

ch 9 Prob 57

14 gauge nichrome wire

$P = 300W$ $V = 110V$

How long should the wire be?

for nichrome wire $\rho = 100.00 \times 10^{-8} \Omega \cdot m$

Looking up the diameter of 14 gauge wire on the internet gives

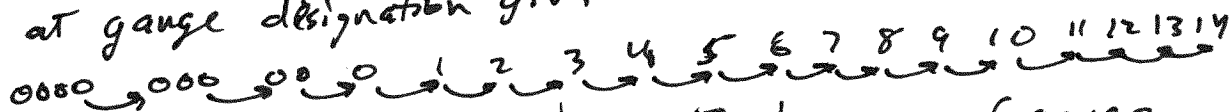
0000 gauge $D_{0000} = 0.46 \text{ in}$ 36 gauge $D_{36} = 0.005 \text{ in}$ (change of $\frac{1}{92}$)

gauges between these values is a geometric series

where ~~each~~ there are ~~40 steps~~ 39 gauges ~~between~~ changes

between 0000 and 36. Each change in gauge is a reduction of $\sqrt[39]{92}$

looking at gauge designation gives



so to get to 14 gauge you have 17 changes of gauge

so the wire is reduced in size by $92^{17/39} = 7.178$

$$D_{14} = \frac{D_{0000}}{7.178} = \frac{0.46 \text{ in}}{7.178} = 0.06408 \text{ in}$$

convert to centimeters gives

$$D_{14} = 0.06408 \text{ in} \left(\frac{2.54 \text{ cm}}{1 \text{ in}} \right)$$

or you could just look it up!

$$D_{14} = 0.163 \text{ cm}$$

$$\text{Now } R = \frac{\rho L}{A} = \frac{\rho L}{\pi D^2/4} = \frac{4\rho L}{\pi D^2}$$

$$\text{Also } P = V \cdot I = V \left(\frac{V}{R} \right) = \frac{V^2}{R} = \frac{V^2}{\left(\frac{4\rho L}{\pi D^2} \right)} = \frac{\pi D^2 V^2}{4\rho L}$$

solve for L

$$L = \frac{\pi D^2 V^2}{4\rho P} = \frac{\pi (1.63 \times 10^{-3} \text{ m})^2 (110 \text{ V})^2}{4 (100 \times 10^{-8} \Omega \cdot m) (300 \text{ W})} = 84.2 \text{ m}$$

Difference from text value to rounded