$$

$$\boxed{V_{rms} = 7.5V}$$

Ans (c)

Solution: 13

most probable velocity $= \sqrt{\frac{2RT}{M}} \propto \frac{1}{\sqrt{M}}$

most probable velocity is highest for C then B then A.

$\Rightarrow \quad M_C < M_B < M_A$

$M_C \rightarrow He$, $M_B \rightarrow Ne$, $M_A \rightarrow O_2$

ANS (d)

Solution:14

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

$T \rightarrow 2$ times , $M \rightarrow \frac{1}{2}$ times

$\Rightarrow \quad V_{rms} \rightarrow 2$ times

ANS (c)

Solution:15

In a gas sample molecules may have any possible velocity.

$V_p = \sqrt{\frac{2RT}{M}}$, $\bar{V} = \sqrt{\frac{8RT}{\pi M}}$, $V_{rms} = \sqrt{\frac{3RT}{M}}$

$\Rightarrow \quad V_p < \bar{V} < V_{rms}$

av. KE of a molecule $= \frac{3}{2} KT = \frac{3}{2} \frac{R}{N_a} \times \frac{M V_p^2}{2R}$

$= \frac{3}{4} m V_p^2$

$N_a \rightarrow$ avagadro Number

ANS(c,d)

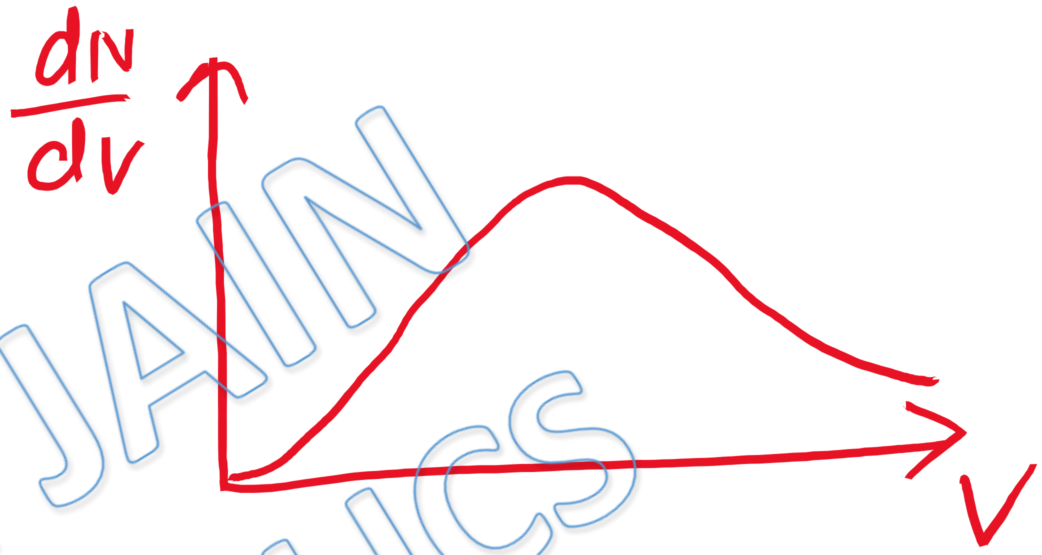
Solution:16

Area under Curve

$$= \int y\,dx = \int \frac{dN}{dv} \times dv$$

$$= \int_0^N dN = N$$

= total no of molecules = Constant



ANS (C)

Solution:17

In mixture of gases av. velocity of a gas does not depend on other gases.

ANS (B)

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