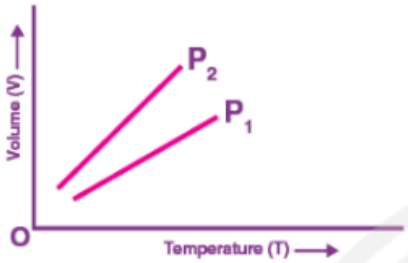
JEE Mains

Physics

Kinetic Theory

Time Duration - 48 Minutes

Q1 For a perfect gas, two pressures P_1 and P_2 are shown in the figure. The graph shows:



[JEE Main 2022, 27 June (Shift 2)]

(A) $P_1 > P_2$

(B) $P_1 < P_2$

(C) $P_1 = P_2$

(D) Insufficient data to draw any conclusion

Q2 Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increases as V^q, where V is the volume of the gas. The value of q is $\left(\gamma = \frac{C_p}{C_V}\right)$

(A) $\frac{3\gamma+5}{6}$

(B) $\frac{\gamma+1}{2}$

(C) $\frac{3\gamma-5}{6}$

(D) $\frac{\gamma-1}{2}$

Q3 The de-Broglie wavelength of neutrons in thermal equilibrium at temperature T is

(A) $\frac{3.08}{\sqrt{T}}\ A^o$

(B) $\frac{0.308}{\sqrt{T}}\ A^o$

(C) $\frac{0.0308}{\sqrt{T}}\ A^o$

(D) $\frac{30.8}{\sqrt{T}}\ A^o$

Q4 The total kinetic energy of 1 mole of oxygen at $27^\circ C$ is : [Use universal gas constant $(R) = 8.31 J/$ mole K]

[JEE Main 2024, 27 Jan (Shift 2)]

(A) $6232.5J$ (B) $6845.5J$

(C) $5942.0J$ (D) $5670.5J$

Q5 A vessel contains $14g$ of nitrogen gas at a temperature of $27^\circ C$. The amount of heat to be transferred to the gas to double the r.m.s speed of its molecules will be: Take $R = 8.32 Jmole^{-1}k^{-1}$.

[JEE Main 2022, 28 Jul (Shift 2)]

(A) $2229J$ (B) $5616J$

(C) $9360J$ (D) $13,104J$

Q6 A sample contains mixture of helium and oxygen gas. The ratio of root mean square speed of helium and oxygen in the sample, is :

[JEE Main 2024, 6 Apr (Shift 1)]

(A) $\frac{1}{32}$ (B) $\frac{1}{2\sqrt{2}}$

(C) $\frac{1}{4}$ (D) $\frac{2\sqrt{2}}{1}$

Q7 The amount of heat energy required to raise the temperature of 1 g of Helium at NTP, from T_1 K to T_2 K is

(A) $\frac{3}{4}N_a k_B (T_2 - T_1)$

(B) $\frac{3}{4}N_a k_B \left(\frac{T_2}{T_1}\right)$

(C) $\frac{3}{8}N_a k_B (T_2 - T_1)$

(D) $\frac{3}{2}N_a k_B (T_2 - T_1)$

Q8 Two kg of a monoatomic gas is at a pressure of 4×10^4 N/m^2. The density of the gas is 8 kg/m^3. What is the order of energy of the gas due to its thermal motion?

[JEE Main 2019, 10 Jan (Shift 2)]

(A) 10^3 J

(B) 10^5 J

(C) 10^6 J
(D) 10^4 J

Q9 For a given gas at 1 atm pressure, rms speed of the molecules is 200 m/s at 127°C. At 2 atm pressure and at 227°C, the rms speed of the molecules will be
[JEE Main 2019, 9 Apr (Shift 1)]
(A) $100\sqrt{5}$ m/s
(B) 80 m/s
(C) 100 m/s
(D) $80\sqrt{5}$ m/s

Q10 Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafloride (polyatomic). Arrange these on the basis of their root mean square speed (V_{rms}) and choose the correct answer from the options given below:
(A) $V_{rms}(\text{ mono }) = V_{rms}(\text{ dia }) = V_{rms}\ (\text{poly})$
(B) $V_{rms}(\text{ mono }) > V_{rms}(\text{ dia }) > V_{rms}\ (\text{poly})$
(C) $V_{rms}(\text{ dia})) < V_{rms}(\text{ poly }) < V_{rms}\ (\text{mono})$
(D) $V_{rms}(\text{ mono }) < V_{rms}(\text{ dia }) < V_{rms}\ (\text{poly})$

Q11 A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Considering only translational and rotational modes, the total internal energy of the system is
(A) $12RT$ (B) $15RT$
(C) $20RT$ (D) $4RT$

