PROBLEM-SOLVING TACTICS

While solving a problem of heat transfer in these cases, do look for state changes because that's where students generally make a mistake. State changes cause some of the energy to be used up as latent heat and hence must be taken care of always.

FORMULAE SHEET

1. Type of thermal expansion

		Coefficient of expansion	For temperature change Δt change in
(i)	Linear	$\alpha = \underset{\Delta t\to 0}{\text{Lim}} \frac{1}{\ell_0}\frac{\Delta \ell}{\Delta t}$	Length $\Delta \ell = \ell_0 \alpha \Delta t$
(ii)	Superficial	$\beta = \underset{\Delta t\to 0}{\text{Lim}} \frac{1}{A_0}\frac{\Delta A}{\Delta t}$	Area $\Delta A = A_0 \beta \Delta t$
(iii)	Volume	$\gamma = \underset{\Delta t\to 0}{\text{Lim}} \frac{1}{V_0}\frac{\Delta V}{\Delta t}$	Volume $\Delta V = V_0 \gamma \Delta t$

- For isotropic solids $\alpha_1 = \alpha_2 = \alpha_3 = \alpha$(let) so $\beta = 2\alpha$ and $\gamma = 3\alpha$
- For anisotropic solids $\beta = \alpha_1 + \alpha_2$ and $\gamma = \alpha_1 + \alpha_2 + \alpha_3$ Here α_1, α_2 and α_3 are coefficient of linear expansion in X, Y, and Z directions.

Variation in density: With increase of temperature volume increases so density decreases and vice-versa.

$$\rho = \frac{\rho_0}{(1+\gamma \Delta t)} \approx \rho_0 (1 - r\,\Delta T)$$

Thermal Stress: A rod of length ℓ_0 is clamped between two fixed walls with distance ℓ_0.

If temperature is changed by amount Δt then stress= $\frac{F}{A}$ (area assumed to be constant)

Strain= $\frac{\Delta \ell}{\ell_0}$; so, $Y = \frac{F/A}{\Delta \ell / \ell_0} = \frac{F\ell_0}{A\Delta \ell} - \frac{F}{A\alpha \Delta t}$ or $F = YA\alpha \Delta t$

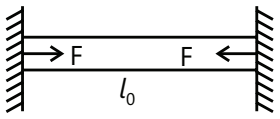

Figure 15.6

- $\Delta Q = mc\Delta T$ where c: Specific heat capacity
- $\Delta Q = nC\Delta T$ C: Molar heat capacity
- Heat transfer in phase change : $\Delta Q = mL$ L: latent heat of substance
- 1 Calorie= 4.18 joules of mechanical work
- Law of Calorimetry: heat released by one of the substances = Heat absorbed by other substances.