Elastic Recovery After Plastic Deformation

6.44 (a) In order to determine the final length of the brass specimen when the load is released, it first becomes necessary to compute the applied stress using Equation 6.1; thus

$$\sigma = \frac{F}{A_0} = \frac{F}{\pi \left(\frac{d_0}{2}\right)^2} = \frac{11,750 \ N}{\pi \left(\frac{10 \ x \ 10^{-3} \ m}{2}\right)^2} = 150 \ MPa \ (22,000 \ psi)$$

Upon locating this point on the stress-strain curve (Figure 6.12), we note that it is in the linear, elastic region; therefore, when the load is released the specimen will return to its original length of 120 mm (4.72 in.).

(b) In this portion of the problem we are asked to calculate the final length, after load release, when the load is increased to 23,500 N (5280 lb$_f$). Again, computing the stress

$$\sigma = \frac{23,500 \ N}{\pi \left(\frac{10 \ x \ 10^{-3} \ m}{2}\right)^2} = 300 \ MPa \ (44,200 \ psi)$$

The point on the stress-strain curve corresponding to this stress is in the plastic region. We are able to estimate the amount of permanent strain by drawing a straight line parallel to the linear elastic region; this line intersects the strain axis at a strain of about 0.012 which is the amount of plastic strain. The final specimen length l_i may be determined from a rearranged form of Equation 6.2 as

$$l_i = l_0(1 + \varepsilon) = (120 \ mm)(1 + 0.012) = 121.44 \ mm \ (4.78 \ in.)$$