AAQIL AHMED

JEE: KINETIC THEORY

1. At what temp. will the average speed of gas molecules be equal to rms speed at 300K?

ANSWER

$$v_{avg} = \sqrt{\frac{8RT}{\pi M}}, \quad v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{3RT}{M}}$$

$$\frac{8T}{\pi} = 900$$

$$\Rightarrow T = \frac{900\pi}{8}$$

$$T \approx 353K$$

2. An ideal gas is kept in a cubical container of side 1m. If the rms speed of the molecules is 500m/s. Find the pressure exerted by the gas [$\rho = 1.2 kg/m^3$]

ANSWER

$\rho = 1.2 kg/m^3$

$v_{rms} = 500 m/s$

$$P = \frac{1}{3}\rho v^2_{rms}$$

$$= \frac{1}{3} \times 1.2 \times 2.5 \times 10^5$$

$$\boxed{P = 1.0 \times 10^5 PA}$$

AAQIL AHMED

3. Hydrogen gas and oxygen gas are at the same temperature. Find the ratio of their rms speeds

ANSWER

$$v_{rms} \propto \frac{1}{\sqrt{M}}$$

$$\frac{v_{H_2}}{v_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}}$$

$$= \sqrt{\frac{32}{2}}$$

$$= \sqrt{16}$$

$$v_{H_2} : v_{O_2} = 4:1$$

Hazique Rizvi
2025-2026

Kinetic Theory of gases

Q The kinetic energy of translation of the molecules in 50 g of CO_2 gas at 17°C is:

a) 4205.5 J
b) 3582.7 J
c) 3986.3 J
d) 4102.8 J

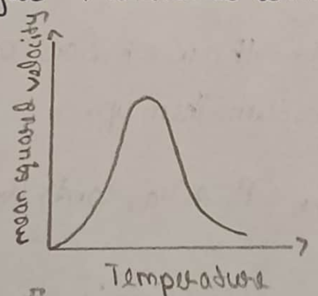
Sol: $(KE)_{\text{Translational}} = \left[\frac{3}{2} KT\right] \times \text{no. of molecule}$

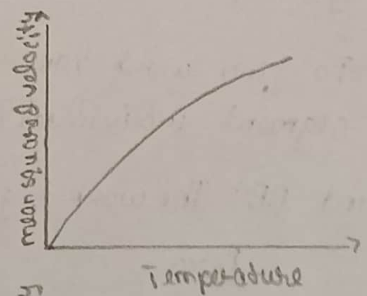
No. of molecule $= \frac{50}{44} \times 6.023 \times 10^{23}$

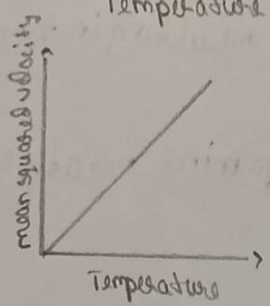
$(KE)_{\text{Transsational}} = 4108.644$ J

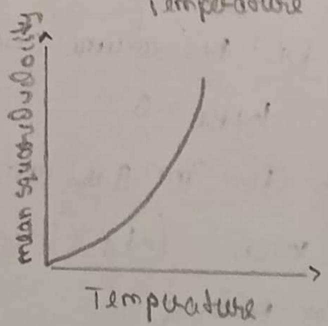
option d) is correct

Q For a particular ideal gas which of the following graphs represents the variation of mean squared velocity of the gas molecules with temperature?

a)


b)


c)


d)


Sol: We know for an ideal gas

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

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

$V_{ms} \propto T$

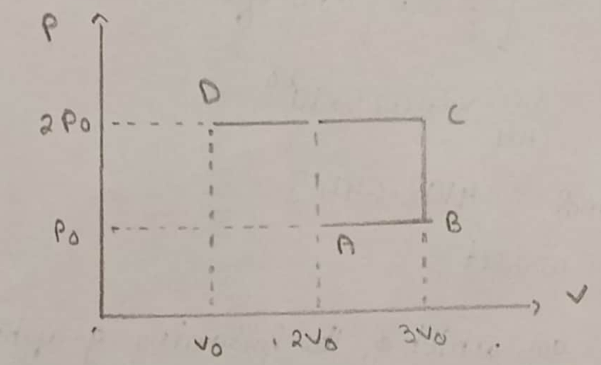
i.e. mean squared velocity is directly proportional to temperature

$V_{ms} = \left(\frac{3R}{M}\right)T$

by comparing it with $y = mx$ (straight line)

option c) matches

Q



Using the given P-V diagram, the work done by an ideal gas along the path ABCD is:

Sol: To find work done we calculate the work done on each segment individually and then sum them up.

