SECTION 3

The Electric Field

SECTION OBJECTIVES

- Calculate electric field strength.
- Draw and interpret electric field lines.
- Identify the four properties associated with a conductor in electrostatic equilibrium.

electric field

a region where an electric force on a test charge can be detected

ELECTRIC FIELD STRENGTH

As discussed earlier in this chapter, electric force, like gravitational force, is a field force. Unlike contact forces, which require physical contact between objects, field forces are capable of acting through space, producing an effect even when there is no physical contact between the objects involved. The concept of a field is a model that is frequently used to understand how two objects can exert forces on each other at a distance. For example, a charged object sets up an **electric field** in the space around it. When a second charged object enters this field, forces of an electrical nature arise. In other words, the second object interacts with the field of the first particle.

To define an electric field more precisely, consider **Figure 7(a),** which shows an object with a small positive charge, q_0, placed near a second object with a larger positive charge, Q. The strength of the electric field, E, at the location of q_0 is defined as the magnitude of the electric force acting on q_0 divided by the charge of q_0:

$$E = \frac{F_{electric}}{q_0}$$

Note that this is the electric field at the location of q_0 produced by the charge Q, and *not* the field produced by q_0.

Because electric field strength is a ratio of force to charge, the SI units of E are newtons per coulomb (N/C). The electric field is a vector quantity. By convention, the direction of **E** at a point is defined as the direction of the electric force that would be exerted on a small *positive* charge (called a test charge) placed at that point. Thus, in **Figure 7(a),** the direction of the electric field is horizontal and away from the sphere because a positive charge would be repelled by the positive sphere. In **Figure 7(b),** the direction of the electric field is toward the sphere because a positive charge would be attracted toward the negatively charged sphere. In other words, the direction of **E** depends on the sign of the charge producing the field.

Figure 7
(a) A small object with a positive charge q_0 placed in the field, **E,** of an object with a larger positive charge experiences an electric force away from the object. **(b)** A small object with a positive charge q_0 placed in the field, **E,** of a negatively charged object experiences an electric force toward the object.