Problem Set: Static Electricity 2

*Complete all the problems in this set in an organized fashion, showing ALL necessary WORK. Problems with only answers may be considered incorrect and lower your grade. Clearly indicate your answers by underlining or circling the final answer to each problem. This set is due at the beginning of the block. YOU MUST INCLUDE VECTOR DRAWINGS FOR EACH PROBLEM TO GET FULL CREDIT.*

Reviewing Concepts #1-8

1. If you comb your hair on a dry day, the comb can become positively charged. Can your hair remain neutral? Explain.

2. The combined charge of all electrons in a nickel coin is hundreds of thousands of coulombs, a unit of electrical charge. Does that imply anything about the net charge on the coin? Explain.

3. List some common insulators and conductors.

4. What property makes a metal a good conductor and rubber a good insulator?

5. Why does a woolen sock taken from a clothes dryer sometimes cling to other clothes?

6. If you wipe a stereo record (vinyl) or DVD with a clean cloth, why does the record now attract dust?

7. Name and define three methods to charge an object.

8. Explain how to charge a conductor negatively if you have only a positively charged rod.

Applying Concepts #1-14

1. How does the charge of an electron differ from the charge of a proton?

2. If you scuff electrons from your feet while walking across a rug, are you now negatively charged or positively charge? Explain.

3. Using a charged rod and an electroscope, how can you determine if an object is a conductor?

4. Explain why an insulator that is charged can be discharged by passing it above a flame.

5. A charged rod is brought near a pile of tiny plastic spheres. Some of the spheres are attracted to the rod, but as soon as they touch the rod, they fly away in different directions. Explain.

6. A rod-shaped insulator is suspended so it can rotate. A negatively charged comb held nearby attracts the rod.

a. What is the charge on the rod?

b. If the comb repelled the rod, what can you conclude about the charge on the rod now?

7. Lightning usually occurs when a negative charge in a cloud is transported to Earth. If Earth is neutral, what provides the attractive force that pulls the electrons toward Earth?

8. Explain what happens to the leaves of a positively charged electroscope when rods with the following charges are nearby but NOT touching the electroscope:

a. positive

b. negative

9. Coulomb’s law and Newton’s law of universal gravitation appear similar. In what ways are the electrical and gravitational forces similar? How are they different?

10. Omit

11. Coulomb measured the deflection of sphere **A** and when **A** and **B** had equal charges and were a distance ***d*** apart. He then made the charge on **B** one third the charge on **A**. How far apart would the two spheres have to be now for **A** to have the same deflection it had before?

12. Two charged bodies exert a force of 0.145 N on each other. If they are now moved so they are one fourth as far apart, what force is exerted?

13. The constant, K, in Coulomb’s equation is much larger than the constant, G, in Newton’s universal gravitation equation. Of what significance is this?

14. Salt water drips slowly from a narrow eye dropper through a negatively charged metal ring (blue) into a bucket. What charge do the salt drops take on, if any. Explain.

Problems #5-18

5. What is the total charge on all of the electrons in one liter, 1.0 kg, of water? One mole of water has a mass of 18 g and each molecule of water contains 10 electrons.

6. Two electrons in an atom are separated by 1.5 x 10-10 m, the typical size of an atom. What is the force between them?

7. Object A has a charge of +1.8 x 10-6 C. Object B has a charge of -1.0 x 10-6 C. They are 0.014 m apart. What is the force on A? On B?

8. A positive and a negative charge, each of magnitude 1.5 x 10-5 C, are separated by a distance of 15 cm. Find the force on each of the particles.

9. Two negatively charged bodies with -5.0 x 10-5 C, are 0.20 m from each other. What force acts on each particle.

10. Two negatively charges of -3.0 x 10-6 C exert a repulsive force of 2.0 N on each other. By what distance are they separated?

11. How far apart are two electrons if they exert a force of repulsion of 1.0 N on each other?

12. A force of -4.4 x 103 N exists between a positive charge of +8.0 x 10-4 Cand a negative charge of -3.0 x 10-4 C. What distance separates the charges?

13. Two identical positive charges exert a repulsive force of 6.4 x 10-9 N when separated by a distance of 3.8 x 10-10 m. Calculate the charge of each.

14. The hydrogen atom contains a proton, mass 1.67 x 10-27 kg, and an electron, mass 9.11 x 10-31 kg. The average distance between them is 5.3 x 10-11 m. The charge of the proton is the same magnitude, opposite sign of an electron.

a. What is the magnitude of the average electrostatic attraction between them?

b. What is the magnitude of the average gravitational attraction between them?

c. Compare the gravitational and electrostatic forces?

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15. A positive charge of 3.0 x 10-4 C is pulled on by two negative charges. One, -2.0 x 10-6 N, is 0.050 m north and the other, -4.0 x 10-6, is 0.030 m to the south. What total force is exerted on the positive charge?

16. Three particles are placed in a line. The left particle has a charge of -67 x 10-6 C, the middle +45 x 10-6 C, and the right -83 x 10-6 C. The middle particle is 72 cm from each of the others. Let force to the right be positive.

a. Find the net force on the middle particle.

b. Find the net force on the particle to the right.

17. Charges of 4.5 x 10-6 C exist on three spheres. Find the magnitude of the total force on the top sphere (Sphere B).

18. Two charges, q1 and q2, are at rest near a positive test charge, *q*, of 7.2 x 10-6 C. The first charge, q1, is a positive charge of +3.6 x 10-6 C, located 0.025 m away from *q* at 35⁰; q2 is a negative charge of -6.6 x 10-6 C, located 0.068 m away at 125⁰.

a. Determine the magnitude of each of the forces acting on *q*.

b. Draw a force diagram.

c. Graphically determine the resultant force acting on *q*.