Charging by Conduction and Grounding

Read from **Lesson 2** of the **Static Electricity** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/estatics/u8l2b.html
http://www.physicsclassroom.com/Class/estatics/u8l2d.html

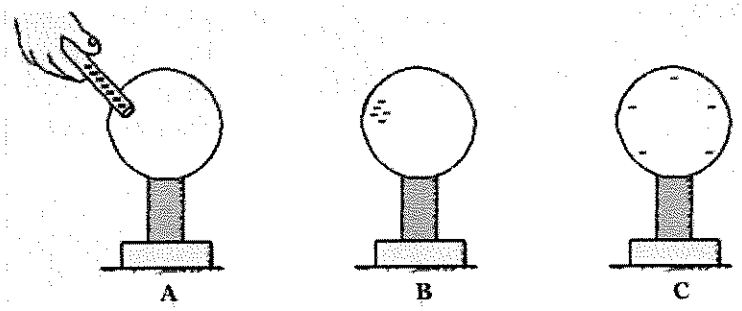
MOP Connection: Static Electricity: sublevel 4

Review:

1. Fill in the following blanks with the words **electrons** or **protons**.
   _____ are negatively charged and _____ are positively charged. The _____ reside in the nucleus of atoms and are tightly bound; they will never leave an atom as a result of electrostatic procedures. On the other hand, _____ are located outside the nucleus and are easily removed from or added to atoms. As an object begins to gain or lose _____ from its atoms, it becomes positively or negatively charged. A negatively charged object has more _____ than _____. A positively charged object has more _____ than _____.

2. A metal sphere is resting upon an insulating stand. A teacher holds a metal bar (with an insulating handle). The teacher uses the metal bar to charge the metal sphere by **conduction**. Which one of the processes describes what the teacher likely did to charge the sphere by conduction?
   a. The teacher rubbed the bar and the sphere together.
   b. The teacher held the bar near the sphere and then touched the sphere with her hand.
   c. The teacher charged the bar and then contacted it to the sphere.

Consider the conduction charging process described below:



A: A teacher holds a negatively charged metal bar by its insulating handle and touches it to a metal sphere (attached to an insulating stand).
B: The teacher pulls the metal bar away and the metal sphere acquires a charge.
C: The excess negative charge spreads uniformly about the surface of the metal sphere.

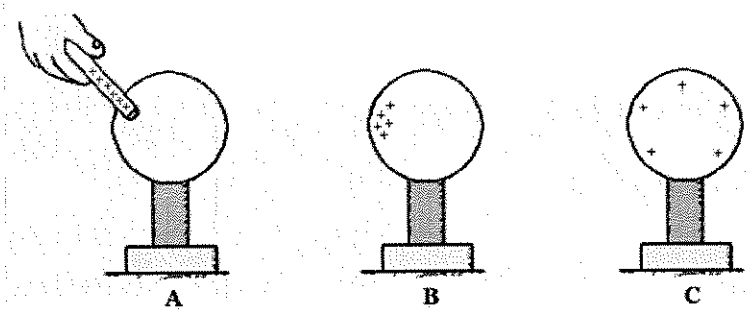
3. Diagram A is the charging step. How does the sphere become charged?
   a. Electrons move from the insulating stand into the sphere.
   b. Electrons move from the charged metal bar into the sphere.
   c. Protons move from the sphere into the negatively charged bar.

4. When the metal bar is pulled away in Diagram B, the metal bar is _____.
   a. positively charged b. electrically neutral
   c. still negatively charged, but has fewer excess electrons than it previously did.

5. Diagram C shows the excess negative charge distributed differently than it is in Diagram B. Explain why the excess negative charge would distribute itself as it does in Diagram C.

like charges repel!

