

2 VSAQ = 2M + 2 M = 4 MARKS

11. THERMAL PROPERTIES OF MATTER

• Heat & Temperature • Thermal expansion • Heat capacity - Types
• Change of states • Latent Heat • Heat transfer • Newton's law of cooling

SMART SYNOPSIS

1. Heat & Temperature :

[VSAQ]

i) **Heat** is a form of energy that flows from a body at a higher temperature to a body at lower temperature.

Calorimeter is a device used to measure the heat of a substance.

ii) **Temperature** is the degree of hotness/coldness of a body.

Thermometer is used to measure temperature of a body.

2. Relation between Fahrenheit (F) and Celsius (C) scales :

$$\frac{F - 32}{180} = \frac{C}{100}$$

Note: $C = \frac{5}{9}(F - 32)$ and $F = \frac{9}{5}(C + 32)$

On Celsius scale, the lower fixed point is 0°C and the upper fixed point is 100°C . [VSAQ]

On Fahrenheit scale, the lower fixed point is 32°F and the upper fixed point is 212°F .

3. Thermal Expansion is the increase in the dimensions (length / area / volume) of a body due to change in its temperature. [VSAQ]

In general substances expand on heating. But certain substances contract on heating.

Ex: Cast iron, Natural Rubber, type metal and pure water between 0°C to 4°C . [VSAQ]

4. Heat Capacity is the amount of heat required to raise the temperature of a substance through 1°C

Heat capacity $= \frac{dQ}{dT}$ **SI unit :** JK^{-1} .

4.1 Specific heat capacity is the amount of heat required to raise the temperature of unit mass of a substance through 1°C (or 1K) [VSAQ]

Mathematically, $s = \frac{\Delta Q}{m\Delta T}$ **SI Unit:** $\text{J kg}^{-1}\text{K}^{-1}$

4.2 Molar specific heat is the amount of heat required to raise the temperature of 1 mole of a gas through 1°C (or 1K)

Molar specific heat $C = \frac{1}{n} \frac{dQ}{dT}$ Here n is the number of moles of the gas

5. Change of states:

Vaporisation is the change of state from liquid to vapour.

Sublimation is the change from solid state to vapour state without passing through the liquid state

Regelation is the phenomenon of refreezing. [VSAQ]

6. Triple point is the point at which the three phases of matter co-exist in equilibrium

Triple point of Water : (273.16K , 611 Pa)

7. **Latent heat** is the amount of heat absorbed or rejected per unit mass of substance during phase change . **Formula :** $L = \frac{Q}{m}$ **SI unit :** J/kg

7.1 **Latent heat of Fusion of ice (L_{ice}) :** It is the amount of heat absorbed by unit mass of ice to change its phase from ice at 0°C to water at 0°C. [VSAQ]

7.2 **Latent heat of Vapourisation (L_{steam}) :** It is the amount of heat absorbed by unit mass of water to change its phase from water at 100°C to steam at 100°C. [VSAQ]

8. HEAT TRANSFER:

Conduction Ex: Heat transfer from the hot end of the rod to the other end .

Convection Ex: Sea breeze, Land breeze, Trade wind.

Radiation Ex: Transfer of heat energy from the Sun.

9. **Wien's displacement Law:** The wavelength λ_m at which a black body emits maximum energy is inversely proportional to the absolute temperature. [VSAQ]

Formula: $\lambda_{max} \propto \frac{1}{T} \Rightarrow \lambda_{max} T = b$ (constant)

The value of the Wien's constant $b = 2.9 \times 10^{-3}$ m-K

Thus hotter body emits shorter wavelength and cooler body emits larger wavelength.

Note: As a body becomes hotter its glow shifts as: red $\rightarrow$ yellow $\rightarrow$ white

10. **Stefan- Boltzmann's Law:** Emissive power(H) of a body is proportional to the fourth power of the absolute temperature (T).

Mathematically, $H = Ae\sigma T^4$. Here, σ is Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$

11. **Green House Effect** is the heating up of earth's surface and atmosphere.

12. **Newtons Law of cooling :** The rate of loss of heat is directly proportional to the difference in average temperature of the hot body and its surroundings. [VSAQ]

Newton's law of cooling is applicable when [VSAQ]

1)Heat is lost mainly through radiation and natural convection.

2)The body has a uniform temperature throughout its mass.

3)The temperature of the surroundings remains constant.

4)The temperature difference between the body and the surroundings is small (less than about 30°C)

