Source of Charge

- An atom
  - _____
    - Protons – _____ charge
    - Neutrons – _____ charge, but same _____ as proton
  - Electron cloud
    - Electron – _____ charge, _____ mass
    - $q_e = -1.60 \times 10^{-19}\ C$
- Unit of charge: _____ (C)
- q_e is the _____ charge discovered
- Electricity is _____ → comes in _____ numbers
- $|q_e|$ is the _____ unit of charge
- In nature atoms have _____ net charge
  - # _____ = # _____

How many electrons does it take to make a charge of $-4 \times 10^{-6}\ C$? What is their mass ($m_e = 9.11 \times 10^{-31}\ kg$)?

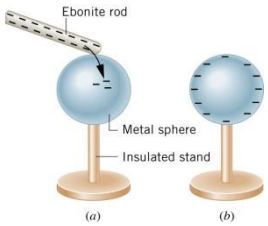
Law of Conservation of Charge
During any process, the net _____ _____ of a _____ system remains _____

- Like charges _____
- Unlike charges _____
  - The attraction and repulsion are _____ and can be used with _____ Laws and other dynamics problems

Conductors and Insulators

- Electricity can flow _____ objects
- Conductors let electrons flow _____
  - Most _____ conductors are also _____ conductors
  - _____
- Insulators are very poor conductors
  - _____ _____ _____

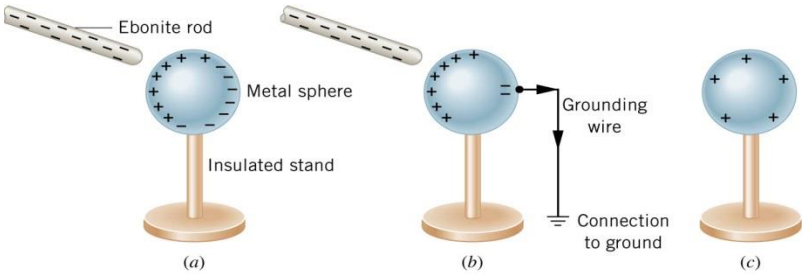
Charging by contact



- Negative charged rod gives some _____ to sphere
- Sphere becomes _____ charged until charges are _____

Charging by Induction

- Charge without _____
- Charged rod comes near _____ sphere
- The like charges are _____ to _____ side of sphere
- A _____ wire lets the charges _____ from the sphere
- The _____ wire is _____, then the charged rod
- Sphere is _____



- If the sphere was _____ instead of metal
  - Electrons _____ flow
  - The surface would become _____ charged as the electrons in each individual atom rearrange, but no _____ effect
  - _____ cling is made by this _____

Homework

1. There are very large numbers of charged particles in most objects. Why, then, don't most objects exhibit static electricity?
2. An eccentric inventor attempts to levitate by first placing a large negative charge on himself and then putting a large positive charge on the ceiling of his workshop. Instead, while attempting to place a large negative charge on himself, his clothes fly off. Explain.
3. When a glass rod is rubbed with silk, it becomes positive and the silk becomes negative—yet both attract dust. Does the dust have a third type of charge that is attracted to both positive and negative? Explain.
4. Describe how a positively charged object can be used to give another object a negative charge. What is the name of this process?
5. What is grounding? What effect does it have on a charged conductor? On a charged insulator?
6. A metallic object is given a positive charge by induction. (a) Does the mass of the object increase, decrease, or remain the same? Why? (b) What happens to the mass of the object if it is given a negative charge by induction?
7. Common static electricity involves charges ranging from nanocoulombs to microcoulombs. (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? (OpenStax 18.1) $\mathbf{1.25 \times 10^{10}}$ **electrons,** $\mathbf{3.13 \times 10^{12}}$ **electrons**
8. 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? (OpenStax 18.2) **-28.8 C**
9. 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? (OpenStax 18.3) **-600 C**
10. A certain lightning bolt moves 40.0 C of charge. How many fundamental units of charge $|q_e|$ is this? (OpenStax 18.4) $\mathbf{2.50 \times 10^{20}}$
11. Suppose a speck of dust in an electrostatic precipitator has 1.0000×10^{12} protons in it and has a net charge of –5.00 nC (a very large charge for a small speck). How many electrons does it have? (OpenStax 18.5) $\mathbf{1.03 \times 10^{12}}$
12. An amoeba has 1.00×10^{16} protons and a net charge of 0.300 pC. (a) How many fewer electrons are there than protons? (b) If you paired them up, what fraction of the protons would have no electrons? (OpenStax 18.6) $\mathbf{1.88 \times 10^{6}}$, $\mathbf{1.88 \times 10^{-10}}$
13. Consider three identical metal spheres, A, B, and C. Sphere A carries a charge of $+5q$. Sphere B carries a charge of $-q$. Sphere C carries no net charge. Spheres A and B are touched together and then separated. Sphere C is then touched to sphere A and separated from it. Last, sphere C is touched to sphere B and separated from it. (a) How much charge ends up on sphere C? What is the total charge on the three spheres (b) before they are allowed to touch each other and (c) after they have touched? (Cutnell 18.5) $\mathbf{1.5q}$, $\mathbf{4q}$, $\mathbf{4q}$