at $T = T$, length $= L \Rightarrow$ compression $= \Delta L = L - L_0$

$$L = L_0(1 + \alpha \cdot \Delta T)$$

$$L = L_0 + L_0 \alpha \cdot \Delta T \Rightarrow L - L_0 = L_0 \alpha \Delta T \quad -(2)$$

$$\text{strain} = \frac{\Delta L}{L_0} = \frac{L_0 \alpha \Delta T}{L_0} = \alpha \cdot \Delta T \quad -(3)$$

$$Y = \frac{\text{Thermal stress}}{\alpha \cdot \Delta T} \Rightarrow \text{Thermal stress} = Y \alpha \cdot \Delta T \quad -(4)$$

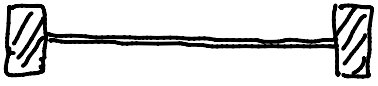
$$\frac{F}{A} = Y \alpha \cdot \Delta T$$

$$F = YA\alpha\Delta T \quad -(5)$$

Restoring force ← , → area of cross section of the rod

Example: A brass wire 1.8 m long at 27 °C is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of –39 °C, what is the tension developed in the wire, if its diameter is 2.0 mm? Co-efficient of linear expansion of brass = $2.0 \times 10^{-5}\ K^{-1}$; Young's modulus of brass = 0.91×10^{11} Pa.

[NCERT Exercise]



$L_0 = 1.8\,m$, $T_0 = 27°C$, $T = -39°C$