





## What is electricity?

- The study of electric charge
- Negative charges:
  - Exist in electrons orbiting around nuclei
- Positive charges:
  - Exist in protons that are in nuclei
- In solids, **ELECTRONS** are responsible for the overall charge, and are the only particles that will move...
  - If there are too **MANY** electrons, the object has an overall negative charge
  - If there are too **FEW** electrons, the object has an overall positive charge





## Important Properties

- Law of Conservation of Charge
  - The total charge within an isolated system will remain constant
  - The charges can transfer between objects within that system, but the sum of all charged objects will remain the same
- Behavior of charged objects:
  - Objects with the same overall charge will repel each other
  - Objects with the opposite overall charge will attract each other



Units of Charge: Coulomb (C)



## Charging by Friction

*Remember:*

- *Substances with an excess of electrons are negatively charged*
- *Substances with a deficiency of electrons are positively charged*
- *Electrons are the only particle that moves between materials!*

**Friction** between two materials will cause the electrons that are less tightly held to move to the other material...

– **For example:** when Plexiglass is rubbed with silk, the electrons from the plexiglass are transferred to the silk.

- **Result:**      **Plexiglass = positively charged**  
                         **Silk = negatively charged**



## Charging by Friction

- Other known effects:
  - Fur and balloon: balloon = negative charge
  - Ebonite and fur: Ebonite = negative
  - Polyethylene and wool: polyethylene = negative charge
  - Glass with silk: glass = positive charge
- Remember: Like charges repel; opposite charges attract



## Charging by Friction

- Electrification by friction is not limited to solids:
  - Liquid sprays, powders, gases flowing through pipes can become charged
- Applications:
  - Electrostatic precipitator—a device that cleans the exhaust gases from power stations and factories by:
    - ionizing the particles in the gas
    - Charging metal collection plates with the opposite charge
    - Collecting the dust particles in the gas, and periodically removing the dust



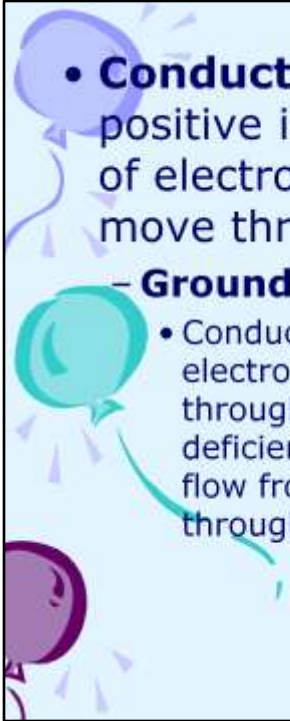
## More electrostatic applications:

- Van de Graaf generator
- Photocopy machines—copy paper is charged with the image to be copied; toner particles are attracted to the charged part of the paper (heat then seals the toner to the paper)



## Final comments on Friction:

- **Friction:** Most common/useful with insulators; conductors get charged typically by moving through the air (i.e cars and airplanes)
  - Conductors held by a person can not maintain (hold) their charge for very long

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- **Conductors:** metals consist of positive ions surrounded by a “sea” of electrons—electrons can easily move through the material

– **Grounding:**

- Conductors held in your hand—excess electrons will be transferred to the earth through you; if the conductor has a deficiency of electrons, the electrons will flow from the earth to the conductor through you.



• **Insulators:**

- Electrons are held tightly by the nuclei; are not as free to move through materials
- Electrons can accumulate on the surface
- Charge will remain until it "leaks" off or is discharged



## Charging by Contact

- A charged object is brought near a conductor (isolated, on an insulating stand)
- Upon contact, electrons are transferred to “less negative” object
- BOTH objects will end up with the same charge
- **Example:** a metal sphere with an excess of 11 electrons touches an identical metal sphere with an excess of 15 electrons. After the spheres touch, the number of excess electrons on the second sphere is...
  - 13 electrons—both spheres will obtain an equal distribution of the charge

