12. (a) The coefficient of linear expansion α for the alloy is

$$\alpha = \Delta L/L\Delta T = \frac{10.015\,\text{cm} - 10.000\,\text{cm}}{(10.01\,\text{cm})(100°\text{C} - 20.000°\text{C})} = 1.88 \times 10^{-5}/\text{C}° \ .$$

Thus, from 100°C to 0°C we have

$$\Delta L = L\alpha\Delta T = (10.015\,\text{cm})\left(1.88 \times 10^{-5}/\text{C}°\right)(0°\text{C} - 100°\text{C}) = -1.88 \times 10^{-2}\ \text{cm} \ .$$

The length at 0°C is therefore $L' = L + \Delta L = 10.015\,\text{cm} - 0.0188\,\text{cm} = 9.996\,\text{cm}$.

(b) Let the temperature be T_x. Then from 20°C to T_x we have

$$\Delta L = 10.009\,\text{cm} - 10.000\,\text{cm} = \alpha L\Delta T = (1.88 \times 10^{-5}/\text{C}°)(10.000\,\text{cm})\Delta T \ ,$$

giving $\Delta T = 48\,\text{C}°$. Thus, $T_x = 20°\text{C} + 48\,\text{C}° = 68°\text{C}$.