48. In a laboratory experiment, five equal negative point charges are placed symmetrically around the circumference of a circle of radius *r*. Calculate the electric field at the center of the circle.

49. An electron and a proton both start from rest and from the same point in a uniform electric field of 370.0 N/C. How far apart are they 1.00 μs after they are released? Ignore the attraction between the electron and the proton. (Hint: Imagine the experiment performed with the proton only, and then repeat with the electron only.)

50. An electron is accelerated by a constant electric field of magnitude 300.0 N/C.

a. Find the acceleration of the electron.

b. Find the electron's speed after 1.00×10^{-8} s, assuming it starts from rest.

51. If the electric field strength is increased to about 3.0×10^{6} N/C, air "breaks down" and loses its insulating quality. Under these conditions, sparking results.

a. What acceleration does an electron experience when the electron is placed in such an electric field?

b. If the electron starts from rest when it is placed in an electric field under these conditions, in what distance does it acquire a speed equal to 10.0 percent of the speed of light?

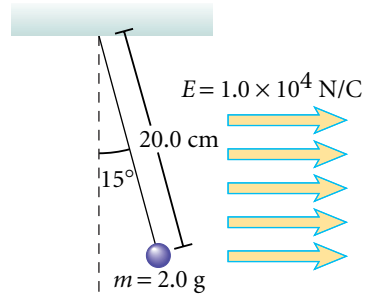
c. What acceleration does a proton experience when the proton is placed in such an electric field?

52. Each of the protons in a particle beam has a kinetic energy of 3.25×10^{-15} J. What are the magnitude and direction of the electric field that will stop these protons in a distance of 1.25 m?

53. A small 2.0 g plastic ball is suspended by a 20.0 cm string in a uniform electric field of 1.0×10^{4} N/C, as shown below.

a. Is the ball's charge positive or negative?

b. If the ball is in equilibrium when the string makes a 15° angle with the vertical as indicated, what is the net charge on the ball?



Graphing Calculator Practice

Coulomb's Law

One of the most important and fundamental laws of physics—and of all science—is Coulomb's law. As you learned earlier in this chapter, this law states that the electric force, $F_{electric}$, between two charges, q_1 and q_2, which are separated by a distance, r, is given by the following equation.

$$F_{electric} = k_C\left(\frac{q_1 q_2}{r^2}\right)$$

In this graphing calculator activity, you will enter the charges and will observe a graph of electric force versus distance. By analyzing graphs for various sets of charges (positive with positive, negative with negative, and positive with negative), you will better understand Coulomb's law and how charge and distance affect electric force.

Visit go.hrw.com and enter the keyword **HF6ELFX** to find this graphing calculator activity. Refer to **Appendix B** for instructions on downloading the program for this activity.