

Ch. 9 Pwb. 41

Find ratio of diameter of Aluminum to that of copper assuming the same resistance per length

$$\rho_{Cu} = 1.68 \times 10^{-8} \Omega \cdot m$$

$$\rho_{Al} = 2.65 \times 10^{-8} \Omega \cdot m$$

Now for resistance

$$R = \frac{\rho L}{A}$$

Copper

$$R_{Cu} = \frac{\rho_{Cu} L_{Cu}}{A_{Cu}}$$

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

for copper  $R_{Cu} = \frac{4 \rho_{Cu} L_{Cu}}{\pi D_{Cu}^2}$  and Aluminum  $R_{Al} = \frac{4 \rho_{Al} L_{Al}}{\pi D_{Al}^2}$

~~Now  $R_{Cu} = R_{Al}$~~   
 ~~$\frac{4 \rho_{Cu} L_{Cu}}{\pi D_{Cu}^2} = \frac{4 \rho_{Al} L_{Al}}{\pi D_{Al}^2}$~~  so  $\frac{R_{Cu}}{L_{Cu}} = \frac{R_{Al}}{L_{Al}}$

$$\frac{4 \rho_{Cu}}{\pi D_{Cu}^2} = \frac{R_{Cu}}{L_{Cu}} = \frac{R_{Al}}{L_{Al}} = \frac{4 \rho_{Al}}{\pi D_{Al}^2}$$

multiply both sides by  $\pi/4$  gives

$$\frac{\rho_{Cu}}{D_{Cu}^2} = \frac{\rho_{Al}}{D_{Al}^2} \rightarrow \frac{D_{Al}^2}{D_{Cu}^2} = \frac{\rho_{Al}}{\rho_{Cu}}$$

$$\frac{D_{Al}}{D_{Cu}} = \sqrt{\frac{\rho_{Al}}{\rho_{Cu}}} = \sqrt{\frac{2.65 \times 10^{-8} \Omega \cdot m}{1.68 \times 10^{-8} \Omega \cdot m}}$$

$$\left[ \frac{D_{Al}}{D_{Cu}} = 1.26 \right]$$

Aluminum wire is 26% larger in diameter than copper.