Segment AB: The work is given by $W_{AB} = P_0 \times V_0$, contributing P_0V_0

Segment BC: No volume change occurs, resulting in zero work

$W_{BC} = 0$

Segment CD: The gas compresses, performing negative work

$W_{CD} = -(2P_0 \times 2V_0) = -4P_0V_0$

On Adding

$W_{ABCD} = P_0V_0 + 0 - 4P_0V_0$

$= -3P_0V_0$

Thus the net work done is $-3P_0V_0$

Prakash swaneer
Batch:-2025-26

JEE Questions
Kinetic Theory Of Gases

Q.1) At what temperature will the root mean square velocity of O_2 molecules be sufficient so as to escape from the earth?

(A) $1.6\times10^{5}K$ (B) $16\times10^{5}K$

(C) $0.16\times10^{5}K$ (D) $160\times10^{5}K$

given:- mass of one molecule $\Rightarrow 5.34\times10^{-26}$

[JEE Main 2023]

Ans:- (A) R.M.S $\Rightarrow \frac{3}{2}KT$

Escape velocity $\Rightarrow V_e \Rightarrow \frac{1}{2}mV_e^2$

$V_e = 11.1$ km/sec

$$T = \left(\frac{mV_e^2}{3K}\right)$$

$$T \Rightarrow \frac{5.32\times10^{-26}(11.1\times10^{3})}{3\times(1.38\times10^{-23})}$$

$$\boxed{\therefore T = 1.6\times10^{5}K}$$ (A)

Q.2) The first excited state of hydrogen atom is 10.2eV above its ground state. What temperature is needed to excite hydrogen atoms to first excited level? [JEE Main 2017]

(A) $7.88\times10^{4}K$ (B) $0.788\times10^{4}K$

(C) $78.8\times10^{4}K$ (D) $788\times10^{4}K$

Ans:- (A) K.E.(per atom) $\Rightarrow \frac{3}{2}KT$

K.E. of $(H_2) \Rightarrow 10.2eV$

$$T = \frac{2}{3}\frac{(10.2\times1.6\times10^{-19})}{(1.38\times10^{-23})} \Rightarrow \boxed{7.88\times10^{4}K}$$ (A)

Q.3) For a gas $C_p - C_v = R$ in a state 'P' and $C_p - C_v = 1.10R$ (2)
in a state 'Q', T_P and T_Q are the temperatures in two different states 'P' and 'Q' respectively then:-

(A) $T_P = T_Q$ (B) $T_P < T_Q$

(C) $T_P = 0.9T_Q$ (D) $T_P > T_Q$

Ans:- ✱ $C_p - C_v = R$; is for ideal gases at high Temperature.

So, $\boxed{T_P = T_Q \text{ (A)}}$

Kinetic Theory of Gasses

Q1. At what temperature (in celsius) will the root mean square (rms) speed of oxygen molecules (O_2) be the same as that of helium atoms (He) at $-73°C$?

⇒ Formula for the rms speed (V_{rms}) of a gas molecule

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

R = gas constant
T = absolute temperature (Kelvin)
M = molar mass.