Q12 If for a gas, $\frac{R}{C_V} = 0.67$, this gas is made up of molecules which are
(A) diatomic
(B) mixture of diatomic and polyatomic molecules
(C) monoatomic
(D) polyatomic

Q13 A mixture of 2 moles of helium gas (atomic mass $= 4u$) and 1 mole of argon gas (atomic mass $= 40u$) is kept at 300 K in a container. The ratio of their rms speeds $\left[\frac{v_{\text{rms(helium)}}}{v_{\text{rms(argon)}}}\right]$ is close to

(A) 0.32
(B) 2.24
(C) 3.16
(D) 0.45

Q14 Let γ_1 be the ratio of molar specific heat at constant pressure and molar specific heat at constant volume of a monoatomic gas and γ_2 be the similar ratio of diatomic gas. Considering the diatomic gas molecule as a rigid rotator, the ratio, $\frac{\gamma_1}{\gamma_2}$ is
[JEE Main 2023, 24 Jan (Shift 2)]
(A) $\frac{27}{35}$
(B) $\frac{35}{27}$
(C) $\frac{25}{21}$
(D) $\frac{21}{25}$

Q15 Two vessels A and B are of the same size and are at same temperature. A contains 1 g of hydrogen and B contains 1 g of oxygen. $\mathrm{P_A}$ and $\mathrm{P_B}$ are the pressures of the gases in A and B respectively, then $\frac{P_A}{P_B}$ is :

[JEE Main 2024, 29 Jan (Shift 1)]
(A) 16 (B) 8
(C) 4 (D) 32

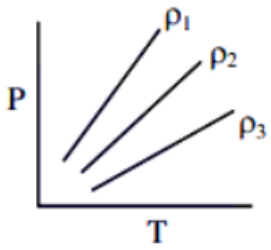
Q16 The rms speeds of the molecules of Hydrogen, Oxygen and Carbon dioxide at the same temperature are v_{H}, v_{O} and v_{C} respectively then
[JEE Main 2021, 26 Aug (Shift 1)]
(A) $v_{\mathrm{C}} > v_{\mathrm{O}} > v_{\mathrm{H}}$
(B) $v_{\mathrm{H}} = v_{\mathrm{O}} > v_{\mathrm{C}}$
(C) $v_{\mathrm{H}} > v_{\mathrm{O}} > v_{\mathrm{C}}$
(D) $v_{\mathrm{H}} = v_{\mathrm{O}} = v_{\mathrm{C}}$

Q17 A 25×10^{-3} m^3 volume cylinder is filled with 1 mole of $\mathrm{O_2}$ gas at room temperature $(300\ \mathrm{K})$. The molecular diameter of $\mathrm{O_2}$ and its root mean square speed are found to be 0.3 nm and 200 m/s, respectively. What is the average collision rate (per second) for an $\mathrm{O_2}$ molecule?
(A) $\sim 10^{10}$

(B) $\sim 10^{12}$
(C) $\sim 10^{11}$
(D) $\sim 10^{13}$

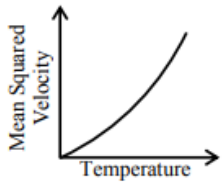
Q18 An HCl molecule has rotational, translational and vibrational motions. If the rms velocity of HCl molecules in its gaseous phase is $\bar{v}$, m is its mass and k_B is Boltzmann constant, then its temperature will be
[JEE Main 2019, 9 Apr (Shift 1)]
(A) $\frac{m\bar{v}^2}{3k_B}$
(B) $\frac{m\bar{v}^2}{7k_B}$
(C) $\frac{m\bar{v}^2}{5k_B}$
(D) $\frac{m\bar{v}^2}{6k_B}$

Q19 P-T diagram of an ideal gas having three different densities ρ_1, ρ_2, ρ_3 (in three different cases) is shown in the figure. Which of the following is correct:

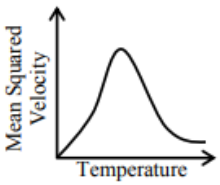


(A) $\rho_1 < \rho_2$
(B) $\rho_2 < \rho_3$
(C) $\rho_1 > \rho_2$
(D) $\rho_1 = \rho_2 = \rho_3$

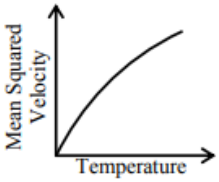
Q20 For a particular ideal gas which of the following graphs represents the variation of mean squared velocity of the gas molecules with temperature?
(A)



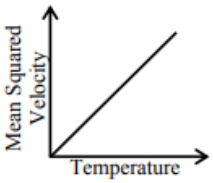
(B)



