7. **REASONING AND SOLUTION**  The conductance of an 0.080 mm thick sample of Styrofoam of cross-sectional area $A$ is

$$\frac{k_A A}{L_s} = \frac{[0.010 \, \text{J} / (\text{s} \cdot \text{m} \cdot \text{C})] A}{0.080 \times 10^{-3} \, \text{m}} = [125 \, \text{J} / (\text{s} \cdot \text{m}^2 \cdot \text{C})] A$$

The conductance of a 3.5 mm thick sample of air of cross-sectional area $A$ is

$$\frac{k_a A}{L_s} = \frac{[0.0256 \, \text{J} / (\text{s} \cdot \text{m} \cdot \text{C})] A}{3.5 \times 10^{-3} \, \text{m}} = [7.3 \, \text{J} / (\text{s} \cdot \text{m}^2 \cdot \text{C})] A$$

Dividing the conductance of Styrofoam by the conductance of air for samples of the same cross-sectional area $A$, gives

$$\frac{[125 \, \text{J} / (\text{s} \cdot \text{m}^2 \cdot \text{C})] A}{[7.3 \, \text{J} / (\text{s} \cdot \text{m}^2 \cdot \text{C})] A} = 17$$

Therefore, the body can adjust the conductance of the tissues beneath the skin by a factor of 17.

15. **REASONING**  The rate at which heat is conducted along either rod is given by Equation 13.1, $Q/t = (kA \Delta T)/L$. Since both rods conduct the same amount of heat per second, we have

$$\frac{k_s A_s \Delta T}{L_s} = \frac{k_i A_i \Delta T}{L_i}$$

(1)

Since the same temperature difference is maintained across both rods, we can algebraically cancel the $\Delta T$s. Because both rods have the same mass, $m_s = m_i$; in terms of the densities of silver and iron, the statement about the equality of the masses becomes

$$\rho_s (L_s A_s) = \rho_i (L_i A_i)$$

or

$$\frac{A_s}{A_i} = \frac{\rho_i L_i}{\rho_s L_s}$$

(2)

Equations (1) and (2) may be combined to find the ratio of the lengths of the rods. Once the ratio of the lengths is known, Equation (2) can be used to find the ratio of the cross-sectional areas of the rods. If we assume that the rods have circular cross sections, then each has an
area of \( A = \pi r^2 \). Hence, the ratio of the cross-sectional areas can be used to find the ratio of the radii of the rods.

**SOLUTION**

a. Solving Equation (1) for the ratio of the lengths and substituting the right hand side of Equation (2) for the ratio of the areas, we have

\[
\frac{L_s}{L_i} = \frac{k_sA_s}{k_iA_i} = \frac{k_s(\rho_i L_i)}{k_i(\rho_s L_s)} \quad \text{or} \quad \left( \frac{L_s}{L_i} \right)^2 = \frac{k_s\rho_i}{k_i\rho_s}
\]

Solving for the ratio of the lengths, we have

\[
\frac{L_s}{L_i} = \sqrt{\frac{k_s\rho_i}{k_i\rho_s}} = \sqrt{\frac{[420 \text{ J/}(\text{s} \cdot \text{m} \cdot \text{C}^\circ)](7860 \text{ kg/m}^3)}{[79 \text{ J/}(\text{s} \cdot \text{m} \cdot \text{C}^\circ)](10500 \text{ kg/m}^3)}} = 2.0
\]

b. From Equation (2) we have

\[
\frac{\pi r_s^2}{\pi r_i^2} = \frac{\rho_i L_i}{\rho_s L_s} \quad \text{or} \quad \left( \frac{r_s}{r_i} \right)^2 = \frac{\rho_i L_i}{\rho_s L_s}
\]

Solving for the ratio of the radii, we have

\[
\frac{r_s}{r_i} = \sqrt{\frac{\rho_i L_i}{\rho_s L_s}} = \sqrt{\frac{7860 \text{ kg/m}^3}{10500 \text{ kg/m}^3}} \left( \frac{1}{2.0} \right) = 0.61
\]

17. **REASONING AND SOLUTION** Solving the Stefan-Boltzmann law, Equation 13.2, for the time \( t \), and using the fact that \( Q_{\text{blackbody}} = Q_{\text{bulb}} \), we have

\[
t_{\text{blackbody}} = \frac{Q_{\text{blackbody}}}{\sigma T^4 A} = \frac{Q_{\text{bulb}}}{\sigma T^4 A} = \frac{P_{\text{bulb}}}{\sigma T^4 A} \times t_{\text{bulb}}
\]

where \( P_{\text{bulb}} \) is the power rating of the light bulb. Therefore,

\[
t_{\text{blackbody}} = \frac{(100.0 \text{ J/s})(3600 \text{ s})}{[5.67 \times 10^{-8} \text{ J/(s} \cdot \text{m}^2 \cdot \text{K}^4)](303 \text{ K})^4 \left[ (6 \text{ sides})(0.0100 \text{ m})^2 \right] / \text{side} \}
\]

\[
\times \left( \frac{1 \text{ h}}{3600 \text{ s}} \right) \left( \frac{1 \text{ da}}{24 \text{ h}} \right) = 14.5 \text{ da}
\]
35. **REASONING** If the cylindrical rod were made of solid copper, the amount of heat it would conduct in a time \( t \) is, according to Equation 13.1, 
\[
Q_{\text{copper}} = (k_{\text{copper}} A_2 \Delta T / L) t.
\]
Similarly, the amount of heat conducted by the lead-copper combination is the sum of the heat conducted through the copper portion of the rod and the heat conducted through the lead portion:
\[
Q_{\text{combination}} = \left[ k_{\text{copper}} (A_2 - A_1) \Delta T / L + k_{\text{lead}} A_1 \Delta T / L \right] t.
\]
Since the lead-copper combination conducts one-half the amount of heat than does the solid copper rod, 
\[
Q_{\text{combination}} = \frac{1}{2} Q_{\text{copper}},
\]
or
\[
\frac{k_{\text{copper}} (A_2 - A_1) \Delta T}{L} + \frac{k_{\text{lead}} A_1 \Delta T}{L} = \frac{1}{2} \frac{k_{\text{copper}} A_2 \Delta T}{L}.
\]

This expression can be solved for \( A_1 / A_2 \), the ratio of the cross-sectional areas. Since the cross-sectional area of a cylinder is circular, \( A = \pi r^2 \). Thus, once the ratio of the areas is known, the ratio of the radii can be determined.

**SOLUTION** Solving for the ratio of the areas, we have
\[
\frac{A_1}{A_2} = \frac{k_{\text{copper}}}{2(k_{\text{copper}} - k_{\text{lead}})}.
\]
The cross-sectional areas are circular so that 
\[
A_1 / A_2 = \left( \frac{\pi r_1^2}{\pi r_2^2} \right) = \left( \frac{r_1}{r_2} \right)^2;
\]
therefore,
\[
\frac{r_1}{r_2} = \sqrt{\frac{k_{\text{copper}}}{2(k_{\text{copper}} - k_{\text{lead}})}} = \sqrt{\frac{390 \text{ J}/(\text{s} \cdot \text{m} \cdot \text{C}^\circ)}{2[390 \text{ J}/(\text{s} \cdot \text{m} \cdot \text{C}^\circ) - 35 \text{ J}/(\text{s} \cdot \text{m} \cdot \text{C}^\circ)]}} = 0.74
\]