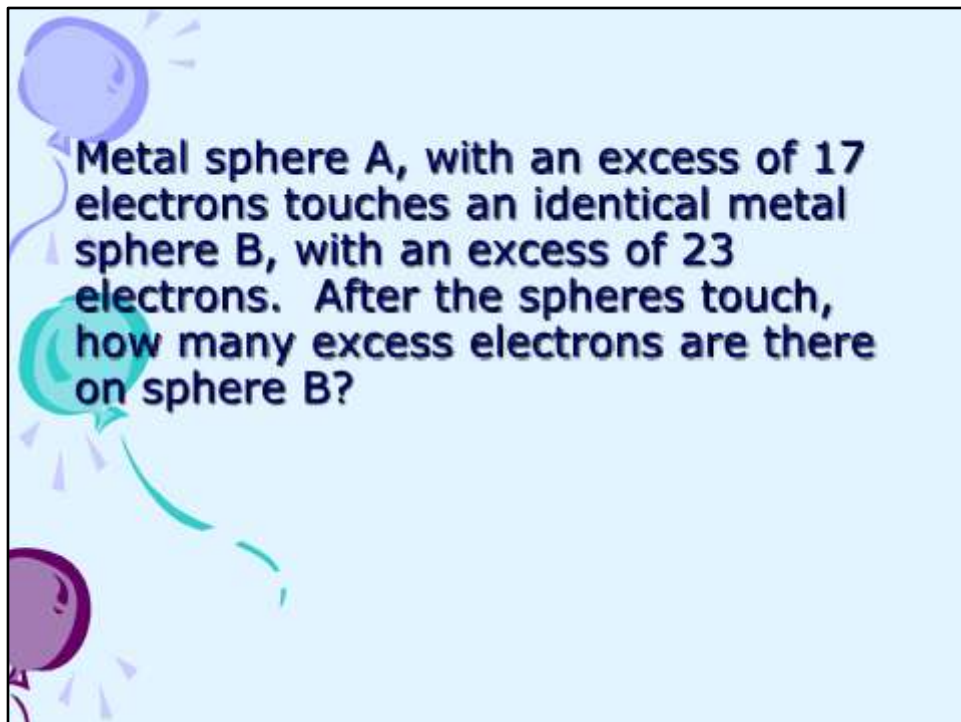
## Induction

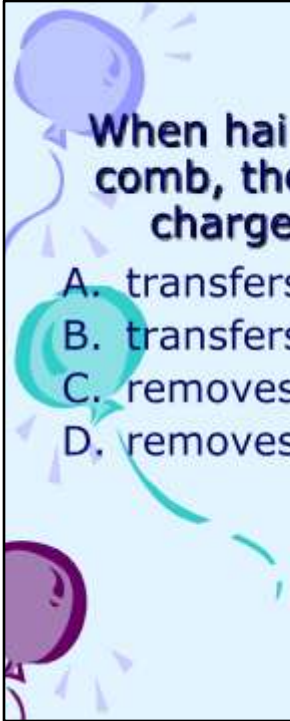
- Induction occurs when a charged object comes near another without touching
- Works best with conductors, but not exclusively
- Process:
  - A negatively charged object is brought near a second object
  - the electrons in the second move through the object to get farther from the negative charge
  - "Grounding" will allow the electrons to flow all the way off the object, leaving it with a positive charge



## Review!

- Grab your Voters, and make sure you've written your name on the voter sign-in sheet that went around!





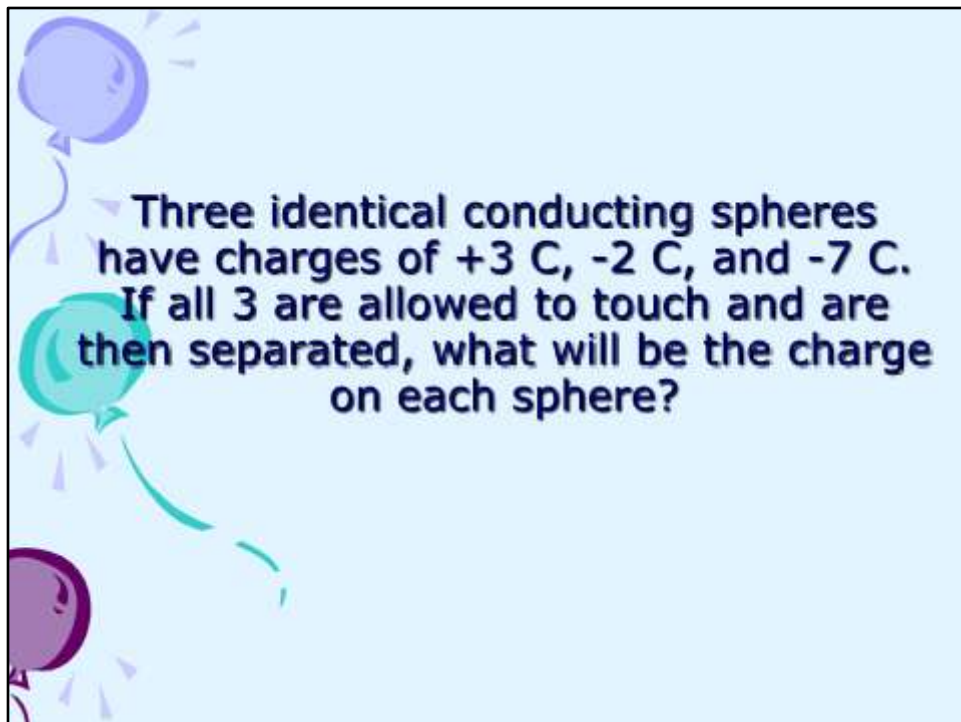
**When hair is combed with a plastic comb, the hair becomes positively charged because the comb...**

