Problem Set 5 Problems

Problem 1: 27.8
An electric current is given by the expression
\[ I(t) = 100 \sin(120 \pi t) \]  
where \( I \) is in amperes and \( t \) is in seconds. What is the total charge carried by the current from \( t = 0 \) to \( t = \frac{1}{240} \) s?

Problem 2: 27.24
The rod in Figure P27.24 (not drawn to scale) is made of two materials. Both have a square cross section of 3.00 mm on a side. The first material has a resistivity of \( 4.00 \times 10^{-3} \) \( \Omega \cdot \text{m} \) and is 25.0 cm long, while the second material has a resistivity of \( 6.00 \times 10^{-3} \) \( \Omega \cdot \text{m} \) and is 40.0 cm long. What is the resistance between the ends of the rod?

Problem 3: 27.53
A high-voltage transmission line with a diameter of 2.00 cm and a length of 200 km carries a steady current of 1000 A. If the conductor is copper wire with a free charge density of \( 8.00 \times 10^{28} \) electrons/m\(^3\), how long does it take one electron to travel the full length of the cable?

Problem 4: 27.66
A resistor is constructed by shaping a material of resistivity \( \rho \) into a hollow cylinder of length \( L \) and with inner and outer radii \( r_i \) and \( r_o \), respectively (Fig. P27.66).
In use, the application of a potential difference between the ends of the cylinder produces a current parallel to the axis.

(a) Find a general expression for the resistance of such a device in terms of $L, \rho, r_a$ and $r_b$.

(b) Obtain a numerical value for $R$ when $L = 4.00 \text{ cm}$, $r_a = 0.500 \text{ cm}$, $r_b = 1.20 \text{ cm}$, and $\rho = 3.50 \times 10^5 \Omega \cdot \text{m}$

(c) Now suppose that the potential difference is applied between the inner and outer surfaces so that the resulting current flows radially outward. Find a general expression for the resistance of the device in terms of $L, \rho, r_a$ and $r_b$. Calculate the value of $R$, using the parameter values given in part (b).

**Problem 5: 27.70**
A material of resistivity $\rho$ is formed into the shape of a truncated cone of altitude $h$, as shown in Figure P27.70.

![Diagram of truncated cone](image)

The bottom end has a radius $b$, and the top end has a radius $a$. Assuming that the current is distributed uniformly over any particular cross-section of the cone so that the current density is not a function of radial position (although it does vary with position along the axis of the cone), show that the resistance between the two ends is given by the expression

$$ R = \frac{\rho}{\pi} \left( \frac{h}{ab} \right) $$

(2.1)

**Problem 1: 28.6**
(a) Find the equivalent resistance between points $a$ and $b$ in Figure P28.6.
(b) Calculate the current in each resistor if a potential difference of $34.0 \text{ V}$ is applied between points $a$ and $b$.

**Problem 2: 28.16.**
Two resistors connected in series have an equivalent resistance of $690 \ \Omega$. When they are connected in parallel, their equivalent resistance is $150 \ \Omega$. Find the resistance of each resistor.
Problem 3: 28.17
In Figures 28.4 and 28.5, let $R_1 = 11.0 \, \Omega$, let $R_2 = 22.0 \, \Omega$, and let the battery have a terminal voltage of 33.0 V.

(a) in the parallel circuit shown in Figure 28.5, which resistor uses more power?
(b) Verify that the sum of the power ($I^2R$) used by each resistor equals the power supplied by the battery ($I\Delta V$).
(c) In the series circuit, which resistor uses more power?
(d) Verify that the sum of the power ($I^2R$) used by each resistor equals the power supplied by the battery ($P = I\Delta V$).
(e) Which circuit configuration uses more power?