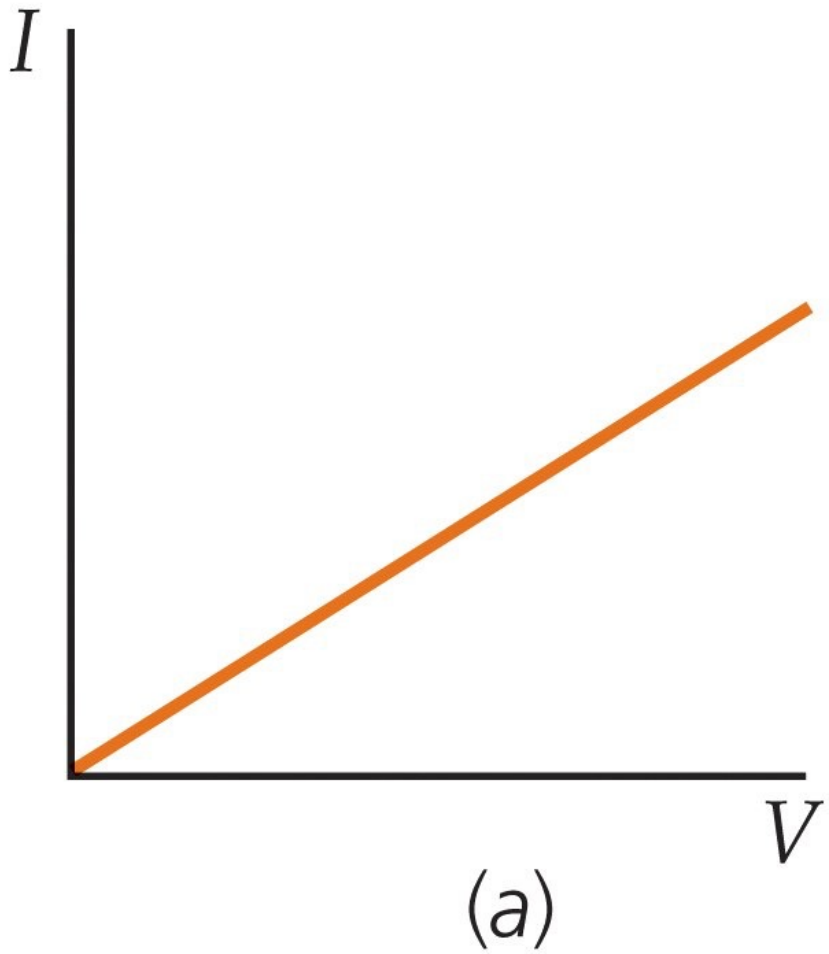
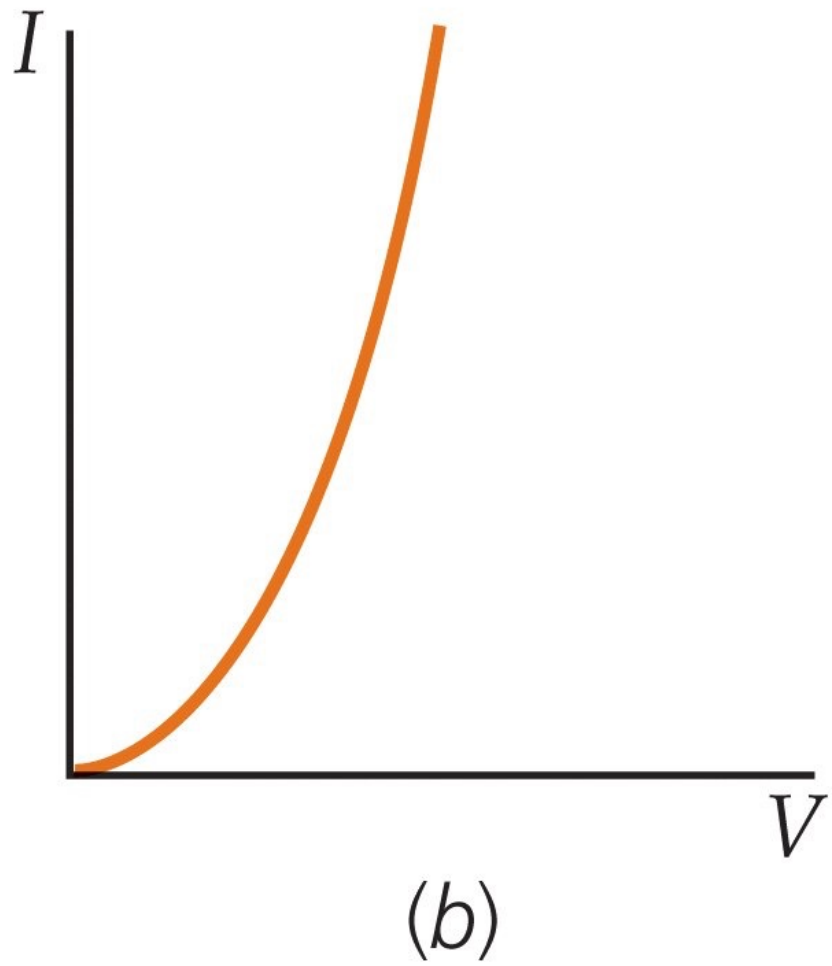
Chapter 19: Current and Resistance

