



Credit: © iStockphoto.com/John J. Schaller

The shiny globe in the photograph is part of a Van de Graaff generator, which is a device that can separate the electric charges that are one of the fundamental building blocks of atoms. Since she is touching the globe, all parts of the girl's body, including her hair, acquire the same kind of electric charge. The charges do not simply flow through her body into the earth, because she is standing on a platform that prevents that from happening. As we will see in this chapter, like charges repel each other, which is why the girl's hair is standing on end.

# Electric Forces and Electric Fields

## 18.1 The Origin of Electricity

The electrical nature of matter is inherent in atomic structure. An atom consists of a small, relatively massive nucleus that contains particles called protons and neutrons. A proton has a mass of  $1.673 \times 10^{-27}$  kg, and a neutron has a slightly greater mass of  $1.675 \times 10^{-27}$  kg. Surrounding the nucleus is a diffuse cloud of orbiting particles called electrons, as Figure 18.1 suggests. An electron has a mass of  $9.11 \times 10^{-31}$  kg. Like mass, **electric charge** is an intrinsic property of protons and electrons, and only two types of charge have been discovered, positive and negative. A proton has a positive charge, and an electron has a negative charge. A neutron has no net electric charge.

Experiment reveals that the magnitude of the charge on the proton exactly equals the magnitude of the charge on the electron; the proton carries a charge  $+e$ , and the electron carries a charge  $-e$ . The SI unit for measuring the magnitude of an electric charge is the **coulomb**<sup>†</sup> (C), and  $e$  has been determined experimentally to have the value

$$e = 1.60 \times 10^{-19} \text{ C}$$

<sup>†</sup>The definition of the coulomb depends on electric currents and magnetic fields, concepts that will be discussed later. Therefore, we postpone its definition until Section 21.7.

### LEARNING OBJECTIVES

After reading this module, you should be able to...

- 18.1 Define electric charge.
- 18.2 Describe the electric force between charged particles.
- 18.3 Distinguish between conductors and insulators.
- 18.4 Explain charging by contact and charging by induction.
- 18.5 Use Coulomb's law to calculate the force on a point charge due to other point charges.
- 18.6 Calculate the net electric field due to a configuration of point charges.
- 18.7 Draw electric field lines.
- 18.8 Describe the electric field inside a conductor.
- 18.9 Use Gauss' law to obtain the value of the electric field due to charge distributions.
- 18.10 Describe how copiers and printers operate.

# Chapter 18 Physics Solutions

**RS Peters**



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