

54. A constant electric field directed along the positive x -axis has a strength of $2.0 \times 10^3 \text{ N/C}$.
- Find the electric force exerted on a proton by the field.
 - Find the acceleration of the proton.
 - Find the time required for the proton to reach a speed of $1.00 \times 10^6 \text{ m/s}$, assuming it starts from rest.
55. Consider an electron that is released from rest in a uniform electric field.
- If the electron is accelerated to 1.0 percent of the speed of light after traveling 2.0 mm, what is the strength of the electric field?
 - What speed does the electron have after traveling 4.0 mm from rest?
56. A DNA molecule (deoxyribonucleic acid) is $2.17 \mu\text{m}$ long. The ends of the molecule become singly ionized so that there is $-1.60 \times 10^{-19} \text{ C}$ on one end and $+1.60 \times 10^{-19} \text{ C}$ on the other. The helical molecule acts as a spring and compresses 1.00 percent upon becoming charged. Find the effective spring constant of the molecule.

Alternative Assessment

- A metal can is placed on a wooden table. If a positively charged ball suspended by a thread is brought close to the can, the ball will swing toward the can, make contact, then move away. Explain why this happens and predict whether the ball is likely to make contact a second time. Sketch diagrams showing the charges on the ball and on the can at each phase. How can you test whether your explanation is correct? If your teacher approves of your plan, try testing your explanation.
- The common copying machine was designed in the 1960s, after the American inventor Chester Carlson developed a practical device for attracting carbon-black to paper using localized electrostatic action. Research how this process works and determine why the last copy made when several hundred copies are made can be noticeably less sharp than the first copy. Create a report, poster, or brochure for office workers containing tips for using copiers.
- The *triboelectric series* is an ordered list of materials that can be charged by friction. Use the Internet to find a copy of the triboelectric series, and to learn about how it works. Design a series of demonstrations to illustrate charging by friction, and use the triboelectric series to determine the resulting charges for each material. If your teacher approves of your plan, conduct your demonstrations for the class. Explain to the class how the triboelectric series works, and discuss whether it is always completely accurate.
- Research how an electrostatic precipitator works to remove smoke and dust particles from the polluting emissions of fuel-burning industries. Find out what industries use precipitators. What are their advantages and costs? What alternatives are available? Summarize your findings in a brochure.
- Imagine you are a member of a research team interested in lightning and you are preparing a grant proposal. Research information about the frequency, location, and effects of thunderstorms. Write a proposal that includes background information, research questions, a description of necessary equipment, and recommended locations for data collection.
- Electric force is also known as the *Coulomb force*. Research the historical development of the concept of electric force. Describe the work of Coulomb and other scientists such as Priestley, Cavendish, and Faraday.
- Benjamin Franklin (1706-1790) first suggested the terms *positive* and *negative* for the two different types of electric charge. Franklin was the first person to realize that lightning is a huge electric discharge. He demonstrated this with a dangerous experiment in which he used a kite to gather charges during a thunderstorm. Franklin also invented the first lightning rod. Conduct research to find out more about one of these discoveries, or about another one of Franklin's famous inventions. Create a poster showing how the invention works, or how the discovery was made.