For the speeds to be equal, $\sqrt{\frac{3RT_{O_2}}{M_{O_2}}} = \sqrt{\frac{3RT_{He}}{M_{He}}}$

Converting celsius to Kelvin; $T_{He} = -73 + 273 = \underline{200K}$

Molar mass, $M_{O_2} = \underline{32\ g/mol}$

$M_{He} = \underline{4\ g/mol}$

$$\therefore \frac{T_{O_2}}{32} = \frac{200}{4}$$

$$T_{O_2} = 50 \times 32 = \underline{1600K}$$

Converting back to celsius, $1600 - 273 = \underline{1327C}$

Q2. A mixture contains 2 moles of Helium (monatomic) and 4 moles of Nitrogen (diatomic, rigid). What is the specific heat capacity at constant volume (C_V) for the mixture?

⇒ The molar heat capacity at constant volume is $C_V = \frac{f}{2}R$,

f = degree of freedom

Degrees of freedom (f): Helium (Monatomic): $f_1 = 3$

Nitrogen (Diatomic): $f_2 = 5$

Mixture Formula $\Rightarrow C_{V(mix)} = \dfrac{n_1 C_{V_1} + n_2 C_{V_2}}{n_1 + n_2}$

$\therefore C_{V_1} = \dfrac{3}{2} R$

$C_{V_2} = \dfrac{5}{2} R$

$\Rightarrow C_{V(mix)} = \dfrac{2(3/2 R) + 4(5/2 R)}{2+4}$

$= \dfrac{3R + 10R}{6}$

$= \dfrac{13}{6} R$

Q3. If the temperature of a gas is increased, how do the most probable speed (V_{mp}) and the fraction of molecules possessing that speed change?

$\Rightarrow$ Maxwell-Boltzmann distribution curve shows how particle speeds are distributed in a sample.

Most probable speed (V_{mp}) is the speed at the peak of the curve which is calculated as

$V_{mp} = \sqrt{\dfrac{2RT}{M}}$, As T increases, V_{mp} increases, shifting the peak to the right.

The peak height - Since the total area under the curve must remain constant (representing 100% of the molecules), if the curve stretches to the right, it must also flatten.

∴ The fraction of molecules possessing the most probable speed decreases as temperature rises, even though the value of that speed itself is higher.

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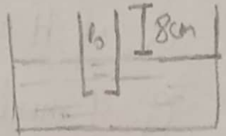
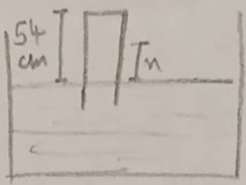
KINETIC THEORY OF GASES

Q.1 An open glass tube is immersed in mercury in such a way that a length of 8cm extends above mercury level. The open of the tube is then closed and sealed and the tube is raised vertically up by addition of 46cm. What will be length of air column above mercury now? [Atm. Pressure = 76cm of Hg].





Ans $P_0 A(8) = P'(A)[54-x] \Rightarrow P_0(8) = P'(54-x)$

$\Rightarrow P' = P_0 - \rho g x$

Comparing, $P_0(8) = (P_0 - \rho g x)(54-x)$

$\Rightarrow 76(8) = (76-x)(54-x)$

$\Rightarrow \underline{x = 38cm}$

$\therefore$ Air column $= 54 - 38 = \underline{16cm}$

Q.2 The specific heats C_p and C_v of gas of diatomic molecules, A, is given by $29 J mol^{-1}K^{-1}$ and $22 J mol^{-1}K^{-1}$ respectively. Another gas of diatomic molecules, B, has the corresponding values of 30 & 21. If they're treated as ideal gases, then

(a) A has a vibrational mode; B has none
(b) A has one vibrational mode; B has two
(c) A is rigid; B has a vibrational mode
(d) Both A and B have a vibrational ~~mode~~ mode each

Ans For A, $\frac{C_p}{C_v} = 1 + \frac{2}{f} \Rightarrow f = 6$

Molecule A, has 3 translational, 2 rotational and 1 vibrational degree of freedom

For B, $\frac{C_p}{C_v} = 1 + \frac{2}{f} \Rightarrow \underline{f = 5}$

i.e, B has 3 translational and 2 rotational degrees of freedom

Answer $\longrightarrow$ (a)

Q.3 2 moles of He gas is mixed with three moles of hydrogen molecules (rigid). What is the molar specific heat of mixture at constant volume? ($R = 8.3 J/mol K$).

