PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

KINETIC THEORY OF GASES

Example

1. A football at $27^{\circ}C$ has 0.5 mole of air molecules. Calculate the internal energy of air in the ball.

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2. A room contains oxygen and hydrogen molecules in the ratio $3:1$. The temperature of the room is $27^{\circ}C$. The molar mass of O_2 is $32g \quad mol^{-1}$ and for $H_2 2 \text{ g } mol^{-1}$. The value of gas constant R is 8.32 J $mol^{-1}K^{-1}$.

(a) rms speed of oxygen and hydron molecule

(b) Average kinetic energy per oxygen molecule and per hydrogen molecule

(c) Ratio of average kinetic energy of oxygen molecules and hydrogen molecules.

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3. Ten particles are moving at the speed of $2, 3, 4, 5, 5, 5, 6, 6, 7$ and $9ms^{-1}$. Calculate rms speed, average speed and most probable speed.

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4. Calculate the rms speed, average speed and the most probable speed of 1 mole of

hydrogen molecules at 300 K. Neglect the mass of electron.

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5. Find the adiabatic exponent γ for mixture of μ_1 moles of monoatomic gas and μ_2 moles of a diatomic gas at normal temperature.

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6. An oxygen molecule is travelling in air at 300 K and 1 atm, and the diameter of oxygen molecule is $1.2 \times 10^{-10} m$. Calculate the mean free path of oxygen molecule.

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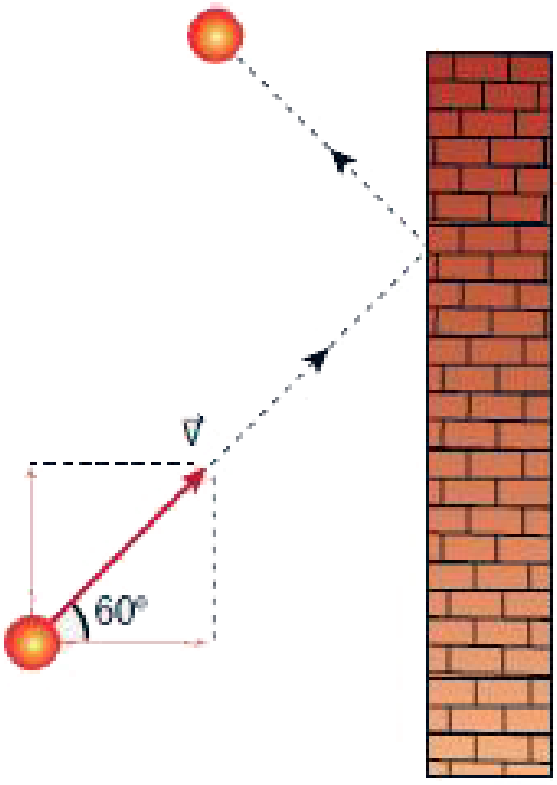
Evaluation Multiple Choice Questions

1. A particle of mass m is moving with speed u in a direction which makes 60° with respect to

x axis. It undergoes elastic collision with the wall. What is the change in momentum in x and y direction ?



A. $\Delta p_x = -\mathrm{mu}, \Delta p_y = 0$

B. $\Delta p_x = -2\mathrm{mu}, \Delta p_y = 0$

C. $\Delta p_x = 0, \Delta p_y =$ mu

D. $\Delta p_x =$ mu, $\Delta p_y = 0$

Answer: A

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2. A sample of ideal gas is at equilibrium which of the following quantity is zero ?

A. rms speed

B. average speed

C. average velocity

D. most probable speed

Answer: C

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3. An ideal gas is maintained at constant pressure. If the temperature of an ideal gas increases from 100K to 1000K then the rms speed of the gas molecules

A. increases by 5 times

B. increases by 10 times

C. remains same

D. increases by 7 times

Answer: B

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4. Two identically sized rooms A and B are connected by an open door. If the room A is air conditioned such that its temperature is 4°

lesser than room B, which room has more air in it?

A. Room A

B. Room B

C. Both room has same air

D. Cannot be determined

Answer: A

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5. The average translational kinetic energy of gas molecules depends on

A. number of moles and T

B. only on T

C. P and T

D. P only

Answer: A

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6. If the internal energy of an ideal gas U and volume V are doubled then the pressure

A. doubles

B. remains same

C. halves

D. quadruples

Answer: B

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7. The ratio $\gamma = \frac{C_p}{C_v}$ for a gas mixture consisting of 8 g of helium and 17 g of oxygen is

A. $23/15$

B. $15/23$

C. $27/11$

D. $17/27$

Answer: C

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8. A container has one mole of monoatomic ideal gas. Each molecule has f degrees of freedom. What is the ratio of $\gamma = \frac{C_p}{C_v}$

A. f

B. $\frac{f}{2}$

C. $\frac{f}{f+2}$

D. $\frac{f+2}{f}$

Answer: D

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9. If the temperature and pressure of a gas is doubled the mean free path of the gas molecules

