

## Kinetic Theory

### Very Short Answer Type Questions

1. Calculate the number of atoms in 39.4 g gold. Molar mass of gold is  $197\text{g mole}^{-1}$ .
2. The volume of a given mass of a gas at  $27^\circ\text{C}$ , 1 atm is 100 cc. What will be its volume at  $327^\circ\text{C}$ ?
3. The molecules of a given mass of a gas have root mean square speeds of  $100\text{ m s}^{-1}$  at  $27^\circ\text{C}$  and 1.00 atmospheric pressure. What will be the root mean square speeds of the molecules of the gas at  $127^\circ\text{C}$  and 2.0 atmospheric pressure?
4. Two molecules of a gas have speeds of  $9 \times 10^6\text{ ms}^{-1}$  and  $1 \times 10^6\text{ ms}^{-1}$ , respectively. What is the root mean square speed of these molecules.
5. A gas mixture consists of 2.0 moles of oxygen and 4.0 moles of neon at temperature T. Neglecting all vibrational modes, calculate the total internal energy of the system. (Oxygen has two rotational modes.)
6. Calculate the ratio of the mean free paths of the molecules of two gases having molecular diameters 1 A and 2 A. The gases may be considered under identical conditions of temperature, pressure and volume.

### Short Answer Type Questions

1. The container shown in Fig. 13.6 has two chambers, separated by a partition, of volumes  $V_1 = 2.0$  litre and  $V_2 = 3.0$  litre. The chambers contain  $\mu_1 = 4.0$  and  $\mu_2 = 5.0$  moles of a gas at pressures  $p_1 = 1.00$  atm and  $p_2 = 2.00$  atm. Calculate the pressure after the partition is removed and the mixture attains equilibrium.

$V_1$	$V_2$
$\mu_1, P_1$	$\mu_2, P_2$

Fig 13.6

2. A gas mixture consists of molecules of types A, B and C with masses  $m_A > m_B > m_C$ .

- Rank the three types of molecules in decreasing order of (a) average K.E., (b) rms speeds.
3. We have 0.5 g of hydrogen gas in a cubic chamber of size 3cm kept at NTP. The gas in the chamber is compressed keeping the temperature constant till a final pressure of 100 atm. Is one justified in assuming the ideal gas law, in the final state?  
(Hydrogen molecules can be consider as spheres of radius 1 A ).
  4. When air is pumped into a cycle tyre the volume and pressure of the air in the tyre both are increased. What about Boyle's law in this case?
  5. A balloon has 5.0 g mole of helium at 7°C. Calculate
    - (a) the number of atoms of helium in the balloon,
    - (b) the total internal energy of the system.
  6. Calculate the number of degrees of freedom of molecules of hydrogen in 1 cc of hydrogen gas at NTP.
  7. An insulated container containing monoatomic gas of molar mass  $m$  is moving with a velocity  $v_0$ . If the container is suddenly stopped, find the change in temperature.

## Long Answer Type Questions

1. Explain why
  - (a) there is no atmosphere on moon.
  - (b) there is fall in temperature with altitude.
2. Consider an ideal gas with following distribution of speeds.

Speed (m/s)	% of molecules
200	10
400	20
600	40
800	20
1000	10

- (i) Calculate  $V_{rms}$  and hence  $T$ . ( $m = 3.0 \times 10^{-26}$  kg)
- (ii) If all the molecules with speed 1000 m/s escape from the system, calculate new  $V_{rms}$  and hence  $T$ .
3. Ten small planes are flying at a speed of 150 km/h in total darkness in an air space that is  $20 \times 20 \times 1.5$  km<sup>3</sup> in volume. You are in one of the planes, flying at random within this space with no way of knowing where the other planes are. On the average about how long a time will elapse between near collision with your plane. Assume for this rough computation that a safety region around the plane can be approximated by a sphere of radius 10m.
4. A box of 1.00m<sup>3</sup> is filled with nitrogen at 1.50 atm at 300K. The box has a hole of an area 0.010 mm<sup>2</sup>. How much time is required for the pressure to reduce by 0.10 atm, if the pressure outside is 1 atm.
5. Consider a rectangular block of wood moving with a velocity  $v_0$  in a gas at temperature  $T$  and mass density  $\rho$ . Assume the velocity is along x-axis and the area of cross-section of the block perpendicular to  $v_0$  is  $A$ . Show that the drag force on the block is  $4\rho A v_0 \sqrt{(KT/m)}$ , where  $m$  is the mass of the gas molecule.