Thermodynamics

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): Specific heat capacity and molar heat capacity both have the same units.

Reason (R): Specific heat capacity and molar heat capacity both depend on mass.

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

Explanation: Specific heat capacity,

$$S = \frac{\Delta Q}{m\Delta T}$$

Where m is the mass of a substance. Molar-specific heat capacity,

$$C = \frac{\Delta Q}{\mu\Delta T}$$

Wheres μ is the number of moles. Both of these are constant characteristics of a substance and are independent of mass.

2. Assertion (A): The first law of thermo- dynamics is the restatement of the conservation of energy. Mathematically, it reads AQ =AU + AW, where AQ is the heat energy supplied to the system, AU is the change in the internal energy, and AW is the work done by the system against external forces.

Reason (R): The Fundamental quantity is a physical quantity that cannot be expressed in any other physical quantity. For example, energy is a fundamental quantity.

Ans. (c) A is true but R is false.

Explanation: The first law of thermodynamics states that heat is a form of energy and thermodynamic processes are subject to the principle of conservation of energy. This means that heat energy cannot be created or destroyed. "So, it's a restatement of

conservation of energy." According to the first law, AQ=AU + AW that is, heat supplied to a system is equal to the amount of work done by the system plus the increase in its internal energy. So, it's the same as the law of conservation of energy.

3. Assertion (A): Rotating the blade in a liquid stops after a certain time is an irreversible process.
Reason (R): Irreversibility arises as the system attains a non- equilibrium state.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: Irreversibility mainly arises due to:
(1) Dissipative factors like friction, viscosity etc.
(2) And as many processes take the system to an equilibrium state.
So, when the blade is rotated in a liquid, then due to viscosity, the system becomes irreversible as it stops after a certain time. Thus it's an irreversible process.

4. Assertion (A): The specific heat of a gas in an adiabatic process is zero and in an isothermal process is infinite.
Reason (R): Specific heat of gas is directly proportional to the change of heat in the system and inversely proportional to the change in temperature.

Ans. (c) A is true but R is false.
Explanation: Assertion is true, since in the adiabatic process there is no transfer of heat,

$$\text{therefore, } c = \frac{Q}{\Delta T} = 0$$

Since, $Q = 0$ therefore, $c = 0$

In isothermal process, $\Delta T = 0$

therefore, $c = \infty$

Whereas specific heat is constant for a material, therefore the reason is false.

5. Assertion (A): Work and heat are two equivalent forms of energy. of mechanical energy
Reason (R): Work is the transfer irrespective of the temperature difference, whereas heat is the transfer of thermal energy because of temperature difference only.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: Heat and work are comparable in that they both represent methods of

transmitting energy. We cannot state that a system includes a given amount of heat or work since neither is a fundamental attribute of a system.

6. Assertion (A): In an adiabatic process, the temperature of the gas remains constant.
Reason (R): An ideal gas's work equals a change in its internal energy in an adiabatic process.

Ans. (c) A is true but R is false.
Explanation: In an adiabatic process, no exchange of heat takes place. Therefore the reason is incorrect. From the first law of thermodynamics,
$Q=U+W$
$0 = U+W$
$|W| = |U|$

7. Assertion (A): The process in which a high- pressure fluid is converted to low-pressure by using a throttle valve is Throttling. In the process of throttling, temperature neither increases nor decreases.
Reason (R): For ideal gas, throttling process is isothermal and for real gases.

Ans. (c) A is true but R is false.
Explanation: In the throttling process enthalpy remains constant, and work done is zero. For ideal gas throttling process is isothermal and for real gases, due to throttling the temperature may increase decrease or remain constant. Throttling process is the process in which a high-pressure fluid is converted to low-pressure fluid at constant pressure using a throttle value. In the throttling process, work done is 0 and enthalpy is constant. It is an irreversible process. Joule's Thompson coefficient,

$$(\mu) = \frac{dT}{dP} \text{ at constant H.}$$

8. Assertion (A): In a thermoflask, inner surface is shiny.
Reason (R): Shiny surface is a poor radiator of heat.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: The wall of thermoflask is polished because shiny surfaces are good radiators of heat. Since we intend to keep it in the vacuum flask and not have it radiated, Outside the shiny surface is the best option. A black wall is a bad option as they are good emitters and absorbers of heat radiation. As on shiny objects heat is incident, due to the

polishing most of the heat energy gets reflected back and as a result, very less energy (heat) is absorbed. So we can say that shiny bodies are only good radiators of heat, not good absorbers.

9. Assertion (A): A room can be cooled by opening the door of a refrigerator in a closed room.
Reason (R): Heat flows from a lower temperature (refrigerator) to a higher temperature (room).

Ans. (d) A is false and R is also false.
Explanation: The cooler inside of the refrigerator absorbs heat from the room when the door is initially opened. Overall, the heat pump turns electrical energy into heat. As a result, once the temperature within the refrigerator reaches the ambient temperature, the temperature of the room rises.

10. Assertion (A): It is not possible for a system, unaided by an external agency to transfer heat from a body at a lower temperature to another body at a higher temperature.
Reason (R): According to Clausius's statement, no process is possible whose sole result is the transfer of heat from a cooled object to a hotter object.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: The second rule of thermodynamics may be taught using the refrigerator as an example. The cooler inside of the refrigerator absorbs heat from the room when the door is initially opened. Overall, the heat pump transforms electrical energy into heat, so once the temperature inside the refrigerator reaches the ambient temperature, the room temperature rises.