Ans C_{v1} of He $= \frac{3}{2}R$

C_{v2} of H $= \frac{5}{2}R$

C_v of mixture $= \dfrac{2 \times \frac{3}{2}R + 3 \times \frac{5}{2}R}{5}$

$= \dfrac{3R + \frac{15}{2}R}{5}$

$= \underline{\underline{17.4 \ J mol^{-1} K^{-1}}}$

Dhruv Prajapati
XI A

Sarbhak Shinde
JEE - 2025-26

Kinetic Theory Of Gases

Q> The average kinetic Energy of monoatomic molecule is 0.414 eV at temprature: ($k = 1.38 \times 10^{-23}$ J/k)
① 3000k ② 3200k ③ 1600k ④ 1500K

Sol.

For monoatomic gas:

$$KE_{avg} = \frac{3}{2} k_B T$$

$$0.414 = \frac{3}{2} \times 1.38 \times 10^{-23} \times T$$

$$T = \frac{0.414 \times 10^{23} \times 2}{3 \times 1.38} \approx 3202.97k$$

$\boxed{② \ 3200k}$

Q> Total kinetic energy of 1 mol of O_2 at 27°C is: ($R = 8.31$)
① 6845.5J ② 5942.0 ③ 6232.5 ④ 5670.5

Sol.

Given
$n = 1$ mol
$T = 27°C = 300k$
$R = $ J/molk

Since: O_2 is diatomic

for diatomic atom (O_2)

$$KE = \frac{5}{2} nRT$$

$$KE = \frac{5}{2} \times 1 \times 8.31 \times 300$$

$\boxed{\therefore KE = 6232.5J}$

$\boxed{③ \ 6232.5J}$

Q> Two vessels A and B of same volume & temperature, A has 1g H_2 & B has 1g O_2. If their pressures are P_A & P_B, then P_A/P_B is

(1) 16 (2) 8 (3) 4 (4) 32

Sol.

For vessel A:

1g H_2

no. of mole, $n_A = \frac{1}{2} = 0.5$ moles

volum = V

Temperature = T

$PV = nRT$

$P_A V = n_A RT$

$P_A = \frac{n_A RT}{V}$

For vessel B:

1g O_2

no. of mole, $n_B = \frac{1}{32} = 0.03125$ mole

Volume = V

Temperature = T

$PV = nRT$

$P_B V = n_B RT$

$P_B = \frac{n_B RT}{V}$

$$\frac{P_A}{P_B} = \frac{\frac{n_A R\cancel{T}}{\cancel{V}}}{\frac{n_B R\cancel{T}}{\cancel{V}}} = \frac{n_A}{n_B} = \frac{0.5}{0.03125} = \cancel{} = \underline{\underline{16}}$$

$\boxed{(1)\ 16}$

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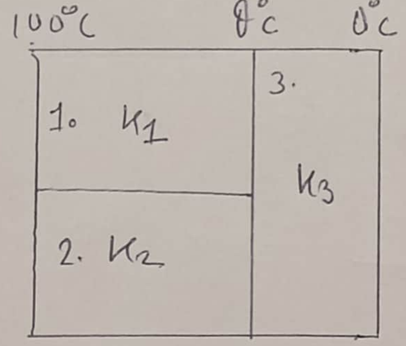
XII-A Roll No. - 3
2025-26

KINETIC THEORY OF GASES

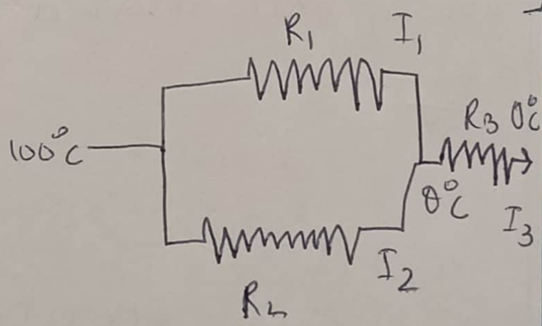
① Three conductors of same lenghts having thermal conductivity K_1, K_2 and K_3 are connected as shown in figure.



