CHAPTER-10:THERMAL PROPERTIES OF MATTER

Part–1: Temperature • Thermal Expansion • Calorimetry

1. Temperature Scales

Celsius Scale

$$\boxed{0^\circ C \rightarrow 100^\circ C}$$

Kelvin Scale

$$\boxed{0\,K = -273.15^\circ C}$$

Relation

$$\boxed{K = {}^\circ C + 273}$$

Fahrenheit Scale

$$\boxed{{}^\circ F = \frac{9}{5}({}^\circ C) + 32}$$

Relation Between Three Scales

$$\boxed{\frac{C}{5} = \frac{F-32}{9} = \frac{K-273}{5}}$$

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2. Thermal Expansion

Increase in dimensions of a body due to increase in temperature.

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3. Linear Expansion

Increase in Length

$$\boxed{\Delta L = \alpha L \Delta T}$$

Final Length

$$\boxed{L = L_0(1+\alpha\Delta T)}$$

Where

- α = Coefficient of Linear Expansion

SI Unit: K^{-1}

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4. Area Expansion

Increase in Area

$$\boxed{\Delta A = \beta A \Delta T}$$

Final Area

$$\boxed{A = A_0(1+\beta\Delta T)}$$

Relation

$$\boxed{\beta = 2\alpha}$$

5. Volume Expansion

Increase in Volume

$$\boxed{\Delta V = \gamma V \Delta T}$$

Final Volume

$$\boxed{V = V_0(1+\gamma \Delta T)}$$

Relation

$$\boxed{\gamma = 3\alpha}$$

6. Thermal Stress

If expansion is prevented,

$$\boxed{\sigma = Y\alpha\Delta T}$$

Where

- Y = Young's Modulus
- $\sigma = Thermal\ Stress$

7. Specific Heat Capacity

Heat required to raise temperature of unit mass by 1^0 or 1K

$$\boxed{Q = mc\Delta T}$$

Or

$$\boxed{c = \frac{Q}{m\Delta T}}$$

SI Unit:$Jkg^{-1}K^{-1}$

8. Heat Capacity

$$\boxed{C = mc}$$

SI Unit:J/K

9. Water Equivalent

$$\boxed{W = \frac{ms}{c_w}}$$

where

- c_W = Specific Heat Capacity of Water

10. Principle of Calorimetry

Heat Lost = Heat Gained

$$\boxed{m_1c_1(T_1 - T) = m_2c_2(T - T_2)}$$

Exam Tips

 हमेशा **Kelvin Scale** का प्रयोग Thermodynamics में करें।
 Expansion के तीनों गुणांक याद रखें:

- Linear → α
- Area → β=2α
- Volume → γ=3α

 In Calorimetry, **Heat Lost = Heat Gained**

Part–2: Latent Heat • Heat Transfer • Thermal Radiation

11. Latent Heat

Heat absorbed or released during change of state without change in temperature.

(i) Latent Heat of Fusion

$$\boxed{Q = mL_f}$$

Where

- L_f = Latent Heat of Fusion

(ii) Latent Heat of Vaporisation

$$\boxed{Q = mL_v}$$

Where

- L_V = Latent Heat of Vaporisation

12. Heat Required for Complete Process

When temperature changes as well as state changes,

$$\boxed{Q = mc\Delta T + mL}$$

13. Modes of Heat Transfer

There are **three modes**:

- Conduction
- Convection
- Radiation

14. Conduction

Heat transfer without actual motion of particles.

15. Rate of Heat Conduction (Fourier's Law)

$$\boxed{\frac{Q}{t} = \frac{kA(T_1 - T_2)}{L}}$$

Where

- k = Thermal Conductivity
- A = Cross-sectional Area
- L = Length

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16. Thermal Resistance

$$\boxed{R = \frac{L}{kA}}$$

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17. Convection

Heat transfer due to actual movement of fluid particles.
Examples

- Sea Breeze
- Land Breeze
- Chimney

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18. Radiation

Heat transfer without any material medium.
Travels through vacuum.

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19. Stefan–Boltzmann Law

Rate of radiation

$$\boxed{P = e\sigma AT^4}$$

Where

- e = Emissivity
- σ = Stefan Constant

$$\boxed{\sigma = 5.67 \times 10^{-8} Wm^{-2} K^{-4}}$$

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20. Wien's Displacement Law

$$\boxed{\lambda_m T = 2.898 \times 10^{-3} mK}$$

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21. Newton's Law of Cooling

For small temperature difference,

$$\boxed{\frac{dT}{dt} \propto (T - T_s)}$$

or

$$\boxed{\frac{dT}{dt} = -k(T - T_s)}$$

We can also say it as:

$$\boxed{\frac{T_1 - T_2}{t} = k\left[\frac{T_1 + T_2}{2} - T_s\right]}$$

Where

- Ts = Surrounding Temperature

Important Constants

Stefan Constant

$$\boxed{5.67 \times 10^{-8} Wm^{-2} K^{-4}}$$

Wien Constant

$$\boxed{2.898 \times 10^{-3} mK}$$

Exam Tips

 Conduction → Solids
 Convection → Liquids & Gases
 Radiation → Possible in Vacuum
 Black Body→ Best **Emitter** and Best **Absorber**