Now consider the conduction charging of the sphere using a positively charged metal bar:

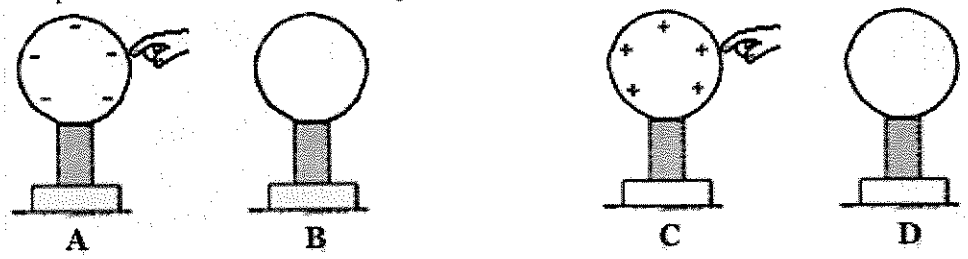


A: A teacher holds a positively charged metal bar by its insulating handle and touches it to a metal sphere (attached to an insulating stand).
B: The teacher pulls the metal bar away and the metal sphere acquires a charge.
C: The excess positive charge is spread uniformly about the surface of the metal sphere.

6. Diagram A is the charging step. How does the sphere become charged?
   a. Protons move from the insulating stand into the sphere.
   b. Protons move from the charged metal bar into the sphere.
   c. Electrons move from the sphere into the positively charged bar.

7. When the metal bar is pulled away in Diagram B, the metal bar is _____.
   a. negatively charged
   b. electrically neutral
   c. still positively charged, but has fewer excess protons than it previously did.

Two different processes are shown in the diagrams below:



A: A negatively charged metal sphere is touched.
B: The hand is pulled away and the sphere is then electrically neutral.

A: A positively charged metal sphere is touched.
B: The hand is pulled away and the sphere is then electrically neutral.

8. The process of neutralizing the charged spheres as depicted above is known as _____.
   a. charging b. polarization c. induction d. grounding

9. When the negatively charged sphere is touched, _____ move from the _____ to the _____.
   a. electrons, sphere, hand
   b. electrons, hand, sphere
   c. protons, sphere, hand
   d. protons, hand, sphere

10. When the positively charged sphere is touched, _____ move from the _____ to the _____.
    a. electrons, sphere, hand
    b. electrons, hand, sphere
    c. protons, sphere, hand
    d. protons, hand, sphere

Charging by Induction

Read from **Lesson 2** of the **Static Electricity chapter** at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/estatics/u8l2c.html

MOP Connection: Static Electricity: sublevels 5, 6, and 7

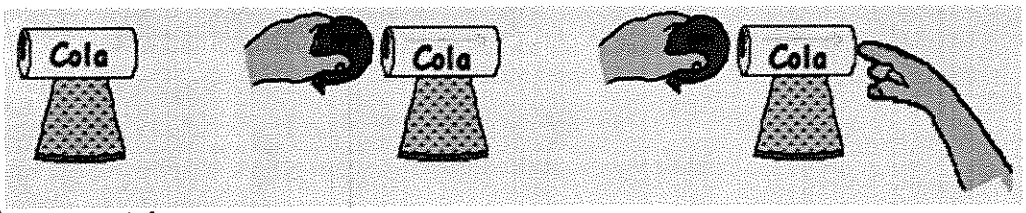
Review:

1. Fill in the following blanks with the words **electrons** or **protons**.

   _____ are negatively charged and _____ are positively charged. The _____ reside in the nucleus of atoms and are tightly bound; they will never leave an atom as a result of electrostatic procedures. On the other hand, _____ are located outside the nucleus and are easily removed from or added to atoms. As an object begins to gain or lose _____ from its atoms, it becomes positively or negatively charged. A negatively charged object has more _____ than _____. A positively charged object has more _____ than _____.

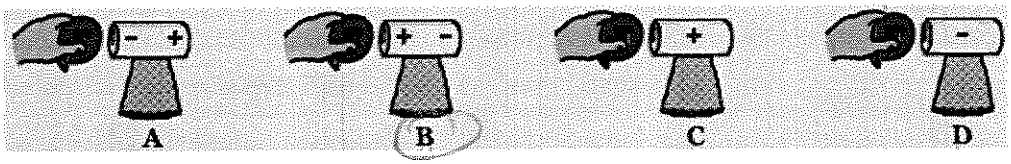
Consider the following process:

An uncharged metal pop can is attached to a Styrofoam cup (which acts as an insulating stand). A negatively charged balloon is brought near the pop can. While the balloon is held near, the can is touched. When the can is pulled away, the pop can is charged.



