Physics 200 (Stapleton) Name: Key

Notes – 18.1 Static Electricity and Charge: Conservation of Charge

1. All the macroscopic forces that we experience directly, such as the sensations of touch and the tension in a rope, are due to the electromagnetic force. This force is one of the four fundamental forces in nature. The gravitational force, another fundamental force, is actually sensed through the electromagnetic interaction of molecules, such as between those in our feet and those on the top of a bathroom scale. (The other two fundamental forces are the weak nuclear force and the strong nuclear force).

2. What are the two types of charges? + and −

3. Like charges repel and unlike charges attract.

4. In atoms, electrons carry negative charge and protons carry positive charge.

5. The SI unit of charge is the coulomb (C). The charge on an electron (q_e) is equal to 1.6×10^{-19} C. It takes 6.25×10^{18} electrons to make 1.00 C.

6. When materials are rubbed together, charges can be separated, particularly if one material has a greater affinity for electrons than another.

7. Law of Conservation of Charge:
   Net charge of a system is constant

8. Whenever a charged particle is created such as in collisions in particle accelerators, another having an opposite charge is always created along with it, so that the total charge created is zero.

9. Besides charge, name three other conserved physical quantities that we have studied.
   1. Energy
   2. Momentum
   3. Angular Momentum

Notes - 18.2 Conductors and Insulators

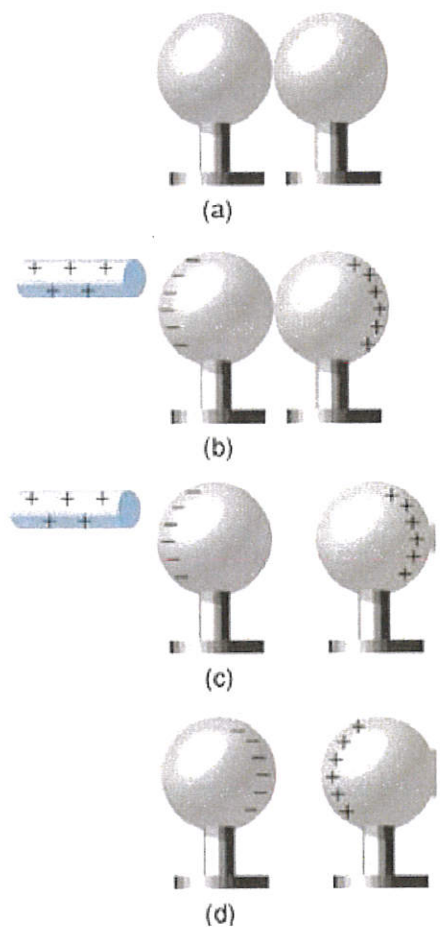
1. Conductors allow electrons to easily move through them. List some examples.

   Metals, salty water

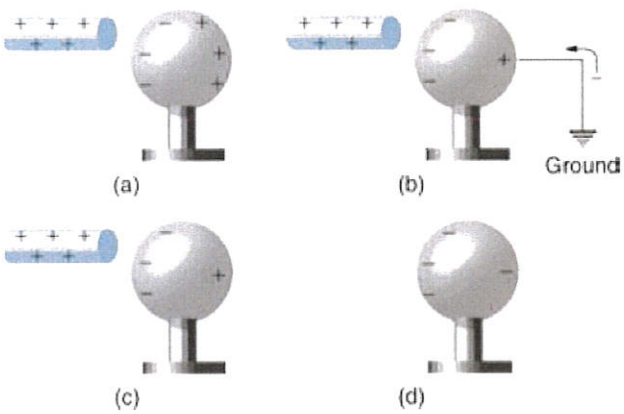
2. Insulators do not allow electrons to move through them. List some examples.

   rubber, glass, plastic

3. Protons cannot (can/cannot) flow through solid conductors.



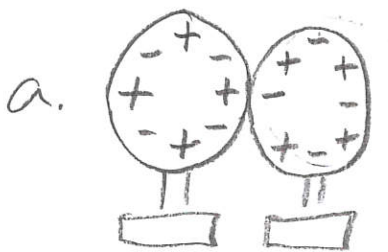
4. The two figures below are examples of induction. Please make sure you understand what is happening here. [See the online textbook for a complete discussion.]