- Current $I = \frac{dQ}{dt}$ $Q = \int_0^t I(t)dt$
- In terms of the current density $I = \int \vec{J} \cdot d\vec{A}$
- For a uniform current density parallel to the area element $J = I / A$
- Ohm's Law $\vec{J} = \sigma \vec{E} = \vec{E} / \rho$
- Practical version $\Delta V = RI$ where the resistance is $R = \rho \frac{l}{A}$

Ohmic material



Nonohmic material



Example Problem

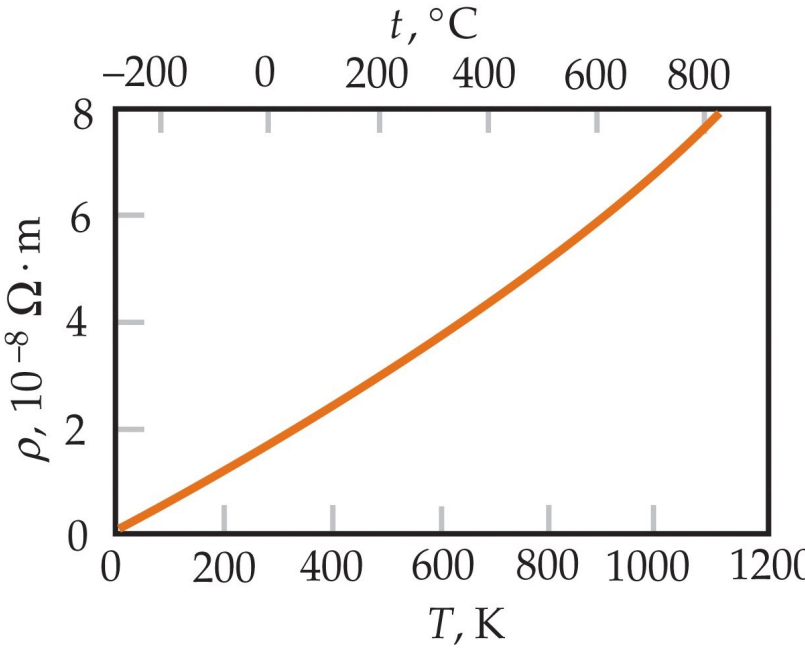
- Lightning strikes the ground with a current of 100 kA. A person and a cow are each a radial distance D=60.0 m from the lightning strike. The current spreads through the ground uniformly over a hemisphere centered on the strike point. The person's feet are separated by radial distance Δr_{per}=0.50 m; the cow's front and rear hooves are separated by the radial distance Δr_{cow}=1.50 m. The resistivity of the ground is ρ_{gr}=100 $\Omega \cdot$m. The resistance both across the person, between left and right feet, and across the cow, between front and read hooves, is R=4.00 kΩ. What are the currents through the person and through the cow?

