THERMAL PROPERTIES OF MATTER

SPECIFIC HEAT CAPACITY

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If a body with a mass denoted by m experiences a temperature increase of ΔT, the heat Q transferred to the body is given by the equation:

$Q = mc\ \Delta T$ …… (i)

Here, c represents the specific heat capacity, or simply the specific heat, of the material comprising the body. The specific heat is a constant characteristic of the material and depends on its nature as well as the temperature range involved.

The specific heat of a substance's material is the quantity of heat needed to elevate the temperature of one unit mass of the substance by 1°C. The units for specific heat are expressed as cal/g°C when mass is measured in grams and temperature change in degrees Celsius. In the SI system, where heat (Q) is measured in joules (J), mass (m) is in kilograms, and temperature change (ΔT) is in Kelvin (K), the unit for specific heat is J/ (kg·K).

When considering one mole of a substance instead of unit mass, we refer to the molar specific heat. Molar specific heat is defined as the amount of heat required to raise the temperature of one mole of a substance by 1°C. Denoted by C, it is related to specific heat (c) by $C = Mc$, where M is the molar mass of the substance.

$Q = mc\Delta T$

For molar specific heat:

$Q = nC\Delta T$

Where n is the number of moles of the substance with mass m Thus, $C = \frac{Q}{n\Delta T}$

The SI unit for molar specific heat (C) is $J/(mol \cdot K)$.

The heat capacity or thermal capacity of a body, denoted by C', is defined as the amount of heat required to raise the temperature of the entire body by one degree. It is expressed by the formula $C' = mc$, where m is the mass of the body and c is its specific heat.

$C' = mc$

If Q is the heat supplied to the body, and ΔT is the change in temperature, then $C' = \frac{Q}{\Delta T}$

The SI unit of heat capacity is joules per Kelvin (J/K).

Water Equivalent: When expressing the heat capacity of a body in terms of the mass of water, it is referred to as the water equivalent of the body. The water equivalent, denoted by w, is the quantity of water whose temperature would be raised by 1°C (or 1 K) with the same amount of heat required to raise the temperature of the body by 1°C (or 1 K). It is given by the product of the mass (m) of the body and its specific heat (c):

$w = mc$ …… (ii)

The unit of water equivalent (w) is grams (g) in the cgs system and kilograms (kg) in the SI system.

Latent Heat refers to the amount of heat required to change the state of a unit mass of a substance without altering its temperature, under constant pressure. The relationship is expressed by the formula

$Q = mL,$ …… (iii)

Where L the latent heat, and its SI unit is is joules per kilogram (J/kg).

The value of latent heat depends on several factors:

1. Pressure: Typically quoted at standard atmospheric pressure.

2. Nature of the phase change.

3. Properties of the substance undergoing the phase change.

The latent heat of fusion (L) represents the heat gained during the phase change from a solid to a liquid. For water at 1 atm, its value is 79.7 cal/g, equivalent to $3.33 \times 10^5\ J/kg$, and it is termed the latent heat of ice.

The latent heat of vaporization (L) corresponds to the phase change from liquid to gas. For water at 1 atm, its value is 540 cal/g, which is equal to $22.6 \times 10^5\ J/kg$, and it is also known as the latent heat of steam.