2. This process is known as _____.
   a. charging by conduction
   b. charging by induction
   c. polarization
   d. grounding

3. When the balloon is held near to the pop can (and before being touched by the hand), the distribution of charge on the pop can is best depicted by diagram _____.



4. When the pop can is touched by the hand, _____ move from the _____ to the _____.
   a. protons, hand, can
   b. protons, can, hand
   c. electrons, hand, can
   d. electrons, can, hand

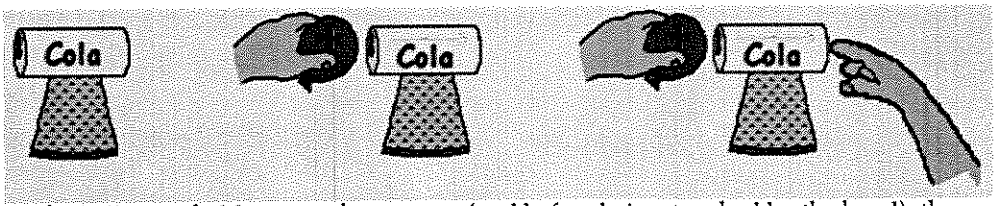
5. This process causes the can to acquire a _____ charge.
   a. negative
   b. positive
   c. neutral

6. When the induction charging process is complete, the balloon is _____.
   a. positively charged
   b. electrically neutral
   c. still negatively charged, only having fewer excess electrons as before the process began
   d. still negatively charged, having the same amount of negative charge as it previously had

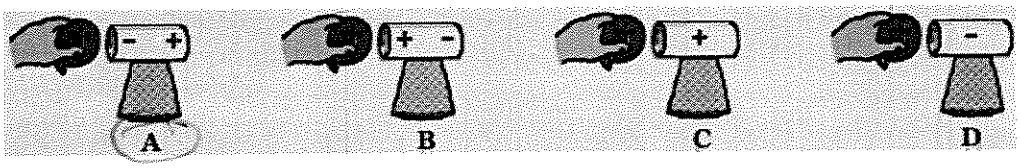
7. In general, the use of a negatively charged object to charge another object by induction causes the other object to acquire a _____ charge.
   a. positive
   b. negative

Now consider a similar process:

An uncharged metal pop can is attached to a Styrofoam cup (which acts as an insulating stand). A positively charged balloon is brought near the pop can. While the balloon is held near, the can is touched. When the can is pulled away, the pop can is charged.



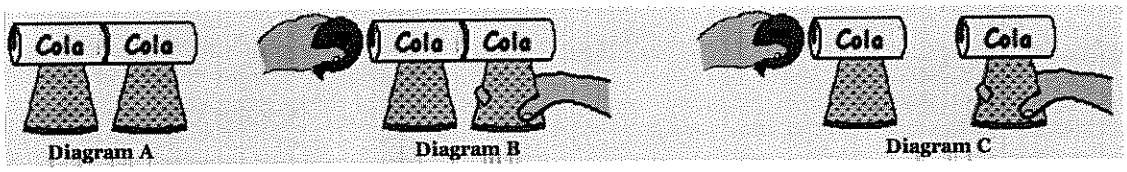
8. When the balloon is held near to the pop can (and before being touched by the hand), the distribution of charge on the pop can is best depicted by diagram _____.



9. When the pop can is touched by the hand, _____ move from the _____ to the _____.
   a. protons, hand, can
   b. protons, can, hand
   c. electrons, hand, can
   d. electrons, can, hand

10. This process causes the can to acquire a _____ charge.
    a. negative
    b. positive
    c. neutral

In the above induction charging processes, there are two basic steps: a **polarization step** and a **charging step**. In the charging step, the hand serves as a **ground** - an object that serves as a seemingly infinite source of or sink for electrons. During the charging step, electrons move into or out of the ground (hand) in order to charge the pop can. Another means of charging the pop can involves the use of another conducting object. For instance, another pop can could be used. The diagrams below depict the induction charging process using a second pop can in place of the hand.



11. In terms of electron movement, explain what is happening in Diagrams B and C above. Finally, state the charge acquired by the left and the right can as a result of this process.

B → electrons move to right cola can

C → cans pulled apart

left can = positive

right can = negative