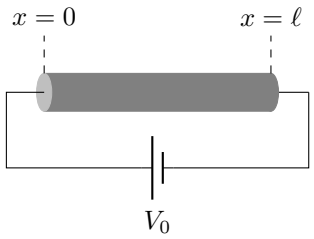
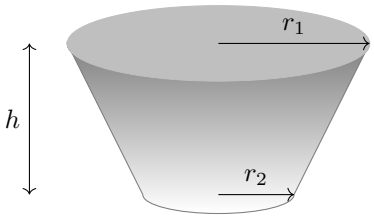
Chapter 25 - Current, Resistance and Emf

Physics 207

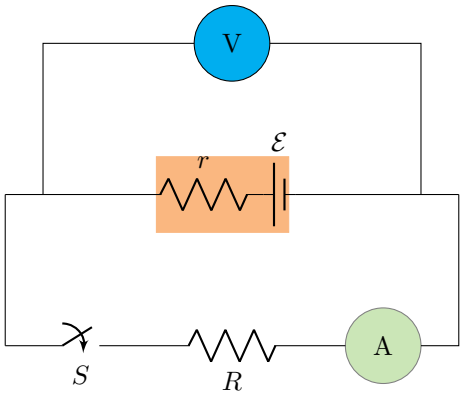
1. A cylindrical resistor is connected to a voltage source V_0. The cylinder has length ℓ and radius B. The material has a variable resistivity $\rho(x) = \rho_0 \frac{x^2}{\ell^2}$.
a) Find the current through the resistor.
b) Find the electric field $E(x)$ magnitude in the rod as a function of x.
c) Find the electric potential $V(x)$ as a function of x.
d) Graph $\rho(x)$, $E(x)$, and $V(x)$ for values of x between 0 and ℓ.
e) What is the power dissipated by the resistor?



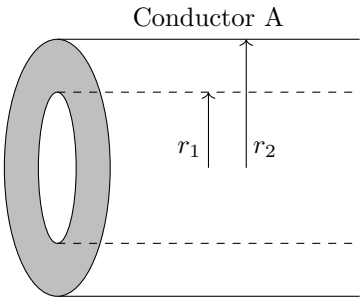
2. A material of uniform resistivity ρ is formed into a solid, truncated cone of height h and radii r_1 and r_2 at either end. If the taper is small, we assume that the current density is uniform across any cross section.
a) Calculate the resistance of the cone between the two flat end faces.
b) Show that the results satisfy $R = \frac{\rho \ell}{A}$ when $r_1 = r_2$.

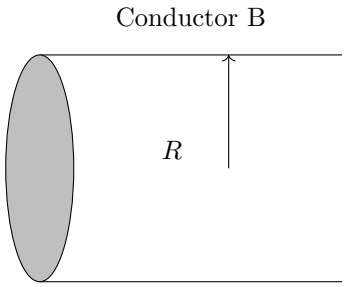


3. When switch S is open, the voltmeter reads V_1. When the switch is closed, the voltmeter reading drops to V_2 and the ammeter reads I_2. Find the internal resistance of the battery, and the circuit resistance R. Assume that the two meters are ideal, so they don't affect the circuit.



4. Conductor A with uniform resistivity ρ_A is in the shape of a hollow cylinder with inner radius r_1 and outer radius r_2. Conductor B is in the shape of a solid cylinder with radius R. The two conductors are the same length.
a) If conductor B has the same resistivity as conductor A, what does R have to be so that the two conductors have the same resistance between the ends?
b) If R was the same as r_2, what would the resistivity of conductor B have to be so that the two conductors have the same resistance between the ends?





5. A certain brand of hot dog cooker applies a potential difference of 120 V to opposite ends of the hot dog and cooks it by means of the heat produced. If 48.0 kJ is needed to cook a hot dog, a) what current is needed to cook the hot dog in 2.00 minutes and b) what is the resistance of a hot dog? Assume the hot dog is ohmic.

6. Standard incandescent light bulbs (lets assume 75.0 W at operating temperature) use a small tungsten wire as the filament. These bulbs tend to break at the moment you turn the switch on, rather than during normal operation. To demonstrate this, calculate by what percentage more current is passing through a tungsten filament when it first comes on (at 20 °C) than while at its operating temperature (2550 °C). The resistivity of tungsten at 20 °C is 5.60×10^{-8} Ωm and the temperature coefficient is 0.0045/°C.

7. A cylindrical wire with radius r and length ℓ is deformed by stretching so that it has now doubled in length but the volume has remained the same. By what factor has the resistance of this wire changed?