Steel measuring tape

A surveyor uses a steel measuring tape that is exactly 50.000 m at a temperature of 20 °C.

(a) What is the length on a hot summer day when the temperature is 35 °C? ($\alpha_{\text{steel}} = 1.2\times10^{-5}\ \text{K}^{-1}$)

(b) On this day, when the tape reads 35.794 m, what is the true distance?

Solution

(a) $L_0 = 50.000$ m, $\Delta T = 35 - 20 = 15$ °C, $\alpha_{\text{steel}} = 1.2\times10^{-5}\ \text{K}^{-1}$ so

$$\Delta L = (1.2\times10^{-5})(50.000)(15) = 0.009\ \text{m}$$

so

$$L = L_0 + \Delta L = 50.009\ \text{m}$$

(b) Since the tape is now longer, it will read true distances as *shorter* than they actually are, e.g. a distance of 50.009 m will be read as 50.000 m. So we need to *increase* any measured distance by a factor of 50.009/50.000.

Thus a tape measure reading of $x = 35.794$ m means a true distance of

$$L = (35.794)\times\frac{50.009}{50.000} = 35.800\ \text{m}$$