Materials that do not function according to Ohm's law are said to be *non-ohmic*. **Figure 11(b)** shows a graph of current versus potential difference for a non-ohmic material. In this case, the slope is not constant because resistance varies. Hence, the resulting graph is nonlinear. One common semiconducting device that is non-ohmic is the *diode*. Its resistance is small for currents in one direction and large for currents in the reverse direction. Diodes are used in circuits to control the direction of current. This book assumes that all resistors function according to Ohm's law unless stated otherwise.

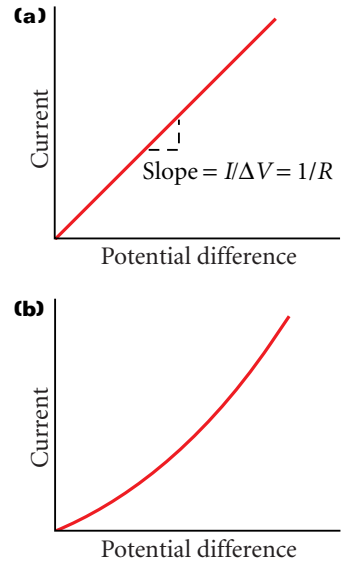

Figure 11
(a) The current–potential difference curve of an ohmic material is linear, and the slope is the inverse of the material's resistance. **(b)** The current–potential difference curve of a non-ohmic material is nonlinear.

Resistance depends on length, area, material, and temperature

Earlier in this section, you learned that electrons do not move in straight-line paths through a conductor. Instead, they undergo repeated collisions with the metal atoms. These collisions affect the motion of charges somewhat as a force of internal friction would. This is the origin of a material's resistance. Thus, any factors that affect the number of collisions will also affect a material's resistance. Some of these factors are shown in **Table 2.**

Two of these factors—length and cross-sectional area—are purely geometrical. It is intuitive that a longer length of wire provides more resistance than a shorter length of wire does. Similarly, a wider wire allows charges to flow more easily than a thinner wire does, much as a larger pipe allows water to flow more easily than a smaller pipe does. The material effects have to do with the structure of the atoms making up the material. Finally, for most materials, resistance increases as the temperature of the metal increases. When a material is hot, its atoms vibrate fast, and it is more difficult for an electron to flow through the material.

Table 2 Factors That Affect Resistance

Factor	Less resistance	Greater resistance
Length	L_1	L_2
Cross-sectional area	A_1	A_2
Material	Copper	Iron
Temperature	T_1	T_2