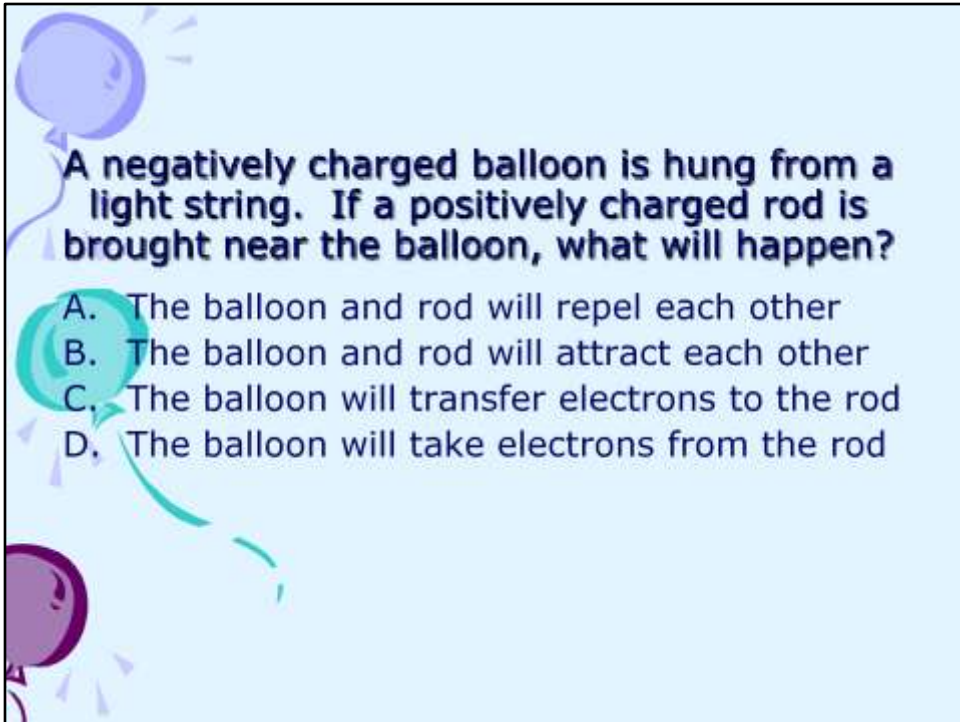
- A. transfers electrons to the hair
- B. transfers protons to the hair
- C. removes protons from the hair
- D. removes electrons from the hair



**A positively charged rod is brought near an uncharged metal plate, but does not touch it. As a result...**

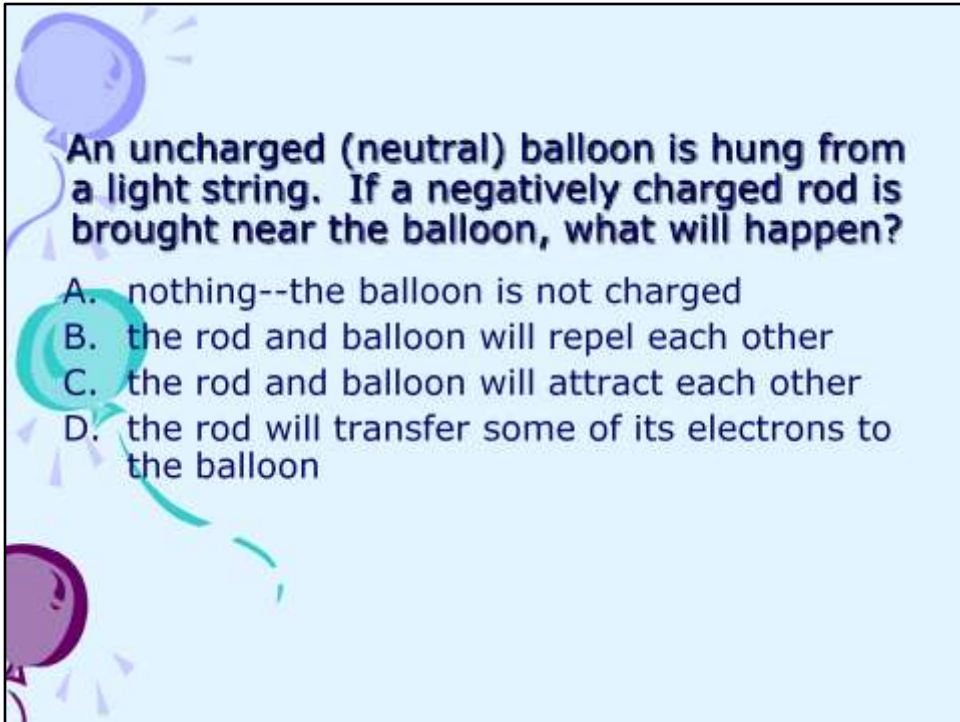
- A. the metal plate will gain a charge depending on how close the rod gets
- B. the metal plate will remain uncharged
- C. the metal plate will become positively charged
- D. the metal plate will become negatively charged





**A negatively charged balloon is hung from a light string. If a positively charged rod is brought near the balloon, what will happen?**

- A. The balloon and rod will repel each other
- B. The balloon and rod will attract each other**
- C. The balloon will transfer electrons to the rod
- D. The balloon will take electrons from the rod



**An uncharged (neutral) balloon is hung from a light string. If a negatively charged rod is brought near the balloon, what will happen?**

- A. nothing--the balloon is not charged
- B. the rod and balloon will repel each other**
- C. the rod and balloon will attract each other
- D. the rod will transfer some of its electrons to the balloon