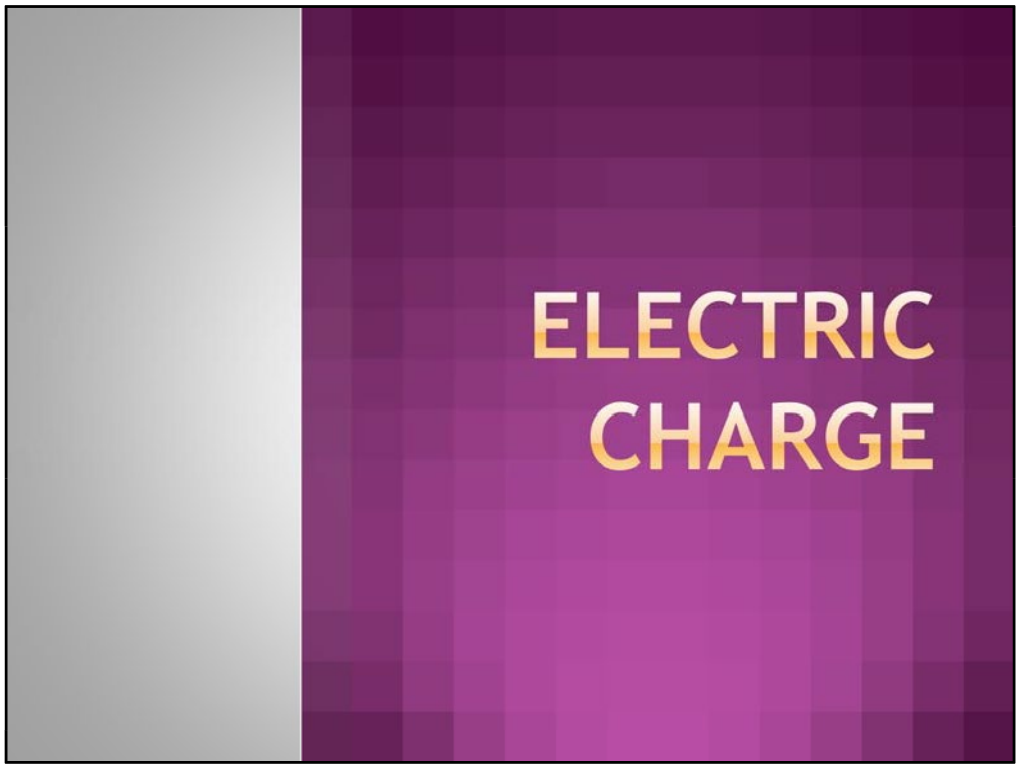
# Module 7: Electricity - Electric Charge and Current
## Topic 1 Content: Electric Charge Presentation Notes




Electric Charge

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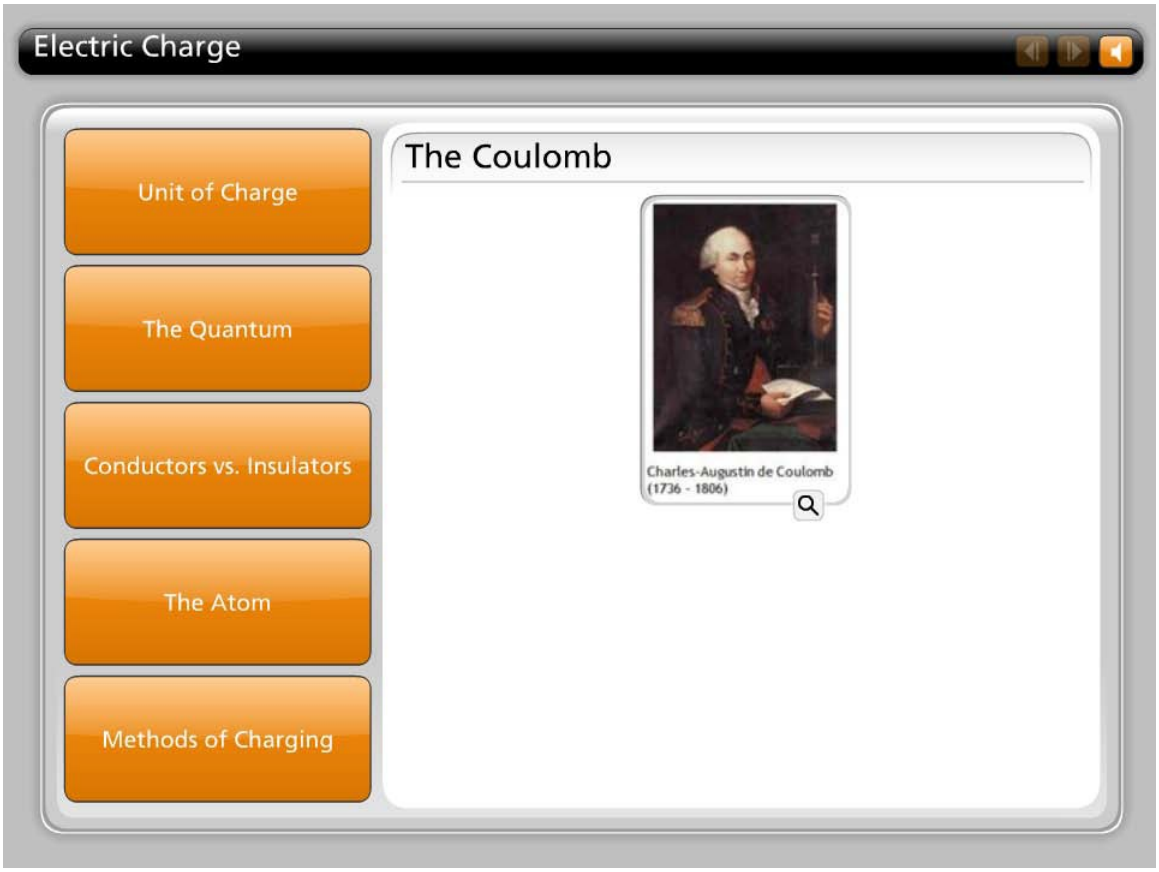


