Physics 07-01 Electric Charge **Name: ________________________**

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

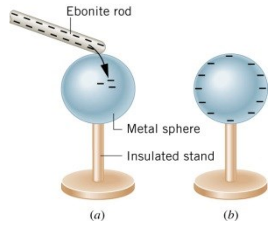
During any process, the net ____________ ____________ of a ____________ system remains ____________

- 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
  - ____________ ____________ ____________

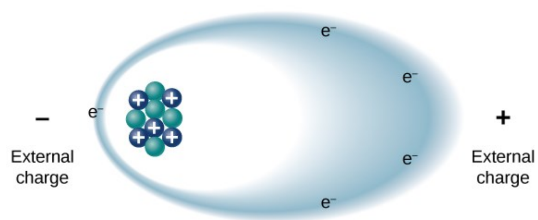
Charging by contact



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

Polarization

- Insulators
  - Electrons are ____________ free to move away from the atoms or molecule
  - When a ____________ is brought near, the electrons move to ____________ side of the atom/molecule so that more ____________ are on that side
  - One side is ____________, and the other side is more ____________



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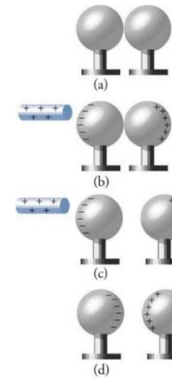
Charging by Induction

- Charge without ______________
- Charged rod comes near ______________ sphere
- The like charges are ______________ to _______________ sphere
- The spheres are separated
- The __________ is removed
- Sphere is ______________



Practice Work

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. 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?
6. 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**
7. 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**
8. 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**
9. A certain lightning bolt moves 40.0 C of charge. How many fundamental units of charge $|q_e|$ is this? (OpenStax 18.4) $\mathbf{2.50 \times 10^{20}}$
10. 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) $\mathbf{1.03 \times 10^{12}}$
11. 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) $\mathbf{1.88 \times 10^{6}}$**,** $\mathbf{1.88 \times 10^{-10}}$
12. 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) $\mathbf{1.5q, 4q, 4q}$
13. Consider four identical metal spheres, A, B, C, and D. Sphere A carries a charge of 5×10^{-6} C. Sphere B carries a charge of 2×10^{-6} C. Sphere C carries a charge of -3×10^{-6} C. And, Sphere D carries a charge of -4×10^{-6} C. Spheres A and C are touched together and then separated. Spheres B and D are touched together and then separated. Sphere C is touched to sphere B and separated. Last, sphere D is touched to sphere C and separated. (a) How much charge ends up on each sphere? (b) What is the total charge on the four spheres before they were touched and (c) after they have touched? (RW) $\mathbf{1\times10^{-6}}$ **C, 0 C,** $\mathbf{-0.5\times10^{-6}}$ **C,** $\mathbf{-0.5\times10^{-6}}$ **C; 0 C; 0 C**