Solution to HW Problems
Chapter 27

104 Phys

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5. Two wires A and B of circular cross section are made of the same metal and have equal lengths, but the resistance of wire A is three times greater than that of wire B. What is the ratio of their cross-sectional areas? How do their radii compare?

Q # 5 /127: $l_A = l_B$ $\rho_A = \rho_B$ $R_A = 3 R_B$

find r_B / r_A ?

$\because R = \frac{\rho l}{A} \rightarrow \frac{R_A}{R_B} = \frac{\rho l}{\pi r_A^2} \div \frac{\rho l}{\pi r_B^2} = 3$

$\therefore \frac{r_B^2}{r_A^2} = 3 \rightarrow r_B = \sqrt{3}\, r_A$ #

21. A metal wire of resistance R is cut into three equal pieces that are then connected side by side to form a new wire the length of which is equal to one-third the original length. What is the resistance of this new wire?

P 21/27:

for the original wire $R = \rho \frac{l}{A}$

Now $l \to \frac{1}{3} l$ $\quad A \to 3A$

$\therefore R \to \rho \frac{l/3}{3A} = \frac{\rho l}{9A} \to R' = \frac{R}{9}$

22. Aluminum and copper wires of equal length are found to have the same resistance. What is the ratio of their radii?

P 22/27: $\rho_{AL} = 2.82 \times 10^{-8}\ \Omega \cdot m$ $\rho_{Cu} = 1.7 \times 10^{-8}\ \Omega \cdot m$

$l_{AL} = l_{Cu}$ $R_{AL} = R_{Cu}$

$\therefore R = \frac{\rho l}{A} \rightarrow R_{AL} = \frac{\rho_{AL} l}{A_{AL}} = R_{Cu} = \frac{\rho_{Cu} l}{A_{Cu}}$

$\rightarrow \frac{\rho_{AL}}{\pi R_{AL}^2} = \frac{\rho_{Cu}}{\pi R_{Cu}^2} \rightarrow \frac{R_{AL}}{R_{Cu}} = \sqrt{\frac{\rho_{AL}}{\rho_{Cu}}} = \sqrt{\frac{2.82}{1.7}} = 1.29$

35. The temperature of a sample of tungsten is raised while a sample of copper is maintained at 20.0°C. At what temperature will the resistivity of the tungsten be four times that of the copper?

P 27/27: ρ_{Cu} at $T = 20° = 1.7 \times 10^{-8}\ \Omega\text{-m}$ $\alpha_t = 4.5 \times 10^{-3}$

ρ_t at $T = 20° = 5.6 \times 10^{-8}\ \Omega\text{-m}$

$\because \rho_t = \rho_{0t}(1 + \alpha_t \Delta T) \rightarrow \rho_t = 5.6 \times 10^{-8}[1 + 4.5 \times 10^{-3} \Delta T]$

we need $\rho_t = 4\rho_{0Cu} = 4 \times 1.7 \times 10^{-8}$

$\therefore 4 \times 1.7 \times 10^{-8} = 5.6 \times 10^{-8}(1 + 4.5 \times 10^{-3} \Delta T) \Rightarrow \Delta T = \frac{4 \times 1.7}{5.6} - 1 / 4.5 \times 10^{-3}$

$\Rightarrow \Delta T = 47.62°C \rightarrow T = 47.62 + 20 = 67.62°C$

49. Compute the cost per day of operating a lamp that draws a current of 1.70 A from a 110-V line. Assume the cost of energy from the power company is \$0.060 0/kWh.

P. 49/27: $I = 1.7A$ $V = 110V$ $\$ = 0.06 / kWh$

$t = 24\ h.$

$\because P = VI = 110 \times 1.7$

$\therefore$ total $P = 110 \times 1.7 \times 24 = 4488\ W = 4.488\ kW$

$\therefore \$ = 4.488 \times 0.06 = \$0.27$ #