Variation of Resistivity and Resistance with Temperature

- The values of most physical properties of materials vary with temperature
- For a conductor, it is found, over a limited temperature range, that this variation is linear in temperature

$$\rho(T) = \rho_0[1 + \alpha(T - T_0)]$$

ρ_0 is the resistivity at room temperature T_0=20 °C and α is the temperature coefficient of resistivity. It is given in Table 27.1 and has units of 1/°C

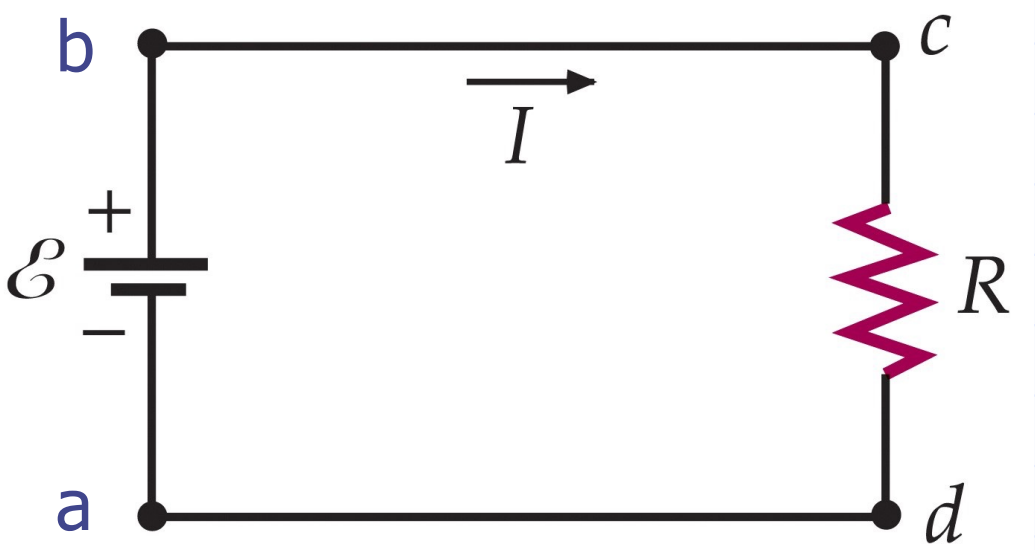


Example Problem

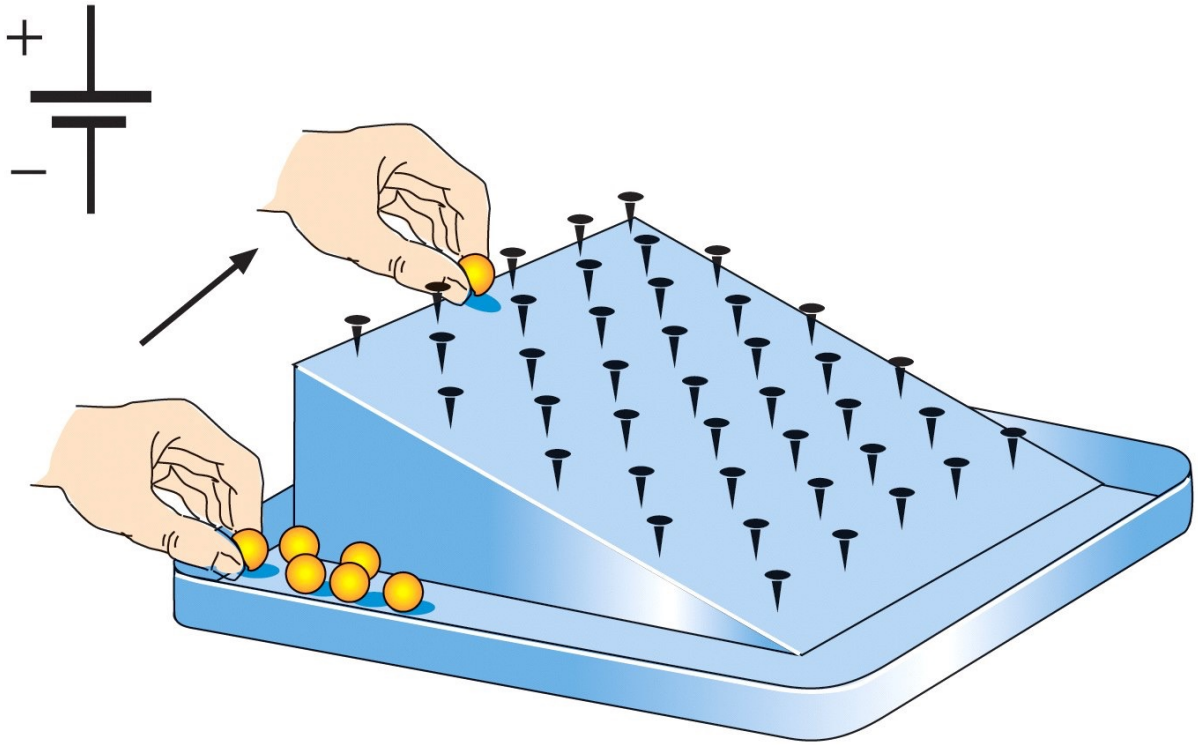
- A certain light bulb has a tungsten filament with a resistance of 19.0 Ω when cold and 140 Ω when hot. Assume that the resistivity of tungsten varies linearly with temperature even over the large temperature involved here, and find the temperature of the hot filament. Assume the initial temperature is 20.0 °C.