Area of cross section of 1st and 2nd conductor are same and for 3rd conductor it is double of the 1st conductor. The temperature are given in the figure. In steady state condition, the value of θ is 40°C.

[Given,
$K_1 = 60\ J s^{-1} m^{-1} K^{-1}$; $K_2 = 120\ J s^{-1} m^{-1} K^{-1}$; $K_3 = 135\ J s^{-1} m^{-1} K^{-1}$]

Ans:-



$R_1 = \frac{2L}{K_1 A}$ [As $l_1 = l_2 = l_3 = l$]

$\therefore (A_1 = A_2 = A/2$; $A_3 = A)$

$R_2 = \frac{2L}{K_2 A}$; $R_3 = \frac{L}{K_3 A}$

$\therefore I_1 + I_2 = I_3$

$$\Rightarrow \frac{100-\theta}{\frac{2L}{K_1 A}} + \frac{100-\theta}{\frac{2L}{K_2 A}} = \frac{\theta - 0}{\frac{L}{K_3 A}}$$

$$\Rightarrow \frac{100-\theta}{2}(K_1 + K_2) = K_3\theta$$

$$\Rightarrow 50(K_1 + K_2) = \theta \times \left[K_3 + \frac{K_1 + K_2}{2}\right]$$

$$\Rightarrow \theta = 40°C$$

(2) A faulty thermometer reads 5°C in melting ice and 95°C in steam. The correct temp. on absolute scale will be <u>313 K</u>, when the faulty thermometer reads 41°C.

Ans:-

Let correct temp. be x°C.

$$\therefore \frac{x-0}{100-0} = \frac{41-5}{95-5} \Rightarrow x = 40$$

$\therefore$ Temperature is $(273+40)\,K = 313\,K$

(3) At certain temperature, the degree of freedom per ~~per~~ molecule for gas is 8. The gas performs 150 J of work when it expands under constant pressure. The amt. of heat absorbed by the gas will be <u>750</u> J.

Ans:-

$$f = 8$$

$$W = PdV = 150$$

$$Q = W + \Delta U = PdV + \frac{f}{2} PdV$$

$$\Rightarrow Q = 5 \times 150 = 750\,J.$$

KaushikoB

KINETIC THEORY OF GASES

Q The root mean square speed of oxygen molecules at temperature T is v. The rms speed of hydrogen molecules at same temperature is

(A) v (B) 2v (C) 4v (D) $\frac{v}{4}$

Solutions

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

$M_{H_2} = \frac{1}{16} M_{O_2}$,

$V_{rms}(H_2) = \sqrt{\frac{M_O}{M_{h_2}}} \cdot v = \sqrt{16} \cdot v = 4v$

option (c) 4v

Q The average kinetic energy of a molecule of an ideal gas at temperature T is

(A) $\frac{3}{2}KT$ (B) $\frac{1}{2}KT$ (c) KT (d) 2KT

Solution

$E = \frac{3}{2}kT$

answer - option A

$\frac{3}{2}KT$

(Q) The mean free path of molecules in a gas depends on

(A) Pressure only

(B) Temperature only

(C) Pressure and molecular diameter

(d) Volume only

Solutions

$$\lambda = \frac{1}{2\sqrt{2}\pi d^2 n}$$

d = molecular distance , n = number density

Option (c) Pressure and molecular diameter

Arun Sam Isac
2025-26

Kinetic Theory of Gases

Q.1 One kg of a diatomic gas is at a pressure of $8 \times 10^4 N/m^2$. The density of the gas is $4 kg/m^3$. What is the energy of the gas due to its thermal motion?

