

7. Electric Current

Self-test questions

1. Calculate the current density J in the filament of a flashlight bulb, if the power is 10 W for voltage 3 V. Assume the length of the filament is 1 cm and the resistivity is $20 \times 10^{-8} \Omega \text{ m}$.
2. Current I flows in a long wire. The resistance is R for one-half of the length of the wire, and $2R$ for the other half. What is the potential across the wire? What is the electric field in each half of the wire? What is the surface charge density on the boundary between the two halves?
3. A battery with emf \mathcal{E} and internal resistance r is connected to a load with variable resistance R . Find R such that the power dissipated in R is maximum. For this optimal R , what fraction of the power is dissipated in R ?
4. As a model of conductivity, suppose electrons in a certain material experience a “frictional force” of magnitude γv^2 in the direction opposite to the velocity v . What is the relation between I and V for a wire of this material? Is the model reasonable?