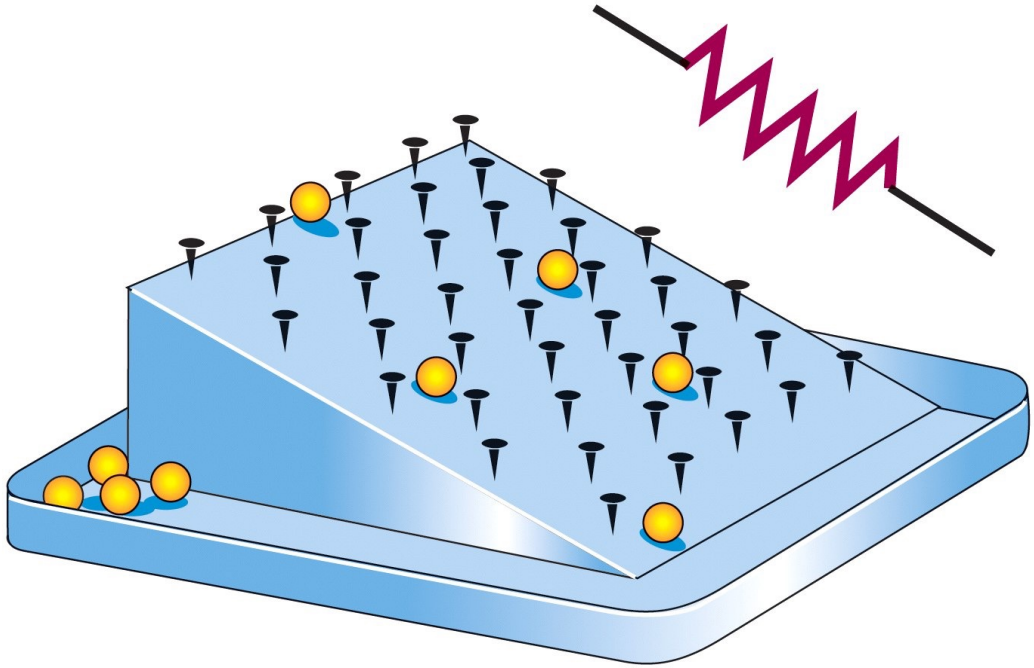
Power in Electrical Circuits

- A circuit is a closed loop (usually consisting of high conductivity wire) with a battery and one or more circuit elements
- We assume now that the resistance in the wire is small and can be neglected



Mechanical Analogy





Example Problem

- A toaster is rated at 600 W when connected to a 120-V source. What current does the toaster carry, and what is its resistance?