Charging by Induction

Charging by **induction** is a method used to charge an object without actually touching it to any other charged object.

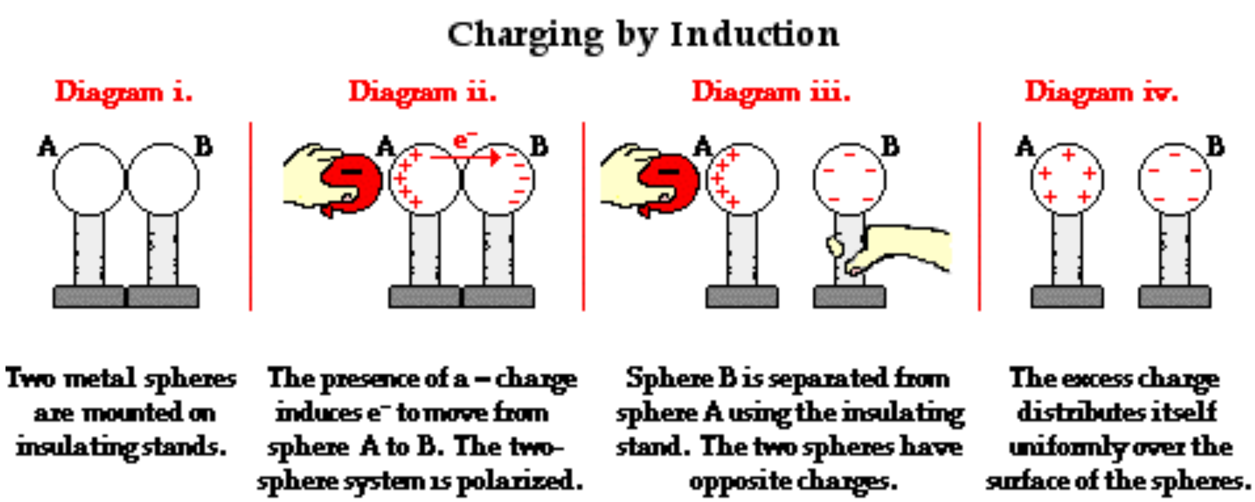
Charging a Two-Sphere System Using a Negative Object

A common example of induction is the charging of two metal spheres using a negatively charged object. The spheres are placed side by side, as shown in Diagram i, so that they are touching. Since they are made of metal, electrons are free to move between the two spheres.

A negatively charged object is brought close to sphere A, but not allowed to touch. Electrons in sphere A are repelled by the negative object, and move as far away as possible — in this case, moving from sphere A onto sphere B, as shown in Diagram ii. Due to this movement of charges, sphere B will now have an excess of electrons (making it negative). Sphere A, on the other hand, will have an excess of protons (making it positive).

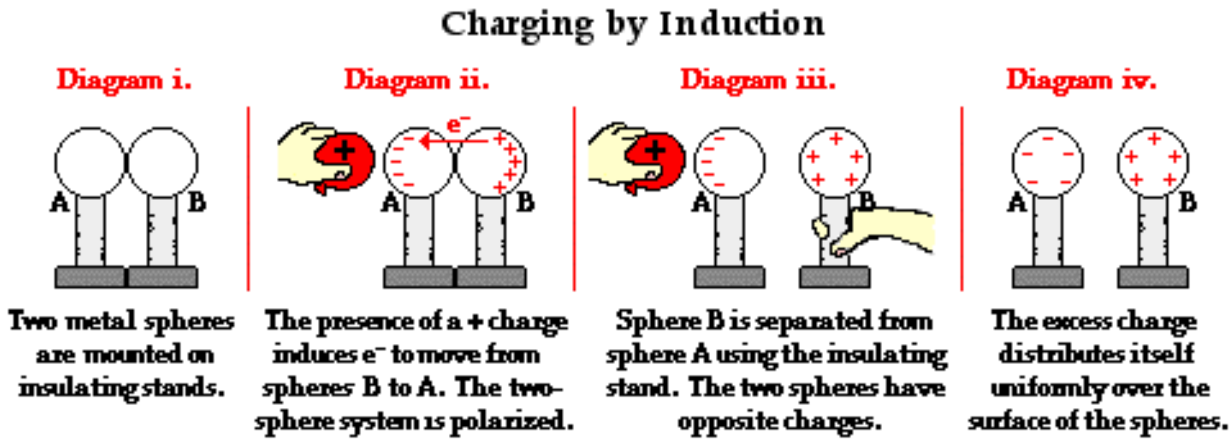
Sphere B is separated from sphere A so that they are no longer in contact, as shown in Diagram iii.. If this is done while the negatively charged object is still present, then the two spheres will now be charged (A is positive, B is negative).