Ans: $PV = RT$

$$V = \frac{mass}{density} = 1kg / \left(\frac{4 kg}{m^3}\right) = \left(\frac{1}{4}\right) m^3$$

$P = 8 \times 10^4 N/m^2$

$$U = \frac{5}{2} \times 8 \times 10^4 \times \frac{1}{4}$$

$$= 5 \times 10^4 J$$

Q.2 A gaseous mixture consists of 16g of helium and 16g of oxygen. The ratio C_p / C_v of the mixture is

Ans: For helium, $n_1 = \frac{16}{4} = 4$

For Oxygen, $n_2 = \frac{16}{32} = \frac{1}{2}$

For a mixture of gases

$$C_v = \frac{n_1 C_{v1} + n_2 C_{v2}}{n_1 + n_2} \quad \text{where } C_v = \left(\frac{f}{2}\right) R$$

$$C_p = \frac{n_1 C_{p1} + n_2 C_{p2}}{n_1 + n_2} \quad \text{where } C_p = \left(\left(\frac{f}{2}\right)+1\right)R$$

For helium, $f = 3, n_1 = 4$

For Oxygen, $f = 5, n_2 = \frac{1}{2}$

$$\frac{C_P}{C_V} = \frac{\left(4 \times \frac{5}{2}R\right) + \left(\frac{1}{2} \times \frac{7}{2}R\right)}{\left(4 \times \frac{3}{2}R\right) + \left(\frac{1}{2} \times \frac{5}{2}R\right)} = \frac{47}{29} = 1.62$$

Q-3 The temperature, at which the root mean square velocity of hydrogen molecules equals their escape velocity from the earth, is closest to.

Ans: The escape speed of the molecule

$$V_e = \sqrt{2gR}$$

Root mean square velocity

$$V_{rms} = \sqrt{\frac{3(K_B N)T}{m}}$$

$$V_e = V_{rms} = 2gR = \frac{3(K_B N)T}{m}$$

$$T = \frac{2gRm}{3K_B N} = \frac{2 \times 10 \times 6.4 \times 10^6 \times 2 \times 10^{-3}}{3 \times 1.38 \times 10^{-23} \times 6.02 \times 10^{23}}$$

$$= 10^4 \text{ K}$$

2025-2026
Zaid Shamsheeri
XI-A.

Kinetic Theory of Gases.

Q1. Ideal gas has density $\rho = 1.25\,kg/m^3$ and pressure $P = 10^5\,Pa$ calculate rms speed of gas molecules.

Sol:

$$P = \frac{1}{3}\rho v^2_{rms}$$

$$v_{rms} = \sqrt{\frac{3P}{\rho}}$$

$$v_{rms} = \sqrt{\frac{3\times10^5}{1.25}}$$

$$v_{rms}\sqrt{2.4\times10^5}$$

$$\boxed{v_{rms} = 490\,m/s}$$

Q2. Two gases A and B are at the same temperature. The molar mass of "A" is 4 times of B. Find ratio of "rms" speed.

Sol:

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

$$v \propto \frac{1}{\sqrt{m}}$$

$$\frac{v_A}{v_B} = \sqrt{\frac{M_B}{M_A}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

$$\boxed{1:2}$$

Q3. The average kinetic energy of gas molecules at temperature "T" is ϵ; if the temperature is increased to "3T" what will be the new total of 2 moles of gas compared to 1 moles at T.

Sol :

$$\epsilon \propto T$$

$$\epsilon_1 \propto T$$

$$\epsilon_2 \propto 2 \times 3T = 6T$$

$$\frac{\epsilon_2}{\epsilon_1} = 6$$

$$\boxed{6}$$

D. S. HARINI, XI - A
2025 - 2026
KTG

Q. N moles of a polyatomic gas (f =) must be mixed with 2 mole of a monoatomic gas so that the mixture ~~as~~ behaves as diatomic gas. The value of N :-
[JEE Main 2024]

A] 6 B] 3
C] 4 D] 2

⇒ $f_{eq} = \dfrac{n_1 f_1 + n_2 f_2}{n_1 + n_2}$

For diatomic gas $f_{eq} = 5$

$5 = \dfrac{N(6) + (2)(3)}{N+2}$ = $5N + 10 = 6N + 6$

$\boxed{N = 4}$ ⟶ Ans

Q. The average KE of a monoatomic molecule is 0.414 eV at temperature :
(Use $K_B = 1.38 \times 10^{-23}$ J/mol - K)
[JEE Main 2024]

A] 3000 K B] 3200 K
C] 1600 K D] 1500 K

⇒ For monoatomic molecule degree of freedom = 3

$\therefore K_{avg} = \frac{3}{2} K_B T$

$T = \dfrac{0.414 \times 1.6 \times 10^{-19} \times 2}{3 \times 1.38 \times 10^{-23}}$

$\boxed{T = 3200 K}$

The pressure P_1 & density d_1 of diatomic gas ($\gamma = 7/5$) changes suddenly to P_2 ($>P_1$) and d_2 respectively during ~~the~~ an adiabatic process. The temp. of the gas increases and becomes ______ times of its initial temp.

