19.14 This problem asks for us to determine the temperature to which a cylindrical rod of tungsten 15.025 mm in diameter must be heated in order for it of just fit into a 15.000 mm diameter circular hole in a plate of 1025 steel (which, of course, is also heated), assuming that the initial temperature is 25°C. This requires the use of Equation 19.3a, which is applied to the diameters of both the rod and hole. That is

$$\frac{d_f - d_0}{d_0} = \alpha_l (T_f - T_0)$$

Solving this expression for d_f yields

$$d_f = d_0 \left[1 + \alpha_l (T_f - T_0) \right]$$

Now all we need do is to establish expressions for d_f(steel) and d_f(W), set them equal to one another, and solve for T_f. According to Table 19.1, α_l(steel) = 12.0 x 10^{-6} (°C)$^{-1}$ and α_l(W) = 4.5 x 10^{-6} (°C)$^{-1}$. Thus

$$d_f(\text{steel}) = d_f(\text{W})$$

$$(15.000 \text{ mm}) \left[1 + \left\{ 12.0 \text{ x } 10^{-6} (^\circ\text{C})^{-1} \right\} (T_f - 25^\circ\text{C}) \right]$$

$$= (15.025 \text{ mm}) \left[1 + \left\{ 4.5 \text{ x } 10^{-6} (^\circ\text{C})^{-1} \right\} (T_f - 25^\circ\text{C}) \right]$$

Now solving for T_f gives T_f = 222.4°C