The charged object can now be removed, as shown in Diagram iv. The spheres are now charged, without ever having touched either of them with the charged object.



Charging a Two-Sphere System Using a Positive Object

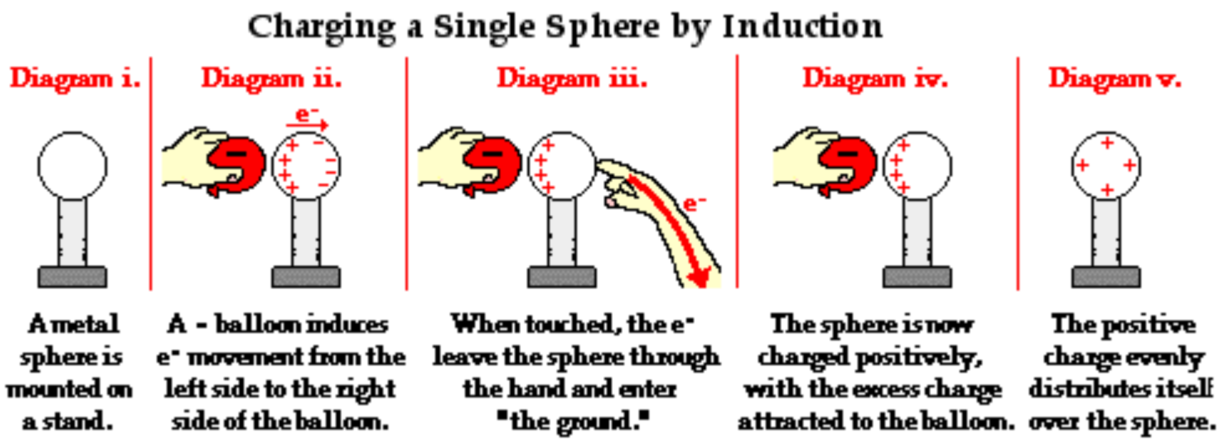
The same method can be used to charge the two spheres with a positive object instead. The procedure is the same, but the movement of charges is not. In this case, electrons will be attracted to the positive object and will move from sphere B onto sphere A, as shown in the series of diagrams below.



Notice that, in this case, sphere A ends up negative while sphere B ends up positive.

Charging a Single Sphere Using a Negative Object

Suppose that a negatively charged object is brought near a single metal sphere, as shown in Diagram ii below.



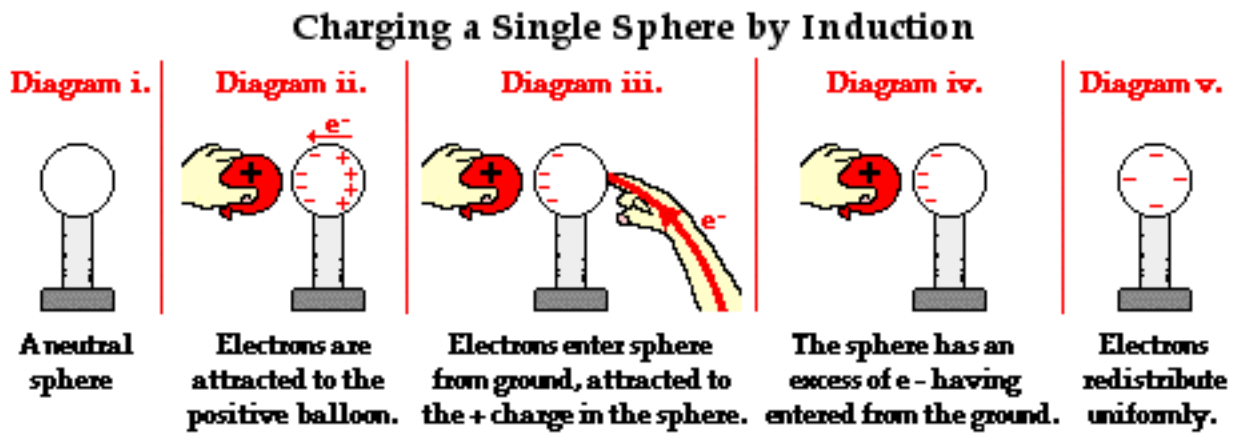
The presence of the negative object will cause electrons in the sphere to move to the side farthest from the object. This separation of charges to opposite sides of the sphere is called **polarization**.

