17.3: Resistance and Resistors

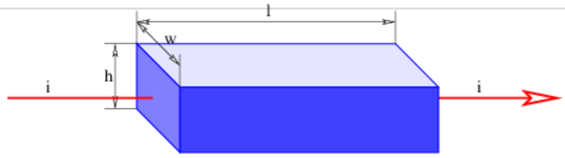

Figure 17.3.6:: Rectangular resistor with a current i flowing through it.

Normal conducting materials require an electric field to keep an electric current flowing through them. The electric field causes a force on the electrons in the material, which is balanced by the energy loss that occurs when the electrons collide with the atoms forming the material. Most objects exhibit a linear relationship between the current i through them and the potential difference $\Delta\phi$ applied to them. This relationship is called **Ohm's law** ,

$$\Delta\phi = iR \quad (R \text{ constant }) \tag{17.3.1}$$

where the constant of proportionality R is called the **resistance**. The quantity $\Delta\phi$ is sometimes called the **voltage drop** across the resistor.

For certain materials, such as semiconductors, the resistance depends on the current. For such materials, the above equation defines resistance, but since the resistance doesn't remain constant when the current changes, these materials don't obey Ohm's law.

Figure $17.3.6$ illustrates a rectangular resistor. The resistance of such a resistor can be written

$$R = \frac{l}{wh}\rho \tag{17.3.2}$$

where the **resistivity** ρ is characteristic only of the material and not its shape or size.

Unlike capacitors and inductors, resistors are dissipative devices. The work done on a charge q passing through a resistor is just $q\,\Delta\phi$. This energy is converted to heat. The work done per unit time, which equals the power dissipated by a resistor is therefore

$$P = i\Delta\phi = i^2 R = (\Delta\phi)^2/R \tag{17.3.3}$$