(given $\frac{d_2}{d_1} = 32$)

[JEE Main 2022]

$$\Rightarrow P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

$$\frac{P_1}{d_1^{\gamma}} = \frac{P_2}{d_2^{\gamma}}$$

$$\frac{d_1 T_1}{d_1^{\gamma}} = \frac{d_2 T_2}{d_2^{\gamma}}$$

$$T_2 = \left(\frac{d_2}{d_1}\right)^{\gamma - 1} T_1$$

$$= (32)^{2/5} T_1$$

$$\boxed{T_2 = 4 T_1}$$

RAYAN

KTG

Q.) The mean free path of a molecule of diameter $5 \times 10^{-10} m$ at the $T = 41^\circ c$ and pressure $1.38 \times 10^{5} Pa$, is given as ___ $\times 10^{-8} m$

$(k_B = 1.38 \times 10^{-23} J/K)$

Ans →

$$\lambda = \frac{k_B T}{\sqrt{2} \pi d^2 p}$$

$d = 5 \times 10^{-10} m$, $T = 41^\circ c = 314 K$, $P = 1.38 \times 10^{5} Pa$

$$\boxed{\lambda = 1 \times 10^{-8} m}$$

Q.) A gas of certain mass filled in a closed cylinder at $P = 3.23$ KPa has $T = 50^\circ c$. The gas is now heated to double its Temperature. The modified Pressure is ___ Pa.

Ans → $T_1 = 323 K$

$T_f = 373 K$

$$\frac{P_f}{P_1} = \frac{T_f}{T_1}$$

$$\boxed{P_f = 3730 Pa}$$

Q) If 2 mole of an ideal monoatomic gas at Temperature 'T' is mixed with 6 mol of another ideal monoatomic gas at temperature 2T then temperature of mixture is

(A) $\frac{5}{2}T$ (B) $\frac{5}{4}T$

(C) $\frac{7}{2}T$ (d) $\frac{7}{4}T$

Ans →

$U_{mix} = U_1 + U_2$

$(n_1 + n_2) C_v T_{mix} = n_1 C_v T_1 + n_2 C_v T_2$

$C_v = \frac{3}{2} R$

$(2+6) T_{mix} = 2T + 6(2T)$

$8 T_{mix} = 2T + 12T$

$\boxed{T_{mix} = \frac{7}{4} T}$

SAANVI PATEL, XII-A
KTG 2025-2026

Q. An ideal gas in enclosed in a cylinder at a pressure of 2 atm and temperature, 300K. The mean time b/w two successive collisions is 6×10^{-8} s. If the pressure is doubled and the temperature is increased to 500 K, the mean time b/w two successive collisions will be close to

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

$$V_{rms} \propto \sqrt{T}$$

$$V_{rms} \propto \frac{\text{mean free path}}{\text{time b/w successive collisions}}$$

$$\lambda = \frac{kT}{\sqrt{2}\pi\sigma^2 P} \qquad V_{rms} \propto \frac{\lambda}{t}$$

$$V_{rms} \propto \frac{T}{\sqrt{P}} \times t \longrightarrow (1)$$

$$V_{rms} \propto \sqrt{T} \longrightarrow (2)$$

$$\sqrt{T} \propto T/\sqrt{P} \times t$$

$$t \propto \sqrt{T/P}$$

$$t_2/t_1 = \sqrt{\frac{T_2}{T_1} \times \frac{P_1}{P_2}}$$

$$t_2/t_1 = \sqrt{500/300 \times P_1/2P_1} = \sqrt{5/6}$$

$$t_2 = \sqrt{5/6}\, t_1 \qquad \boxed{t_2 = 4\times10^{-8}\,s}$$

Q. Two moles of helium gas is mixed with three moles of hydrogen molecules. What is the ~~major~~ molar specific heat of mixture at constant volume? ($R = 8.3 J/mol K$)