Once the charges within the sphere have become polarized, the sphere is touched on the side farthest from the charged object (as in Diagram iii). Touching the sphere acts as a ground, allowing the negative charges to exit the sphere and move through the hand to the ground.

At this point, the sphere has acquired a positive charge, since it now has more protons than it does electrons. If the ground is removed, and then the charged object is removed, the sphere will remain positively charged.

Charging a Single Sphere Using a Positive Object

Suppose that a positively charged object is brought near a single metal sphere, as shown in Diagram ii below.



The presence of the positive object will cause electrons in the sphere to move to the side closest to the object (polarization).

Once the charges within the sphere have become polarized, the sphere is touched on the side farthest from the charged object (as in Diagram iii). Touching the sphere acts as a ground, allowing negative charges from the ground to move through the hand and enter the sphere.

At this point, the sphere has acquired a negative charge, since it now has more electrons than it does protons. If the ground is removed, and then the charged object is removed, the sphere will remain negatively charged.

Worksheet

1. Two neutral conducting pop cans are touching each other. A positively charged balloon is brought near one of the cans as shown below. The cans are separated while the balloon is nearby, as shown. After the balloon is removed the cans are brought back together.

When touching again, can X is

a) positively charged.
b) negatively charged.
c) neutral.
d) impossible to tell.

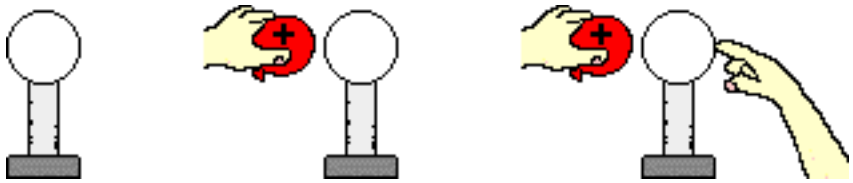
2. Two neutral conducting pop cans are touching each other. A positively charged glass rod is brought near Can X as shown below.

Which of the following occur as the glass rod approaches Can X? List all that apply.

a) Electrons jump from the glass rod to can X.
b) Electrons jump from the glass rod to can Y.
c) Electrons jump from can X to the glass rod.
d) Electrons jump from can Y to the glass rod.
e) Protons jump from the glass rod to can X.
f) Protons jump from can X to the glass rod.
g) ... nonsense! None of these occur.

3. TRUE or FALSE: Two neutral conducting pop cans are touching each other. A negatively charged balloon is brought near Can X as shown below. As the balloon approaches Can X, there is a movement of electrons between the balloon and can X (in one direction or the other).

4. A positively charged balloon is brought near a neutral conducting sphere as shown below. While the balloon is near, the sphere is touched (grounded).



At this point, there is a movement of electrons. Electrons move

a) into the sphere from the ground (hand).
b) out of the sphere into the ground (hand).
c) into the sphere from the balloon.
d) out of the sphere into the balloon.
e) from the ground through the sphere to the balloon.
f) from the balloon through the sphere to the ground.
g) .... nonsense! Electrons do not move at all.

5. A negatively charged balloon is brought near a neutral conducting sphere as shown below. As it approaches, charge within the sphere will distribute itself in a very specific manner. Which one of the diagrams below properly depicts the distribution of charge in the sphere?