CBT PHYSICS -XI, JANUARY 2025 - ANSWERS

CASE STUDY-1
THERMODYNAMICS- ISOTHERMAL AND ADAIBATIC PROCESS
Read the following paragraph and answer the questions that follows:

For an isothermal process, pressure of a given mass of gas varies inversely as its volume. There is no change in the internal energy of an ideal gas in an isothermal process. In an adiabatic process, the system is insulated from the surroundings and heat absorbed or released is zero. The P-V curve for Isothermal and Adiabatic process of an ideal gas is given below.

1.   If a system goes from initial to final state without changing internal energy, then the heat supplied to system………….
(a) Is fully utilised for doing work
(b) Is partially utilised for doing work by the system
(c) Is partially utilised for doing work on the system
(d) Not used for doing work

ANS - (a) Is fully utilised for doing work

2.   When steam is converted into water, internal energy of the system
(a) increases
(b) decreases
(c) remains constant
(d) becomes zero

ANS- (b) decreases

3. Read the following question and choose correct response from the options provided with the question.

A litre of hydrogen at $127\,^{\circ}C$ and 10^6 dyne per square cm pressure expands isothermally until its volume is doubled. Find the final pressure of the gas.

(a) 2×10^3 dyne per square cm
(b) 5×10^3 dyne per square cm
(c) 2×10^5 dyne per square cm
(d) 5×10^5 dyne per square cm

ANS - (d)

4. Which of the following is NOT true about isothermal expansion of an ideal gas
(a) There is no change in internal energy
(b) Heat supplied to the gas equals work done
(c) The ideal gas equation for the process is PV/T= constant
(d) The ideal gas equation for the process is PV = constant

ANS - (c) The ideal gas equation for the process is PV/T= constant

5. Assertion-Reasoning Question:

Assertion : In isothermal process whole of the heat energy supplied to the body is converted into internal energy.
Reason : According to the first law of thermodynamics $\Delta Q = \Delta U$

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

ANS - (D) A is false and R is also false.

CASE STUDY - 2
KINETIC THEORY OF GASES - LAW OF EQUIPARTITION OF ENERGY

The average kinetic energy of a molecule is proportional to the absolute temperature of the gas; it is independent of pressure, volume or the nature of the ideal gas. This is a fundamental result relating temperature, a macroscopic measurable parameter of a gas (a thermodynamic variable as it is called) to a molecular quantity, namely the average kinetic energy of a molecule. The two domains are connected by the Boltzmann constant and given by $E = \frac{1}{2} kT$, Where k is Boltzmann constant.

We have seen that in thermal equilibrium at absolute temperature T, for each translational mode of motion, the average energy is $\frac{1}{2} kT$. The most elegant principle of classical statistical mechanics (first proved by Maxwell) states that this is so for each mode of energy: translational, rotational and vibrational. That is, in equilibrium, the total energy is equally distributed in all possible energy modes, with each mode having an average energy equal to $\frac{1}{2} kT$. This is known as the law of equipartition of energy.

Accordingly, each translational and rotational degree of freedom of a molecule contributes ½ kT to the energy, while each vibrational frequency contributes 2 × ½ kT = kT, since a vibrational mode has both kinetic and potential energy modes.

6. A polyatomic gas with 'n' degrees of freedom has a mean energy per molecule given by ('N' is number molecule of the gas and 'k' is Boltzmann constant)
(a) nkT/N
(b) nkT/2N
(c) nkT/2
(d) 3kT/2

ANS - (c) nkT/2

7. Moon has no atmosphere because
(a) RMS velocity of all gases is more than the escape velocity on moon's surface.
(b) its surface is not smooth.
(c) it is quite far away from the earth.
(d) moon does not have gravity.

ANS - (a) RMS velocity of all gases is more than the escape velocity on moon's surface.

8. The temperature of a gas is raised from 27 degree Celsius to 927 degree Celsius. The RMS molecular speed
(a) remains unchanged
(b) gets halved
(c) gets doubled
(d) gets 1/27 times the earlier value

ANS - (c) gets doubled

9. A gas behaves as an ideal gas at
(a) low pressure and high temperature.
(b) low pressure and low temperature.
(c) high pressure and low temperature.
(a) high pressure and high temperature.

ANS - (a) low pressure and high temperature.

10. Assertion-Reasoning Question:

Assertion (A) : Vibrational energy of diatomic molecule corresponding to each degree of freedom is kT.

Reason (R) : For every molecule, vibrational degree of freedom is 2

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

(B) Both A and R are true but 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.

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