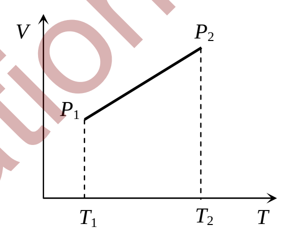
Kinetic Theory of Gases

1. One mole of an ideal monatomic gas requires 210 J heat to raise the temperature by 10 K, when heated at constant temperature. If the same gas is heated at constant volume to raise the temperature by 10 K then heat required is

(a) 238 J (b) 126 J (c) 210 J (d) 350 J



2. From the following V-T diagram we can conclude

(a) $P_1 = P_2$ (b) $P_1 > P_2$ (c) $P_1 < P_2$ (d) None of these

3. When the temperature of a gas is raised from 27°C to 90°C, the percentage increase in the r.m.s. velocity of the molecules will be

(a) 10% (b) 15% (c) 20% (d) 17.5%

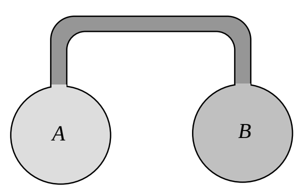
4. Two spherical vessel of equal volume, are connected by a narrow tube. The apparatus contains an ideal gas at one atmosphere and 300K. Now if one vessel is immersed in a bath of constant temperature 600K and the other in a bath of constant temperature 300K. Then the common pressure will be

(a) 1 atm

(b) $\frac{4}{5}$ atm

(c) $\frac{4}{3}$ atm

(d) $\frac{3}{4}$ atm



5. At what temperature, the mean kinetic energy of O_2 will be the same for H_2 molecules at – 73°C

(a) 127°C (b) 527°C (c) – 73°C (d) – 173°C

6. If the r.m.s. velocity of a gas at a given temperature (Kelvin scale) is 300 m/sec. What will be the r.m.s. velocity of a gas having twice the molecular weight and half the temperature on Kelvin scale =

(a) 300 m/sec (b) 600 m/sec (c) 75 m/sec (d) 150 m/sec

7. The energy of a gas/litre is 300 joules, then its pressure will be

(a) $3\times10^5\ N/m^2$ (b) $6\times10^5\ N/m^2$ (c) $10^5\ N/m^2$ (d) $2\times10^5\ N/m^2$

8. If pressure of CO_2 (real gas) in a container is given by $P=\frac{RT}{2V-b}-\frac{a}{4b^2}$ then mass of the gas in container is

(a) 11 gm (b) 22 gm (c) 33 gm (d) 44 gm

9. Four particles have speeds 2, 3, 4 and 5 cm/s respectively. Their rms speed is

(a) 3.5 cm/sec (b) 27/2 cm/s (c) $\sqrt{54}$ cm/sec (d) $(\sqrt{54}/2)$ cm/s

10. The root mean square speeds of molecules of ideal gases at the same temperature are

(a) The same

(b) Inversely proportional to the square root of the molecular weight

(c) Directly proportional to the molecular weight

(d) Inversely proportional to the molecular weight.

11. Which of the following gases possess maximum rms velocity, all being at the same temperature?

(a) Oxygen (b) Air (c) Carbon dioxide (d) Hydrogen

12. At 0 K which of the following properties of a gas will be zero?

(a) Kinetic energy (b) Potential energy (c) Vibrational energy (d) Density

13. Gases exert pressure on the walls of containing vessel because the gas molecules

(a) Possess momentum (b) Collide with each other

(c) Have finite volume (d) Obey gas laws

14. The phenomenon of Brownian movement may be taken as evidence of

(a) Kinetic Theory of Matter (b) Electromagnetic Theory of Radiation

(c) Corpuscular Theory of Light (d) Photoelectric phenomenon

15. Absolute temperature can be calculated by

(a) Mean Square Velocity (b) Motion of the Molecule

(c) Both (1) and (2) (d) None of these

Key

1) **b**	2) **b**	3) **a**	4) **c**	5) **c**	6) **d**	7) **d**	8) **b**	9) **d**	10) **b**
11) **d**	12) **a**	13) **a**	14) **a**	15) **a**					

Hints

1. $(\Delta Q)_P = \mu C_P \Delta T$ and $(\Delta Q)_V = \mu C_V \Delta T$

$$\Rightarrow \frac{(\Delta Q)_V}{(\Delta Q)_P} = \frac{C_V}{C_P} = \frac{\frac{3}{2}R}{\frac{5}{2}R} = \frac{3}{5} \quad \left[\because (C_V)_{mono} = \frac{3}{2}R, (C_P)_{mono} = \frac{5}{2}R\right]$$

$$\Rightarrow (\Delta Q)_V = \frac{3}{5} \times (\Delta Q)_P = \frac{3}{5} \times 210 = 126\ J$$

2. In case of given graph, V and T are related as $V = aT - b$, where a and b are constants.

From ideal gas equation, $PV = \mu RT$

We find $P = \frac{\mu RT}{aT - b} = \frac{\mu R}{a - b/T}$

Since $T_2 > T_1$, therefore $P_2 < P_1$.

3. $v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{(273+90)}{(273+30)}} = 1.1$

% increase $= \left(\frac{v_2}{v_1} - 1\right) \times 100 = 0.1 \times 100 = 10\%$

4. $\mu = \mu_1 + \mu_2$

$\frac{P(2V)}{RT_1} = \frac{P'v}{RT_1} + \frac{P'V}{RT_2} \Rightarrow \frac{2P}{RT_1} = \frac{P'}{R}\left[\frac{T_2 + T_1}{T_1 T_2}\right]$

$P' = \frac{2PT_2}{(T_1 + T_2)} = \frac{2 \times 1 \times 600}{(300 + 600)} = \frac{4}{3} atm$

5. Mean kinetic energy of molecule depends upon temperature only. For O_2 it is same as that of H_2 at the same temperature of $-73°C$.

6. $v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow v_{rms} \propto \sqrt{\frac{T}{M}}$

$\frac{v_2}{v_1} = \sqrt{\frac{M_1}{M_2} \times \frac{T_2}{T_1}} = \sqrt{\frac{1}{2} \times \frac{1}{2}} \Rightarrow v_2 = \frac{v_1}{2} = \frac{300}{2}$ =150m/sec

7. Energy $= 300\ J/litre = 300 \times 10^3\ J/m^3$

$P = \frac{2}{3}E = \frac{2 \times 300 \times 10^3}{3} = 2 \times 10^5\ N/m^2$

8. (b) Vander wall's gas equation for μ mole of real gas

$\left(P + \frac{\mu^2 a}{V^2}\right)(V - \mu b) = \mu RT \Rightarrow P = \frac{\mu RT}{V - \mu b} - \frac{\mu^2 a}{V^2}$

On comparing the given equation with this standard equation we get $\mu = \frac{1}{2}$. Hence

$\mu = \frac{m}{M} \Rightarrow$ mass of gas $m = \mu m = \frac{1}{2} \times 44 = 22 gm$.