Rec 11: Sept 29, 2009

25.12

\[ a) \quad J = \frac{I}{A} = \frac{I}{D^2} = \frac{3.6}{(2.3 \times 10^{-3})^2} = 6.8 \times 10^5 \, \text{N/m}^2 \]

\[ b) \quad V = EL \]

\[ V = IR = I \frac{P}{D^2} \]

\[ E = \frac{V}{L} = \frac{P}{L/D^2} = \frac{(1.72 \times 10^{-8})(3.6)}{(2.3 \times 10^{-3})^2} = 1.17 \times 10^{-2} \, \text{V/m} \]

\[ c) \quad h = \frac{Vd}{t} \Rightarrow t = \frac{L}{Vd} \]

\[ Vd = \frac{J}{mg} = \frac{6.8 \times 10^5}{(8.5 \times 10^{-3})(1.6 \times 10^{-2})} = 5 \times 10^{-5} \, \text{m/s} \]

\[ t = 8 \times 10^{-4} \, \text{s} \approx 22 \, \text{hrs} \]

25.18

\[ L_{cu} \quad L_{Al} \]

\[ \text{Weld} \quad R_{cu} = R_{Al} \Rightarrow \frac{P_{cu}L_{cu}}{A_{cu}} = \frac{P_{Al}L_{Al}}{A_{Al}} \]

\[ L_{cu} = L_{Al} \quad \text{So} \quad \frac{P_{cu}}{P_{Al}} = \frac{A_{cu}}{A_{Al}} = \frac{\pi d_{cu}^2}{\pi d_{Al}^2} \]

\[ \frac{d_{cu}}{d_{Al}} = \sqrt{\frac{P_{cu}}{P_{Al}}} \Rightarrow d_{cu} = d_{Al} \sqrt{\frac{P_{cu}}{P_{Al}}} = (3.26 \, \text{mm}) \sqrt{\frac{1.72 \times 10^{-8}}{2.75 \times 10^{-8}}} \]

\[ d_{cu} = 2.58 \, \text{mm} \]

25.18

\[ p = p_0 \left[ 1 + \alpha (T - T_0) \right] \]

\[ R = \frac{p}{A} \quad R_0 = p_0 \frac{L}{A} \]

Assuming \( L \) \& \( A \) const.

Then \( \frac{R}{R_0} = \frac{p}{p_0} \)

Thus \( R = R_0 \left[ 1 + \alpha (T - T_0) \right] \)
25.28 cont'd
\[ T = \frac{1}{\mu} \left( \frac{E}{k_0} - 1 \right) + T_0 = -0.0005 \left[ \frac{215.8}{217.3} - 1 \right] + 4 \]
\[ T = 17.8 ^\circ C \]

25.58
\[ V = IR \Rightarrow I = \frac{V}{R} = \frac{V}{\rho L/A} = \frac{VA}{\rho L} \]
\[ A = \pi r_2^2 - \pi r_1^2 \] 
So
\[ I = \frac{\pi V (r_2^2 - r_1^2)}{\rho L} = \frac{\pi}{\rho L} \frac{4.5^2 \times 10^{-3}}{(1.47 \times 10^{-8})} \]
\[ = 468.4 \text{ A} \]

25.61
\[ \begin{align*}
\text{cu} \quad b) \quad E_1 &= \rho J = \rho \frac{I}{A_1} = (1.72 \times 10^{-8}) \left( \frac{2.5 \times 10^{-3}}{0.8 \times 10^{-3}} \right)^2 \\
&= 2.14 \times 10^{-5} \text{ V/m} \\
\text{cu} \quad c) \quad E_2 &= \rho \frac{J}{A_2} = (1.72 \times 10^{-8}) \left( \frac{2.5 \times 10^{-3}}{0.4 \times 10^{-3}} \right)^2 = 8.55 \times 10^{-5} \text{ V/m} \\
\text{cu} \quad d) \quad V &= E_1 l_1 + E_2 l_2 = 1.88 \times 10^{-4} \text{ V} 
\end{align*} \]
Physics 24 Test-Level Problems for Recitation 11

A. 1. Two wires, A and B, are made of the same metal and have equal length, but the resistance of wire A is four times the resistance of wire B. How do their diameters compare?
   [A] \( d_A = \frac{1}{2} d_B \)   [B] \( d_A = \frac{1}{4} d_B \)   [C] \( d_A = 4 d_B \)
   [D] \( d_A = 2 d_B \)   [E] \( d_A = d_B \)

B. 2. A wire of resistance R is stretched uniformly (keeping its volume constant) until it is twice its original length. What happens to the resistance?
   [A] it increases by a factor 2   [B] it increases by a factor 4
   [C] it stays the same   [D] it decreases by a factor 4
   [E] it decreases by a factor 2

C. 3. If the current through a conductor is halved, then
   [A] the electron drift velocity is halved and the resistivity is doubled,
   [B] the electron drift velocity is unchanged and the resistivity is doubled,
   [C] the electron drift velocity is halved and the resistivity is unchanged,
   [D] the electron drift velocity is unchanged and the resistivity is unchanged.

4. A bus bar (a conducting bar intended to carry a large value of current) is made of copper and carries a current of 100 A over a distance of 0.25 m at a temperature of 20 °C. What is the minimum cross sectional area of the bus bar if there is to be no more than 2 mV of potential difference between the ends through which current enters and leaves?

\[
V = IR \Rightarrow R = \frac{V}{I}
\]

\[
R = \frac{\rho L}{A} \Rightarrow \frac{V}{I} = \frac{\rho L}{A}
\]

\[
A = \frac{\rho L I}{V} = \frac{(1.72 \times 10^{-8})(0.25)(100)}{2 \times 10^{-3}}
\]

\[
A = 2.15 \times 10^{-4} \text{ m}^2
\]