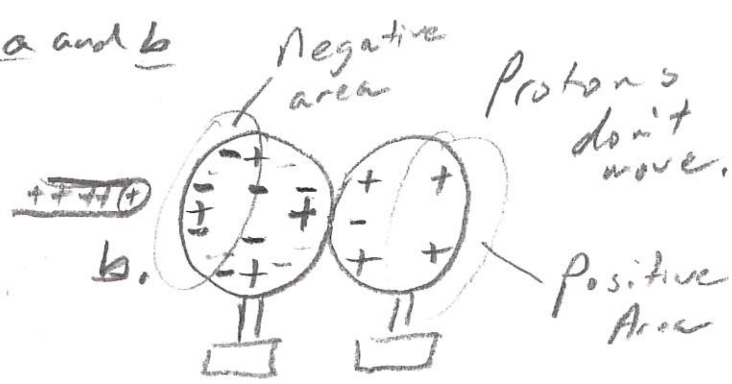


5. a. What's fishy and misleading about the diagrams above?

   It looks like protons are moving through the conductors, but protons can't move through solid conductors.

   b. Re-draw top right diagram(s) s a and b to be more realistic.





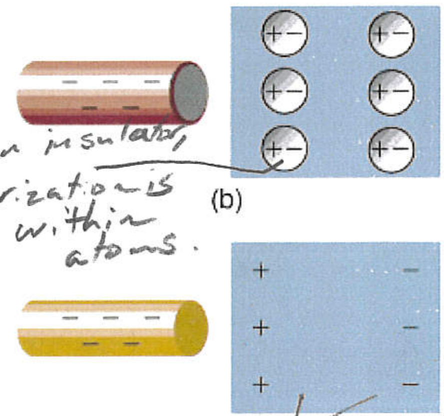
see definition on new version of sheet.

6. What is a (or the) "ground?" Usually a large, nearly neutral reservoir of charge (e.g., literally, the Earth) that provides a destination for excess charge.

7. What is polarization?

separation of charge in an object

In an insulator, polarization is within atoms.



8. The diagram on the right shows polarization by negatively charged rods. A conductor is polarized in diagram __c__, and an insulator is polarized in diagram __b__.

In a conductor, charge can move across the material

9. If you were holding the charged rods, how might you feel the effects of this polarization?

The rods would be pulled toward the polarized objects (like a rubbed balloon to a wall)

Practice – 18.1 Static Electricity and Charge: Conservation of Charge

1. There are very large numbers of charged particles in most objects. Why, then, don't most objects exhibit static electricity? In other words, why doesn't static electricity cause most things to repel one another or stick together?

2. Why do most objects tend to contain nearly equal numbers of positive and negative charges? [Hint: what would happen if they they didn't?]

3. Common static electricity involves charges ranging from nanocoulombs to microcoulombs. [If you don't know what nano and micro mean, look them up.]
   A. How many electrons are needed to form a charge of -2.00 nC?

   B. How many electrons must be removed from a neutral object to leave a net charge of 0.500 μC [μ means micro]?

4. If 1.80×10^{20} electrons move through a pocket calculator during a full day's operation, how many coulombs of charge moved through it?

5. To start a car engine, the car battery moves 3.75×10^{21} electrons through the starter motor. How many coulombs of charge were moved?

6. A certain lightning bolt moves 40.0 C of charge. How many fundamental units of charge $|q_e|$ is this? [q_e is the charge of one electron.]

<u>**Solutions**</u>:

3. A. 1.25×10^{10} e^- B. 3.13×10^{12} e^-
4. 28.8 C
5. -6.00×10^2 C
6. 2.50×10^{20} q_e