The Coulomb is the IS unit of charge. The Coulomb is named after Charles-Agustin de Coulomb, who is attributed with the discovery of the law that describes electrostatic repulsion and attraction.

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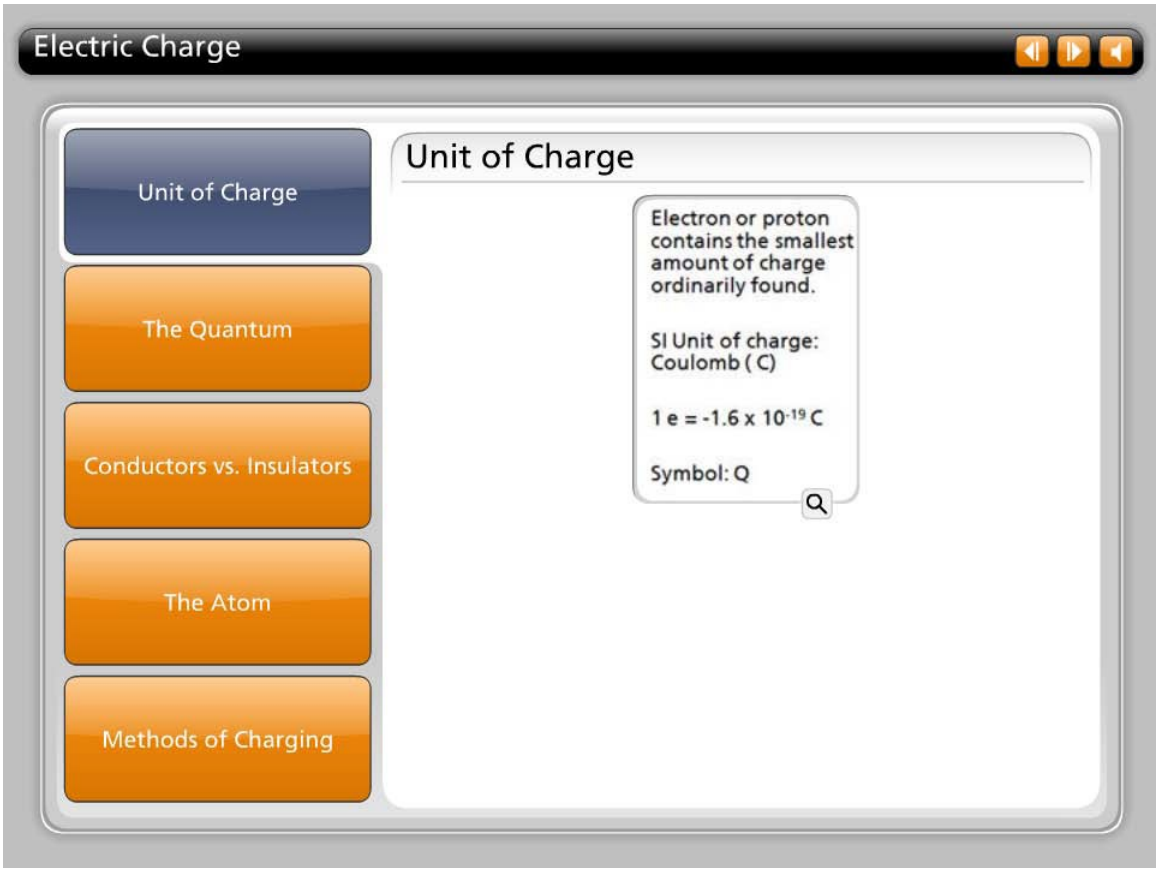


The smallest amount of charge is that found on one electron or one proton.

