PHYSICS

CLASS NOTES FOR CBSE

Chapter 12. Thermal Properties of Matter

01 Heat

Heat is a form of energy which produces in us the sensation of warmth.
Thus heat is form of energy which is transferred form one body at higher temperature to another body at lower temperature when they are placed incontact with each other.
The SI unit of heat is joule (J). The cgs or practical unit of heat is ***calorie****.*

02. Temperature

The degree of hotness of a body is called its temperature.
Temperature of a body as the degree of hotness or coldness of the body.

Measurement of Temperature :
A thermometer is a device which uses any property of matter that changes sufficiently with temperature. The commonly used property may be
(i) the variation of volume of liquid with temperature,
(ii) the variation of resistance of metal with temperature,
(iii) the variation of thermo emf with temperature of a junction in a thermocouple, etc.
The following temperature scales are used :
Celsius temperature scale
Fahrenheight temperature scale

$$\frac{t_c - 0}{100} = \frac{t_F - 32}{180}$$

Absolute temperature scale

$$PV = nRT$$

$$t^{\circ}\text{C} = TK - 273.15$$

$$\frac{T_C - 0}{100} = \frac{T_F - 32}{180} = \frac{T_K - 273.15}{100}$$

03. Thermal Expansion

Almost all solids are found to expand with the rise in temperature. The thermal expansion of solids is of three types namely ***linear expansion, superficial expansion*** *and* ***cubical expansion.***

In each type of expansion, the increase in dimension is observed to be proportional to the original dimension and the rise in temperature. Solids are made up of atoms and molecules. As a given temperature, the atoms and molecules are located at some equilibrium distance. When heat is added to a solid, the amplitude of the vibrations of its atoms and molecules increases. Due to this, the effective interatomic separation increases, which results in the expansion of solids.

(i) **Linear expansion**

Suppose that a solid in the form of a rod of length l is heated, till its temperature rises through $\triangle T$. If the length of the rod becomes l', then it is found that increase in length $(l'-l)$ is

(a) *directly proportional to its original length i.e.*

$$(l'-l) \propto l \qquad \text{...(i)}$$

(b) *directly proportional to rise in temperature of the rod i.e.*

$$(l'-l) \propto \triangle T \qquad \text{...(ii)}$$

From the equations (i) and (ii), we have

$$(l'-l) \propto l \triangle T$$

or $$(l'-l) = al\triangle T$$

or $$l' = l(1+a\triangle T)$$

Here, the constant of proportionality α is called the ***coefficient of linear expansion.*** Its value depends upon the nature of the material.

The coefficient of linear expansion of the material of a solid is defined as the increase in its length per unit length per unit rise in its temperature.

(ii) **Superficial expansion**

Let S be the intial surface area of a solid and S' be its surface area, when the temperature increases by $\triangle T$. Then, it is found that

$$(S'-S) \propto S$$
$$\propto \triangle T$$

or $$(S'-S) = \beta S \triangle T$$

or $$S' = S(1+\beta \triangle T)$$

Here, β is called the ***coefficient of superficial expansion.***

The coefficient of superficial expansion of the material of a solid is defined as the increase in its surface area per unit surface area per unit rise in its temperature.

(iii) **Cubical expansion**

Again, if V is the initial volume and V', the volume of the solid, when temperature increases by $\triangle T$; then as explained above,

$$(V'-V) \propto V$$
$$\propto \triangle T$$

or $$(V'-V) = \gamma V \triangle T$$

or $$V' = V(1+\gamma \triangle T)$$

Here, γ is called the ***coefficient of cubical* or *volumetric expansion.***

The coefficient of cubical expansion of the material of a solid is defined as the increase in its volume per unit volume per unit rise in its temperature.