Thermal Properties of Matter

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): When a solid iron ball is heated, the percentage increase in volume is the greatest.
Reason (R): The coefficient of superficial expansion is twice the coeffi- cient of linear expansion, whereas the coefficient of volume expansion is three times the coefficient of linear expansion.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: As ß= 2a and y = 3a, i.e., coefficient of volume expansion of solid is three times the coefficient of linear expansion and 1.5 times the coefficient of superficial expansion, on heating a solid iron ball, percentage increase in its volume is largest.

2. Assertion (A): The formation of land and sea breezes is caused by specific heat capacity.
Reason (R): The specific heat of water is more than land.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: The temperature of land rises rapidly as compared to sea because the specific heat of land is five times less than that of seawater. Thus, the air above the land becomes hot and light rises up because of pressure drops over land. To compensate for the drop of pressure, the cooler air from the sea starts blowing towards land, so, setting up the sea breeze. During night land as well, the sea radiates heat energy. The temperature of landfalls is more rapid as compared to seawater, as seawater consists of a higher specific heat capacity. The air above seawater being warm and light rises up and

to take its place the cold air from land starts blowing towards sea and so sets up a breeze.

3. Assertion (A): A body's specific heat is always greater than its thermal capacity.
Reason (R): Thermal capacity is the amount of energy required to raise the temperature of a unit mass of the body by one degree.

Ans. (d) A is false and R is also false.
Explanation: Specific heat of a body is the amount of heat required to raise the temperature of a unit mass of the body through unit degree. When the mass of a body is less than unity, then its thermal capacity is less than its specific heat and vice-versa.

4. Assertion (A): Blue and white stars have higher surface temperatures than orange and red stars. The temperature in the center depends more on the mass, so the red giant Betelgeuse has a lower surface temperature but a higher core temperature than the Sun.
Reason (R): According to Wein's displacement law $m = \frac{b}{T}$ where symbols have their usual meanings.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: From Wein's displacement law,

$$\text{temperature, } T \propto \left(\frac{1}{\lambda_m}\right)$$

(where is the maximum wavelength). Thus, the temperature of a body is inversely proportional to the wavelength. Since the blue star has a smaller wavelength and the red star has a maximum wavelength, therefore the blue star is at a higher temperature than the red star.

5. Assertion (A): According to Kirchhoff's law at a given wavelength the absor- ptivity of a body is equal to its emissivity. Also, a body, which is a good radiator, is also a good absorber of radiation or a poor reflector.
Reason (R): Kirchhoff's law states that for an arbitrary body emitting and absorbing thermal radiation in thermodynamic equilibrium, the emissivity is equal to the absorptivity.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: According to Kirchhoff's law, the ratio of the emissive power to the absorptive power for radiation of a given wavelength is the same for all bodies at the same temperature and is equal to the emissive power of a perfectly black body at that temperature. A conclusion from Kirchhoff's law is that, if the surface is a good absorber of a particular wavelength of radiation it is also a good emitter of that wavelength of radiation.

6. Assertion (A): A material will have only one specific heat, if and only if its coefficient of thermal expansion is equal to zero.
Reason (R): An ideal gas has two specific heats (C and Cp) only.

Ans. (c) A is true but R is false.
Explanation: The coefficient of thermal ex- pansion a From the expression,

$$\frac{\Delta L}{L} = \alpha_t \Delta T,$$

the coefficient of thermal expansion measures the deforming capability of a material. This proves that the coefficient of thermal expansion has no relation with the specific heats. It is an independent quantity. The specific heats of gases are given as Cp, and Cv at constant pressure and constant volume respectively while solids and liquids are having only a single value for specific heat.

7. Assertion (A): When a bottle of cold carbonate drink is opened. Then adiabatic expansion of gas evolved due to this temperature of gas decreasing. It condenses the water vapour, which forms a slight fog around the opening.
Reason (R): An adiabatic process is a type of thermodynamic process that occurs without trans- ferring heat or mass between the thermodynamic system and its environment.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: In cold carbonated drinks, gas is dissolved under pressure, when pressure is released expansion of gas occurs due to which gas cools down and temperature falls. Condensation of water vapour occurs. The process takes place very fast so we can assume it is an adiabatic process.