PRACTICE C

Equilibrium

1. A charge of $+2.00 \times 10^{-9}$ C is placed at the origin, and another charge of $+4.00 \times 10^{-9}$ C is placed at $x = 1.5$ m. Find the point between these two charges where a charge of $+3.00 \times 10^{-9}$ C should be placed so that the net electric force on it is zero.

2. A charge q_1 of -5.00×10^{-9} C and a charge q_2 of -2.00×10^{-9} C are separated by a distance of 40.0 cm. Find the equilibrium position for a third charge of $+15.0 \times 10^{-9}$ C.

3. An electron is released above the Earth's surface. A second electron directly below it exerts just enough of an electric force on the first electron to cancel the gravitational force on it. Find the distance between the two electrons.

Electric force is a field force

The Coulomb force is the second example we have studied of a force that is exerted by one object on another even though there is no physical contact between the two objects. Such a force is known as a *field force.* Recall that another example of a field force is gravitational attraction. Notice that the mathematical form of the Coulomb force is very similar to that of the gravitational force. Both forces are inversely proportional to the square of the distance of separation.

However, there are some important differences between electric and gravitational forces. First of all, as you have seen, electric forces can be either attractive or repulsive. Gravitational forces, on the other hand, are always attractive. The reason is that charge comes in two types—positive and negative—but mass comes in only one type, which results in an attractive gravitational force.

Another difference between the gravitational force and the electric force is their relative strength. As shown in Sample Problem A, the electric force is significantly stronger than the gravitational force. As a result, the electric force between charged atomic particles is much stronger than their gravitational attraction to Earth and between each other.

In the large-scale world, the relative strength of these two forces can be seen by noting that the amount of charge required to overcome the gravitational force is relatively small. For example, if you rub a balloon against your hair and hold the balloon directly above your hair, your hair will stand on end because it is attracted toward the balloon. Although only a small amount of charge is transferred from your hair to the balloon, the electric force between the two is nonetheless stronger than the gravitational force that pulls your hair toward the ground.