RESISTANCE TO CURRENT

When a light bulb is connected to a battery, the current in the bulb depends on the potential difference across the battery. For example, a 9.0 V battery connected to a light bulb generates a greater current than a 6.0 V battery connected to the same bulb. But potential difference is not the only factor that determines the current in the light bulb. The materials that make up the connecting wires and the bulb's filament also affect the current in the bulb. Even though most materials can be classified as conductors or insulators, some conductors allow charges to move through them more easily than others. The opposition to the motion of charge through a conductor is the conductor's **resistance.** Quantitatively, resistance is defined as the ratio of potential difference to current, as follows:

resistance

the opposition presented to electric current by a material or device

RESISTANCE

$$R = \frac{\Delta V}{I}$$

$$\textbf{resistance} = \frac{\textbf{potential difference}}{\textbf{current}}$$

The SI unit for resistance, the *ohm,* is equal to one volt per ampere and is represented by the Greek letter Ω (*omega*).

Resistance is constant over a range of potential differences

For many materials, including most metals, experiments show that *the resistance is constant over a wide range of applied potential differences.* This statement, known as Ohm's law, is named for Georg Simon Ohm (1789–1854), who was the first to conduct a systematic study of electrical resistance. Mathematically, Ohm's law is stated as follows:

$$\frac{\Delta V}{I} = \text{constant}$$

As can be seen by comparing the definition of resistance with Ohm's law, the constant of proportionality in the Ohm's law equation is resistance. It is common practice to express Ohm's law as $\Delta V = IR$.

Ohm's law does not hold for all materials

Ohm's law is not a fundamental law of nature like the conservation of energy or the universal law of gravitation. Instead, it is a behavior that is valid only for certain materials. Materials that have a constant resistance over a wide range of potential differences are said to be *ohmic.* A graph of current versus potential difference for an ohmic material is linear, as shown in **Figure 11(a).** This is because the slope of such a graph ($I/\Delta V$) is inversely proportional to resistance. When resistance is constant, the current is proportional to the potential difference and the resulting graph is a straight line.

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