(C)



(D)



Q21 The speed of sound in oxygen at S.T.P. will be approximately: (given, $R = 8.3\mathrm{JK}^{-1}, \gamma = 1.4$)

[JEE Main 2024, 31 Jan (Shift 2)]
(A) $333\ \mathrm{m/s}$
(B) $310\ \mathrm{m/s}$
(C) $341\ \mathrm{m/s}$
(D) $325\ \mathrm{m/s}$

Q22 Energy of 10 non rigid diatomic molecules at temperature T is :

[JEE Main 2024, 6 Apr (Shift 2)]
(A) $35RT$
(B) $35K_BT$
(C) $\frac{7}{2}RT$
(D) $70K_BT$

Q23 If n is the number density and d is the diameter of the molecule, then the average distance covered by a molecule between two successive collisions (i.e. mean free path) is represented by :

[JEE Main 2024, 5 Apr (Shift 2)]
(A) $\sqrt{2}n\pi d^2$
(B) $\frac{1}{\sqrt{2n\pi d^2}}$
(C) $\frac{1}{\sqrt{2}n\pi d^2}$
(D) $\frac{1}{\sqrt{2}n^2\pi^2 d^2}$

Q24 The change in the magnitude of the volume of an ideal gas when a small additional pressure $\Delta\mathrm{P}$ is applied at a constant temperature, is the same as the change when the temperature is reduced by a small quantity $\Delta\mathrm{T}$ at constant pressure. The initial temperature and pressure of the gas were $300\ \mathrm{K}$ and $2\ \mathrm{atm}$. respectively. If $|\Delta\mathrm{T}| = \mathrm{C}|\Delta\mathrm{P}|$ then value of C in (K/atm.) is _____.
[JEE Main 2020, 4 Sep (Shift 2)]

Q25 Initially a gas of diatomic molecules is contained in a cylinder of volume V_1 at a pressure P_1 and temperature $250\ \mathrm{K}$. Assuming that 25% of the molecules get dissociated causing a change in number of moles. The pressure of the resulting gas at temperature $2000\ \mathrm{K}$, when contained in a volume $2V_1$ is given by P_2. The atio $\mathrm{P_2/P_1}$ is _____.
[JEE Main 2020, 6 Sep (Shift 1)]

Q26 The root mean square speed of molecules of a given mass of a gas at $27^{\circ}C$ and 1 atmosphere pressure is $200ms^{-1}$. The root mean square speed of molecules of the gas at $127^{\circ}C$ and 2 atmosphere pressure is $\frac{x}{\sqrt{3}}ms^{-1}$. The value of x will be----------

[JEE Main 2021, 24 Feb (Shift 2)]

Q27 Nitrogen gas is at $300^{\circ}\mathrm{C}$ temperature. The temperature (in K) at which the rms speed of a $\mathrm{H_2}$ molecule would be equal to the rms speed of a nitrogen molecule, is _____.
(answer to nearest integer)
(Molar mass of $\mathrm{N_2}$ gas $28\ \mathrm{g}$).
[JEE Main 2020, 5 Sep (Shift 2)]

Q28 $0.056kg$ of Nitrogen is enclose in a vessel at a temperature of $127^{\circ}C$. The amount of heat required to double the speed of its molecules is ----------$kcal$.
(Take $R = 2$ cal $mole^{-1}K^{-1}$)

[JEE Main 2022, 24 June (Shift 1)]

Q29 A system consists of two types of gas molecules A and B having same number density $2 \times 10^{25}/m^3$. The diameter of A and B are 10 $\overset{o}{A}$ and 5 $\overset{o}{A}$ respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is..... $\times 10^{-2}$.

[JEE Main 2021, 25 Jul (Shift 2)]

Q30 A closed vessel contains 0.1 mole of a monatomic ideal gas at $200\ \mathrm{K}$. If 0.05 mole of the same gas at $400\ \mathrm{K}$ is added to it, the final equilibrium temperature (in K) of the gas in the vessel will be close to nearest integer _____.
[JEE Main 2020, 4 Sep (Shift 1)]

Answer Key

Q1	(A)
Q2	(B)
Q3	(D)
Q4	(A)
Q5	(C)
Q6	(D)
Q7	(C)
Q8	(D)
Q9	(A)
Q10	(B)
Q11	(B)
Q12	(C)
Q13	(C)
Q14	(C)
Q15	(A)
Q16	(C)
Q17	(A)
Q18	(A)
Q19	(C)
Q20	(D)
Q21	(B)
Q22	(B)
Q23	(C)
Q24	150
Q25	5
Q26	400
Q27	41
Q28	12
Q29	25
Q30	267