Ch. 9 Prob 47

$L = 25.0\,m$

$D = 0.100\,mm$

$R = 77.7\,\Omega$ @ $20.0^\circ C$

a) Find the material from which the wire is made.

$$R = \rho\frac{L}{A} \qquad \text{but } A = \pi\left(\frac{D}{2}\right)^2 = \frac{\pi}{4}D^2$$

$$R = \frac{\rho L}{\frac{\pi}{4}D^2} = \frac{4\rho L}{\pi D^2}$$

solving for ρ gives

$$\rho = \frac{\pi D^2 R}{4L} = \frac{\pi(1.0\times10^{-4}\,m)^2(77.7\,\Omega)}{4(25.0\,m)}$$

$$\rho = 2.44\times10^{-8}\,\Omega\cdot m$$

Using table 9.1 the material must be **gold**.

b) Find the resistance at $150.0^\circ C$

The temperature coefficient for gold is

$$\alpha = 0.0034\,^\circ C^{-1}$$

Now $\rho = \rho_0(1+\alpha\Delta T)$ and $R = \frac{\rho L}{A} = \frac{\rho_0(1+\alpha\Delta T)L}{A}$

$$R = \frac{\rho_0 L}{A}(1+\alpha\Delta T)$$

The new resistance is then $R = R_0(1+\alpha\Delta T)$

$$R = (77.7\,\Omega)\left[1 + (0.0034\,^\circ C^{-1})(150-20)^\circ C\right]$$

$$= 77.7\,\Omega[1.442] = \boxed{112\,\Omega}$$

Resistance has increased by 44.2%