Answer on Question 80073, Physics, Other

Question:

(a) A copper bar is 80 cm long at 15℃. What is the increase in length when it is heated to 35℃? The linear expansion coefficient for copper is $1.7 \cdot 10^{-5}$ ℃$^{-1}$.

(b) A cylinder of diameter 1.00 cm at 30℃ is to be slid into a hole in a steel plate. The hole has a diameter of 0.99970 cm at 30℃. To what temperature must the plate be heated? The coefficient of linear expansion for steel is $1.1 \cdot 10^{-5}$ ℃$^{-1}$..

Solution:

(a) By the definition of the linear thermal expansion we have:

$$\frac{\Delta L}{L_0} = \alpha \Delta T,$$

here, ΔL is the increase in length of the copper bar when it is heated to 35℃, L_0 is the initial length of the copper bar at 15℃, α is the linear expansion coefficient for copper and ΔT is the change in temperature.

Then, from this equation we can find the increase in length of the copper bar when it is heated to 35℃:

$$\Delta L = \alpha \Delta T L_0 = 1.7 \cdot 10^{-5}\ ℃^{-1} \cdot (35℃ - \ 15℃) \cdot 0.8\ m = 2.7 \cdot 10^{-4}\ m.$$

(b) By the definition of the linear thermal expansion we have:

$$\frac{\Delta L}{L_0} = \frac{L - L_0}{L_0} = \alpha \Delta T,$$

here, $L_0 = 0.99970\ cm$ is the initial length of the steel plate at $T_0 = 30℃$, $L = 1.00\ cm$ is the length of the steel plate at temperature T, α is the coefficient of linear expansion for steel and ΔT is the change in temperature.

Then, we get:

$$\frac{L - L_0}{L_0} = \alpha (T - \ T_0),$$

$$T = \frac{L - L_0}{\alpha L_0} + T_0 = \frac{1.00\ cm - 0.99970\ cm}{1.1 \cdot 10^{-5}\ ℃^{-1} \cdot 0.99970\ cm} + 30℃ = 57℃.$$

Answer:

(a) $\Delta L = 2.7 \cdot 10^{-4}\ m.$

(b) $T = 57℃.$