Calorimetry

Heat is a form of energy and thus, can be converted into other forms of energy (like mechanical energy, electrical energy, etc.) and vice versa. We use heat for various purposes, like cooking, etc.

The measure that is used for detecting the degree of hotness of a substance is called temperature.

1. Every substance is made up of matter, which is in turn made up of atoms and molecules. These atoms and molecules possess kinetic energy and are constantly in motion.

2. We know that heat is a form of energy. Thus, when we heat a substance, we provide energy to it. This added energy increases the kinetic energy of the molecules and, consequently, the temperature of the substance.

3. The total kinetic energy of all the molecules in a substance is called **heat** and the increase in average kinetic energy of its molecules is called **temperature**.

The S.I. unit of heat is joule (J) and the S.I. unit of temperature is kelvin (K).

Heat depends upon the mass of a substance while temperature does not.

Let us differentiate between heat and temperature.

Heat	Temperature
The total kinetic energy of all the molecules in a substance is called heat.	Temperature is the measure of the degree of hotness of a substance.
It depends upon the speed, number, size or mass and type of particles in a substance.	It does not depend upon the size or mass of an object.
The S.I. unit of heat is joule (J)	The S.I. unit of temperature is kelvin (K).

Relation between degree Celsius and Kelvin

$T\ K = 273 + t\ °C$ T K=273+t °C

$t°C = T\ K - 273$ t°C =T K-273

Specific Heat

- The quantity of heat required to raise the temperature of unit mass of a substance by 1°C
- Unit of Specific Heat—In SI systems—Joules per kilogram per degree—J/kg °C or J/kg-K

In CGS systems—Joules per gram per degree—J/g °C or J/g-K

Heat capacity or thermal capacity

The amount of heat energy required by an object to raise its temperature by 1 ^{o}C is known as its hear capacity. Thus,

$$\text{Heat Capacity, } C' = \frac{\text{Amount of heat energy supplied}}{\text{Rise in temperature}} = \frac{H}{\Delta\theta_r}$$ Heat Capacity, C'=Amount of heat energy suppli

Relationship between heat capacity and specific heat capacity

$$\text{Heat capacity, } C' = \text{Mass, } m \times \text{Specific heat capacity, } C$$ Heat capacity, C'=Mass, m×Specific heat c

Calorimetry

- **Principle of calorimetry :** When a body at higher temperature is brought in contact with another body at lower temperature, the heat lost by the hot body is equal to the heat gained by the colder body.
- **Calorimeter :** A device used for heat measurement is called a calorimeter.

- Determination of Specific Heat by a Calorimeter
  - According to calorimetry principle,

$$(m_1 + w)\,(t - t_1) = s.m_2\,(t_2 - t)$$

$$\therefore s = \frac{(m_1 + w)(t - t_1)}{m_2(t_2 - t)}$$

where,

m_1 = Mass of water

t_1 = Initial temperature of the water and the calorimeter

w = Water equivalent of the calorimeter and the stirrer

m_2 = Mass of the substance

s = Specific heat of the substance

t_2 = Temperature of the substance

t = Common temperature of the mixture

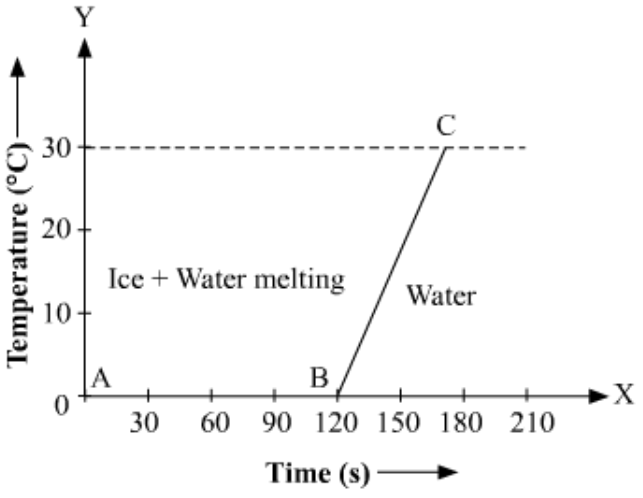
Change of state:

A change of state occurs because heat energy breaks the bonding between particles. Kinetic energy of the particle increases.

- **Melting point –** The temperature at which a solid melts into a liquid at normal atmospheric pressure.

At melting point, the temperature does not change until all solid converts into liquid.

Heating curve of ice during melting



Effect of pressure on melting and boiling point

By increasing the pressure, the melting point decreases for the substances which contract on melting . For instance ice.

By increasing the pressure, the melting point increases of the substances which expand on melting. For instance lead, wax etc.

The boiling point of liquid increases with increase in pressure and decreases with decrease in pressure.

Latent heat – The heat required to break the force of attraction between the particles at transition temperature. This heat becomes confined within the material and is called the latent heat.

- Amount of heat required to change 1 kg of material to change its state at normal atmospheric pressure is called the latent heat for that transition.
- **Specific Latent Heat**

$$L = \frac{\text{Heat absorbed or librated for the change of phase}}{\text{Mass}} = \frac{H}{m}$$ L=Heat absorbed or librated for the change of p

Natural consequences of high specific latent heat of fusion of ice

- Snow on high mountains does not melt all at once
- In extremely cold conditions, water in the lakes and ponds does not freeze all at once
- Pieces of ice can cool a drink more quickly than the ice-cold water at 0 ^{o}C
- Surrounding of a frozen lake becomes extremely cold if it starts melting

- Thermal Expansion: Solid , liquid , and gas all expand on heating.
- **Sublimation**

Solid to gas [directly]

Ammonium chloride