Drift velocity is the net velocity of charge carriers

To see how the electrons move, consider a solid conductor in which the charge carriers are free electrons. When the conductor is in electrostatic equilibrium, the electrons move randomly, similar to the movement of molecules in a gas. When a potential difference is applied across the conductor, an electric field is set up inside the conductor. The force due to that field sets the electrons in motion, thereby creating a current.

These electrons do not move in straight lines along the conductor in a direction opposite the electric field. Instead, they undergo repeated collisions with the vibrating metal atoms of the conductor. If these collisions were charted, the result would be a complicated zigzag pattern like the one shown in **Figure 10.** The energy transferred from the electrons to the metal atoms during the collisions increases the vibrational energy of the atoms, and the conductor's temperature increases.

The electrons gain kinetic energy as they are accelerated by the electric field in the conductor. They also lose kinetic energy because of the collisions described above. However, despite the internal collisions, the individual electrons move slowly along the conductor in a direction opposite the electric field, **E,** with a velocity known as the **drift velocity,** $\mathbf{v}_{drift}$.

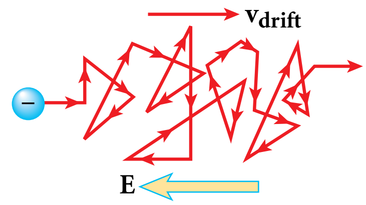

Figure 10
When an electron moves through a conductor, collisions with the vibrating metal atoms of the conductor force the electron to change its direction constantly.

drift velocity

the net velocity of a charge carrier moving in an electric field

Drift speeds are relatively small

The magnitudes of drift velocities, or drift speeds, are typically very small. In fact, the drift speed is much less than the average speed between collisions. For example, in a copper wire that has a current of 10.0 A, the drift speed of electrons is only 2.46×10^{-4} m/s. These electrons would take about 68 min to travel 1 m! The electric field, on the other hand, reaches electrons throughout the wire at a speed approximately equal to the speed of light.

Why it Matters

Conceptual Challenge

1. Electric Field Inside a Conductor

We concluded in our study of electrostatics that the field inside a conductor is zero, yet we have seen that an electric field exists inside a conductor that carries a current. How is this zero electric field possible?

2. Turning on a Light

If charges travel very slowly through a metal (approximately 10^{-4} m/s), why doesn't it take several hours for a light to come on after you flip a switch?

3. Particle Accelerator

The positively charged dome of a Van de Graaff generator can be used to accelerate positively charged protons. A current exists due to the motion of these protons. In this case, how does the direction of conventional current compare with the direction in which the charge carriers move?