C_{v1} of helium $= \left(\frac{3}{2}\right)R$

C_{v2} of hydrogen $= \left(\frac{5}{2}\right)R$

C_v of mixture $= \dfrac{2 \times 3/2 R + 3 \times 5/2 R}{(2+3)}$

$\boxed{C_v \text{ of mixture} = 17.4 \; J/mol \; K.}$

Q. The mass of a hydrogen molecule is 3.32×10^{-27} kg. If 10^{23} hydrogen molecule strike, per second, a fixed wall of area $2 cm^2$ at an angle of 45° to the normal, and rebound elastically with a speed of 10^3 m/s, then the pressure on the wall is?

$p_i = p_f$

$F = dp/dt = 2nmu \cos 45^\circ$

Press $= F/A = (2nmv \cos 45^\circ)/Area$

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

$= 2.35 \times 10^3 N/m^2.$

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Q1) The average translational kinetic energy and the rms speed of molecules in oxygen at 300 K are 6.21×10^{-21} J. and $484\ ms^{-1}$ respectively. The corresponding values at 600 K area nearly are?

A) $K.E = \frac{3}{2} kT$, $V = \sqrt{\frac{3RT}{M}}$

$$\frac{KE_2}{KE_1} = \frac{T_2}{T_1} = 2$$

$$KE_2 = KE_1 \times 2 = 6.21 \times 10^{-21} \times 2 = 12.42 \times 10^{-21}\ J$$ //

$$\frac{V_2}{V_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{2}$$

$$V_2 = \sqrt{2}\, V_1 = \sqrt{2} \times 484\ ms^{-1} = 684\ ms^{-1}$$ //

Q2) A gas mixture contains oxygen and hydrogen in ratio of 1:2 by number of molecules. If rms speed of oxygen molecules is V, what is rms speed of the mixture?

A) $V = \sqrt{\frac{3KT}{m}}$, $V \propto \frac{1}{\sqrt{m}}$

$$V_{mix} = \sqrt{\frac{\Sigma n_i V_i^2 M_i}{\Sigma n_i M_i}} \rightarrow ①$$

$M_{O_2} = 32$, $M_{H_2} = 2$

$$\frac{V_{H_2}}{V_{O_2}} = \sqrt{\frac{32}{2}} = 4$$

$V_{H_2} = 4V$

~~V_{H_2}~~ ① Numerator $= 1 \cdot 32 \cdot V^2 + 2 \cdot 2 \cdot (4V)^2$

$= 32 + 4 \cdot 16V^2 = 32V^2 + 64V^2$

$= 96V^2$ //

Denominator $= 1 \cdot 32 + 2 \cdot 2 = 32 + 4 = 36$

$$V_{mix} = \sqrt{\frac{96V^2}{36}} = V\sqrt{\frac{8}{3}}$$ //

$\therefore$ RMS speed of mixture $= V\sqrt{\frac{8}{3}}$

Q3) A container has a mixture of two ideal gases A and B at the same temperature. Molar masses of A and B are 4 g/mol and 16 g/mol respectively. And number of moles are 2 and 1 respectively. Find ratio of total kinetic energy of gas A to gas B.

A) $K.E. = \frac{3}{2} nRT$

$$E_A = \frac{3}{2} n_A RT = \frac{3}{2} 2RT = 3RT$$

$$E_B = \frac{3}{2} n_B RT = \frac{3}{2} 1 RT = \frac{3}{2} RT$$

$$\frac{E_A}{E_B} = \frac{3RT}{\frac{3}{2}RT} = \frac{1}{\frac{1}{2}} = \frac{2}{1}$$

$\boxed{2:1}$

Hint: K.E. only depends on temperature and moles, not gas type or molar mass.