# Electric Circuits

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Lecture 2 (Ohm's Law & Circuit Elements)





## Overview

- Ohm's law: a central concept in electric circuits.
- Resistors

# Resistivity

- Materials tend to resist the flow of electricity through them.
- This property is called “resistance”
- The resistance of an object is a function of its length, l, and cross sectional area, A, and the material’s resistivity:

$$R = \rho \frac{l}{A}$$





# Ohm’s Law

- In a resistor, the voltage across a resistor is directly proportional to the current flowing through it.

$$V = IR$$

- The resistance of an element is measured in units of Ohms, Ω, (V/A)
- The higher the resistance, the less current will flow through for a given voltage.
- Ohm’s law requires conforming to the passive sign convention.

# Resistivity of Common Materials

**TABLE 2.1**

Resistivities of common materials.

| Material | Resistivity ($\Omega$·m) | Usage |
|---|---|---|
| Silver | $1.64 \times 10^{-8}$ | Conductor |
| Copper | $1.72 \times 10^{-8}$ | Conductor |
| Aluminum | $2.8 \times 10^{-8}$ | Conductor |
| Gold | $2.45 \times 10^{-8}$ | Conductor |
| Carbon | $4 \times 10^{-5}$ | Semiconductor |
| Germanium | $47 \times 10^{-2}$ | Semiconductor |
| Silicon | $6.4 \times 10^{2}$ | Semiconductor |
| Paper | $10^{10}$ | Insulator |
| Mica | $5 \times 10^{11}$ | Insulator |
| Glass | $10^{12}$ | Insulator |
| Teflon | $3 \times 10^{12}$ | Insulator |



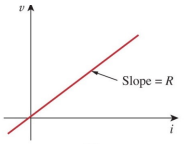


# Short and Open Circuits

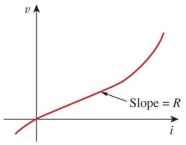
- A connection with almost zero resistance is called a short circuit.
- Ideally, any current may flow through the short.
- In practice this is a connecting wire.
- A connection with infinite resistance is called an open circuit.
- Here, no matter the voltage, no current flows.

# Linearity

- Not all materials obey Ohm's Law.
- Resistors that do are called linear resistors because their current voltage relationship is always linearly proportional.
- Diodes and light bulbs are examples of non-linear elements.



(a)



(b)





# Power Dissipation

- Running current through a resistor dissipates power.

$$p = vi = i^2 R = \frac{v^2}{R}$$

- The power dissipated is a non-linear function of current or voltage
- Power dissipated is always positive
- A resistor can never generate power

## Solved Problem





## Solved Problem

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