Kinetic Theory

Assertion Reason Questions

Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

1. Assertion (A): Bus is driven by a driver at the same time air pressure increases.
Reason (R): Temperature of the air in the tyre increases due to friction of the tyre with the road. Increase in temperature results in an increase in pressure according to Charle's law.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: As per Charle's law, since the volume of the tyre remains constant. Hence, Po T and thus, the pressure of gas in the tyre increases.

2. Assertion (A): The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.
Reason (R): The molecules of a gas collide with each other and the velocities of the molecules change due to collision.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: Total translational kinetic energy

$$= \frac{3}{2}nRT = \frac{3}{2}PV$$

In an ideal gas all molecules moving randomly in all directions collide and their velocity changes after the collision. The molecules are said to move in a chaotic (random) manner since they are never in a steady state. They move in a straight line in every direction while moving at varying but consistent speeds. When molecules collide with a container or with other molecules, their motion changes in both direction and velocity.

3. Assertion (A): The ratio of specific heat of gas to the constant pressure of diatomic gas and constant volume of specific heat is more than that of the monatomic gas.
Reason (R): Degrees of freedom has more molecules of monoatomic gas than the number of diatomic gas molecules

Ans. (d) A is false and R is also false.
Explanation: As we know,

$$\frac{C_p}{C_v} = r = 1 + \frac{2}{f}$$

Where, f is the degree of freedom.

Now, for a monatomic gas, $f = 3$

So, $r_m = 1 + \frac{2}{3} = \frac{5}{3} = 1.6$

For a diatomic gas, $f = 5$

So, $r_d = 1 + \frac{2}{5} = \frac{7}{5} = 1.4$

Thus, $r_d < r_m$
but $f_m < f_d$

4. Assertion (A): The mean free path of gas molecules changes in inverse proportion to the density of the gas.
Reason (R): The mean free path of a gas molecule is defined as the mean distance that the molecule travels between two consecutive collisions.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: The mean free path of a gas molecule is the average distance between two successive collisions. It is represented by 2..

$$\lambda = \frac{1}{\sqrt{2}} \frac{KT}{\pi^2 P} = \frac{m}{\sqrt{2}\pi^2 \sigma d}$$

Here, $\sigma = 0$ diameter of a molecule
and K = Boltzmann's constant

$\Rightarrow \quad \lambda \propto \frac{1}{d'}$

$\Rightarrow \quad \lambda \propto T$

and $\quad \lambda \propto \frac{1}{P}$

Hence, the mean free path varies inversely with the density of the gas. It can easily prove that the mean free path varies directly with the temperature and varies as the pressure of the gas varies.

5. Assertion (A): Equal masses of helium and oxygen gases are given equal quantities of heat. There will be a greater rise in the temperature of helium compared to that of oxygen.
Reason (R): The molecular weight of oxygen is more than the molecular weight of helium.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: There will be a greater rise in temperature of helium compared to oxygen because helium has a greater specific heat capacity. Also, the molecular weight of oxygen is 16 and that of helium is 4.