A. remains same

B. doubled

C. tripled

D. quadrapoled

Answer: A

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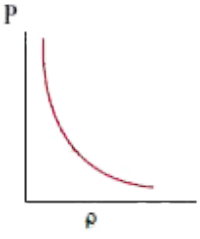
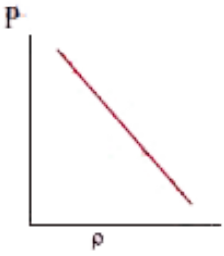
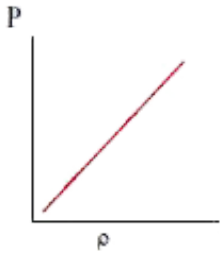
10. Which of the following shows the correct relationship between the pressure and density of an ideal gas at constant temperature?

A. 

B. 

C. 

D. 

Answer: D

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11. A sample of gas consists of μ_1 moles of monoatomic molecules, μ_2 moles of diatomic molecules and μ_3 moles of linear triatomic molecules. The gas is kept at high

temperature. What is the total number of degrees of freedom?

A. $[3\mu_1 + 7(\mu_2 + \mu_3)]N_A$

B. $[3\mu_1 + 7\mu_2 + 6\mu_3]N_A$

C. $[7\mu_1 + 3(\mu_2 + \mu_3)]N_A$

D. $[3\mu_1 + 6(\mu_2 + \mu_3)]N_A$

Answer: A

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12. If S_P and S_V denote the specific heats of nitrogen gas per unit mass at constant pressure and constant volume respectively, then

A. $S_P - S_V = 28R$

B. $S_P - S_V = R/28$

C. $S_P - S_V = R/14$

D. $S_P - S_V = R$

Answer: B

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13. Which of the following gases will have least rms speed at a given temperature ?

A. Hydrogen

B. Nitrogen

C. Oxygen

D. Carbon dioxide

Answer: D

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14. For a given gas molecule at a fixed temperature, the area under the Maxwell-Boltzmann distribution curve is equal to

A. $\frac{PV}{kT}$

B. $\frac{kT}{PV}$

C. $\frac{P}{NkT}$

D. PV

Answer: A

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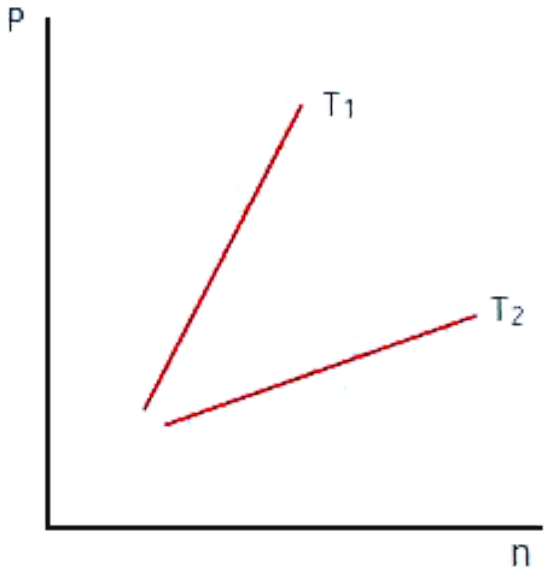
15. The following graph represent the pressure versus number density for ideal gas at two different temperatures T_1 and T_2. The graph implies



A. $T_1 = T_2$

B. $T_1 > T_2$

C. $T_1 < T_2$

D. Cannot be determined

Answer: B

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Evaluation Numerical Problems

1. A fresh air is composed of nitrogen $N_2(78\,\%)$ and oxygen $O_2(21\,\%)$. Find the rms speed of N_2 and O_2 at 20° C.

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2. If the rms speed of methane gas in the jupiter's atmosphere is $471.8ms^{-1}$, show that the surface temperature of jupiter is sub-zero.

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3. Calculate the temperature at which the rms velocity of a gas triples its value at S.T.P.

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4. A gas is at temperature $80^{\circ} C$ and pressure $5 \times 10^{-10} Nm^{-2}$. What is the number of molecules per m^3 if boltzmann's constant is $1.38 \times 10^{-23} JK^{-1}$.

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5. From kinetic theory of gases, show that Moon cannot have an atmosphere (Assume $k = 1.38 \times 10^{-23} JK^{-1}$ Temperature $T = 0^{\circ} C = 273K$)

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6. If 10^{20} oxygen molecules per second strike $4cm^2$ of wall at an angle of 30° with the normal when moving at a speed of $2 \times 10^3 ms^{-1}$, find the pressure exerted on the wall. (mass of 1 atom=$1.67 \times 10^{-27} kg$)

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7. Calculate the mean free path of air molecules at STP. The diameter of N_2 and O_2 is about $3 \times 10^{-10} m$

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8. Estimate the total number of air molecules in a room of capacity $25 m^3$ at a temperature of $27^\circ C$.

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