## Additional Exercises

A-1: $\quad$ A raindrop acquires a negative charge of $3.0 \times 10^{-18} \mathrm{C}$ as it falls. What is the force of attraction when the raindrop is 6.0 cm from the bulb on the end of a car antenna that holds a charge of $2.0 \times 10^{-6} \mathrm{C}$ ?

A-2: In a grain elevator on Farmer Judd's farm, pieces of grain become electrically charged while falling through the elevator. If one piece of grain is charged with $5.0 \times 10^{-16} \mathrm{C}$ while another holds $2.0 \times 10^{-16} \mathrm{C}$ of charge, what is the electrostatic force between them when they are separated by 0.050 m ?

A-3: $\quad$ Rocco, an auto body painter, applies paint to automobiles by electrically charging the car's outer surface and oppositely charging the paint particles that he sprays onto the car. This causes the paint to adhere tightly to the car's surface. If two paint particles of equal charge experience a force of $4.0 \times 10^{-8} \mathrm{~N}$ between them at a separation of 0.020 cm , what is the charge on each?

A-4: $\quad$ After unpacking a shipment of laboratory glasswear, Mrs. Payne dumps the box of Styrofoam packing chips into a recycling bin. The chips rub together and two chips 0.015 m apart repel each other with a force of $6.0 \times 10^{-3} \mathrm{~N}$. What is the charge on each of the chips?

A-5: $\quad$ Wiz the cat is batting at two Ping-Pong balls hanging from insulating threads with their sides just barely touching. Each ball acquires a positive charge of $3.5 \times 10^{-9} \mathrm{C}$ from Wiz's fur and they swing apart. a) If a force of $6.0 \times 10^{-5} \mathrm{~N}$ acts on one of the balls, how far apart are they from each other? b) Is the force between them one of attraction or repulsion?

A-6: $\quad$ A droplet of ink in an ink-jet printer carrying a charge of $8.0 \times 10^{-13} \mathrm{C}$ is deflected onto the paper by a force of $3.2 \times 10^{-4} \mathrm{~N}$. How strong is the field that causes this force?

A-7: In the human body, nerve cells work by pumping sodium ions out of a cell in order to maintain a potential difference across the cell wall. If a sodium ion carries a charge of $1.60 \times 10^{-19} \mathrm{C}$ as it is pumped with an electrical force of $2.0 \times 10^{-12} \mathrm{~N}$, what is the electric field between the inside and outside of the nerve cell?

A-8: $\quad$ Each of two Van de Graaff generators, whose centers are separated from one another by 0.50 m , becomes charged after they are switched on. One Van de Graaff generator holds $+3.0 \times 10^{-2} \mathrm{C}$ while the other holds $-2.0 \times 10^{-2} \mathrm{C}$. What is the magnitude and direction of the electric field halfway between them?

A-9: $\quad$ Willa the witch dusts her crystal ball with her silk scarf, causing the ball to become charged with $5.0 \times 10^{-9} \mathrm{C}$. Willa then stares into the crystal ball and the wart on the end of her nose experiences an electric field strength of 2200 N/C. How far is the tip of her nose from the center of the crystal ball?

A-10: $\quad$ The Millikan oil drop experiment of 1909 allowed Robert A. Millikan to determine the charge of an electron. In the experiment, an oil drop is suspended between two charged plates by an electric force that equals the gravitational force acting on the $1.1 \times 10^{-14}-\mathrm{kg}$ drop. a) What is the charge on the drop if it remains stationary in an electric field of $1.72 \times 10^{5} \mathrm{~N} / \mathrm{C}$ ? b) How many extra electrons are there on this particular oil drop?

A-11: In eighteenth-century Europe, it was common practice to ring the church bells in an attempt to ward off lightning. However, during one 33 -year period, nearly 400 church steeples were struck while the bells were being rung. If a bolt of lightning discharges 30.0 C of charge from a cloud to a steeple across a potential difference of 15000 V , how much energy is lost by the cloud and gained by the steeple?

A-12: $\quad$ In Exercise A-7, how thick is the wall of the nerve cell if there is a potential difference of 0.089 between the inside and outside of the cell?

A-13: $\quad$ Ulrich stands next to the Van de Graaff generator and gets a shock as he holds his knuckle 0.2 m from the machine. In order for a spark to jump, the electric field strength must be $3 \times 10^{6} \mathrm{~V} / \mathrm{m}$. At this distance, what is the potential difference between Ulrich and the generator?

A1. $1.5 \times 10^{-11} \mathrm{~N}$ A3. $4.2 \times 10^{-13} \mathrm{C}$ A5. a) 0.043 m A7. $1.3 \times 10^{7} \mathrm{~N} / \mathrm{C}$ A9. a) 0.14 m A11. 450000 J A13. 600000 V

