22 Electrostatics

Solutions to Chapter 22 Exercises

3. Electrons are loosely bound on the outside of atoms, whereas protons are very tightly bound within the atomic nuclei.

9. Excess electrons rubbed from your hair leave it with a positive charge; excess electrons on the comb give it a negative charge.

29. The huge value of the constant *k* for electrical force indicates a relatively huge force between charges, compared with the small gravitational force between masses and the small value of the gravitational constant *G*.

42. An ion polarizes a nearby neutral atom, so that the part of the atom nearer to the ion acquires a charge opposite to the charge of the ion, and the part of the atom farther from the ion acquires a charge of the same sign as the ion. The side of the atom closer to the ion is then attracted more strongly to the ion than the farther side is repelled, making for a net attraction. (By Newton's third law, the ion, in turn, is attracted to the atom.)

44. The forces on the electron and proton will be equal in magnitude, but opposite in direction. Because of the greater mass of the proton, its acceleration will be less than that of the electron, and be in the direction of the electric field. How much less? Since the mass of the proton is nearly 2000 times that of the electron, its acceleration will be about $^1/_{2000}$ that of the electron. The greater acceleration of the electron will be in the direction opposite to the electric field. The electron and proton accelerate in opposite directions.

46. The field is zero because the force on a test charge midway cancel to zero.

54. In a thunder storm the metal affords a field-free region (called a Faraday cage). Charges on the surface of the metal arrange themselves such that the field in the interior cancels to zero.

Chapter 22 Problem Solutions

1. By the inverse-square law, twice as far is 1/4 the force; **5 N**.
The solution involves relative distance only, so the magnitude of charges is irrelevant.

2. From Coulomb's law, the force is given by $F = \frac{kq^2}{d^2}$, so the square of the charge is
$q^2 = \frac{Fd^2}{k} = \frac{(20\text{ N})(0.06\text{ m})^2}{9 \times 10^9\text{ N m}^2/\text{C}^2} = 8.0 \times 10^{-12}\text{ C}^2$. Taking the square root of this gives
$q =$ **2.8×10^{-6} C**, or 2.8 microcoulombs.

3. From Coulomb's law, $F = k\frac{q_1 q_2}{d^2} = (9 \times 10^9)\frac{(1.0 \times 10^{-6})^2}{(0.03)^2} =$ **10 N**. This is the same as the weight of a 1-kg mass.