Answer on Question 63926, Physics, Other

Question:

A copper cylinder is initially at 20°C. What temperature is required to cause the volume to be 0.15% larger than it is at 20°C?

Solution:

By the definition of the volume thermal expansion we have:

$$\frac{\Delta V}{V_0} = \alpha_V \Delta T = 3\alpha_L \Delta T,$$

here, ΔV is the change in the volume of the copper cylinder after the change in temperature, V_0 is the volume of the copper cylinder before the change in temperature, $\alpha_V = 3\alpha_L$ is the coefficient of volume expansion for copper, α_L is the coefficient of linear expansion for copper and ΔT is the change in temperature.

From the initial conditions of the question, we know that the fractional change in volume is equal to 0.15%:

$$\frac{\Delta V}{V_0} = 0.15\% = 0.0015.$$

Then, from this formula we can find ΔT (for copper $\alpha_L = 17 \cdot 10^{-6}\ \frac{1}{°C}$):

$$\Delta T = \frac{1}{3\alpha_L}\frac{\Delta V}{V_0} = \frac{1}{3 \cdot 17 \cdot 10^{-6}\frac{1}{°C}} \cdot 0.0015 = 29.4°C.$$

Since, $\Delta T = T - T_0$, we can find what temperature is required to cause the volume to be 0.15% larger than it is at 20°C:

$$T = T_0 + \Delta T = 20°C + 29.4°C = 49.4°C.$$

Answer:

$T = 49.4°C.$