

**Review**

1. How do we know that there is such a thing as an electric force?
2. How do two electrically charged objects behave when brought near one another?
3. How can the movement of negative charges, such as electrons, produce a material that has a positive charge?
4. What is static electricity? What are some examples of it in everyday life?
5. When you walk across a rug to open a door, you can get a shock when you reach out toward the doorknob even if you don’t actually touch it. Why is this so?
6. Compare the electric force to the force of gravity. Which is stronger? Do both depend on mass?
7. Explain how eighteenth-century scientists thought of electricity in terms of fluids. Does this make sense?
8. What were Benjamin Franklin’s contributions to the understanding of electricity?
9. How does a lightning rod work?
10. What do we mean, at the atomic level, when we say that something is electrically charged?
11. How can objects acquire an electric charge through friction?
12. What type of charge results when electrons are removed from a particular material? When they are added to a material?
13. How do objects acquire charge through induction? Do the objects need to contact one another physically for this to happen? Explain.
14. What is meant by the conservation of electric charge?
15. What is the basic unit of electric charge? How many electrons are equivalent to 1 unit of charge?
16. What is Coulomb’s law? How does the strength of attraction or repulsion of objects vary with the distance between them?
17. What is k, the Coulomb constant? How is this determined? Does it have the same value everywhere?
18. How can an object exert an electric force even if it has no net electric charge? What is meant by polarization?
19. What is an electric field? When does such a field exist?
20. What happens to free electrons in metals under the influence of an electric field?
21. What is shielding? What is the difference between an electric and a gravitational field with respect to shielding?
22. How do you know there is such a thing as a magnetic force?
23. What was the important result of William Gilbert’s work on magnetism? How is this similar to the electric force?
24. What is a magnetic field?
25. What type of magnetic fields are found in nature?
26. What is a monopole? A dipole?

**Questions**

6. Four small charged spheres sit at the corners of a square, as shown in the figure. Sphere A is negatively charged and the other three have an equal amount of positive charge. Reproduce the figure and draw an arrow at sphere A that represents the net electric force on sphere A due to the other three charges. Repeat this for spheres B, C, and D. Which sphere has the greatest net force acting on it?

7. Two charged spheres sit near each other, as shown in the figure. They carry an equal amount of negative charge. What is the direction of the electric field created by these two charges at locations a, b, and c? (Point b is at the exact midpoint between spheres A and B.)
Questions 7, 8

8. Two charged spheres sit near each other, as shown in the figure. Sphere A is negative and sphere B carries an equal amount of positive charge. What is the direction of the electric field created by these two charges at locations a, b, and c?

9. Two spheres carry the same amount of positive charge. Reproduce the figure and draw an arrow that represents the direction and strength of the electric field at a, b, c, and d.

Questions 9, 10

10. Two spheres carry equal and opposite amounts of electric charge. Sphere A is positive and sphere B is negative. Reproduce the figure and draw an arrow that represents the direction and strength of the electric field at a, b, c, and d.

11. Static cling makes your clothes stick together. What is actually happening in your dryer to generate it? Does this make sense given what you have learned in this chapter?

12. The Greeks had a legend that there was an island in the Mediterranean Sea made entirely of lodestone. They used this story as an argument that ships should not be built with iron nails. How does this argument work? Are there other reasons for not building ships with iron nails?

13. Object A and object B are initially uncharged and are separated by a distance of 2 meters. Suppose 10,000 electrons are removed from object A and placed on object B, creating an electric force between A and B. Is this force attractive or repulsive? If an additional 10,000 electrons are removed from A and placed on B, how much does the electric force change?

14. Object A and object B are initially uncharged and are separated by a distance of 1 meter. Suppose 10,000 electrons are removed from object A and placed on object B, creating an attractive force between A and B. If an additional 10,000 electrons are removed from A and placed on B and the objects are moved so that the distance between them is increased to 2 meters, how much does the electric force between them change?

15. The magnetic field at the equator points north. If you throw a positively charged object (for example, a baseball with some electrons removed) to the east, what is the direction of the magnetic force on that object?

16. The magnetic field at the equator points north. If you throw a negatively charged object (for example, a baseball with some extra electrons) to the east, what is the direction of the magnetic force on that object?

17. A charged particle is located on the right side of a bar magnet and is moving to the right, as shown. If the particle is being deflected in such a way that its path is curving out of the page, is the particle negative or positive?

18. Two identical bar magnets are aligned as shown. What is the approximate direction of the magnetic field created by this arrangement at locations a, b, and c?

19. A small bar magnet pulls on a larger one with a force of 100 newtons. What is the magnitude of the force the larger one exerts on the smaller one?

20. A charge of +1 coulomb is placed at the 0-cm mark of a meter stick. A charge of −1 coulomb is placed at the 100-cm mark of the same meter stick. Is it possible to place a proton somewhere on the meter stick so that the net force on it due to the charges at the ends is 0? If so, where should it be placed? Explain.

21. A charge of +1 coulomb is placed at the 0-cm mark of a meter stick. A charge of +4 coulombs is placed at the 100-cm mark of the same meter stick. Is it possible to place a proton somewhere on the meter stick so that the net force on it due to the charges at the ends is 0? If so, where should it be placed? Explain.

22. Identify five objects in your room that would not be possible without discoveries in electromagnetism.

Problems

1. Based on electric charges and separations, which of the following atomic bonds is strongest? [Hint: You are interested only in the relative strengths, which depend only on the relative charges and distances.]

   a. A +1 sodium atom separated by 2.0 distance units from a −1 chlorine atom in table salt
   b. A +1 hydrogen atom separated by 1.0 distance unit from a −2 oxygen atom in water