The Coulomb is a fundamental unit, which means it cannot be expressed as a combination of other units. The Coulomb is abbreviated as capital C. Charge is represented in equations with the letter Q.

The charge of one electron is negative one point six times ten to the negative nineteenth Coulomb. The charge of the proton is positive one point six times ten to the negative nineteenth Coulombs, so we see that electrons and protons have equal amounts of charge with opposite signs. Atoms are electrically neutral because they have equal numbers of protons and electrons and the total charge adds to zero.

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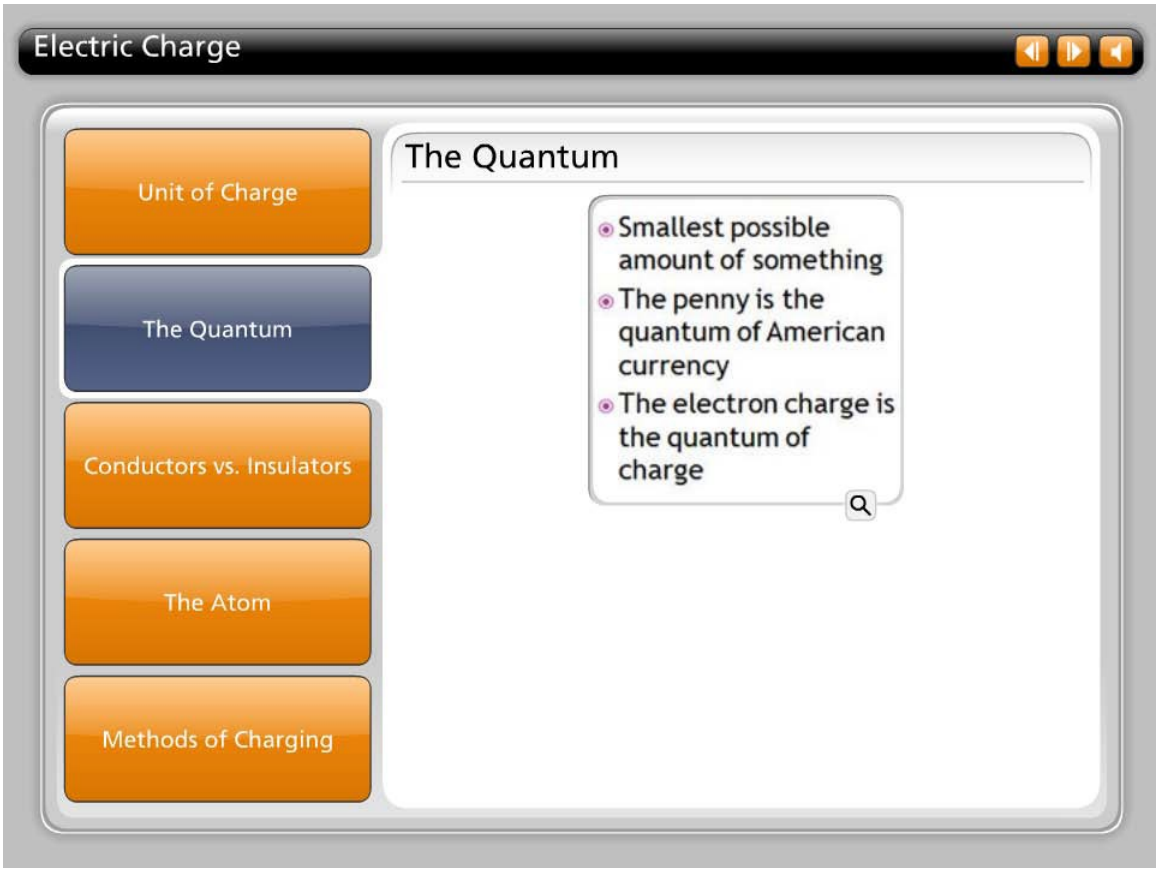


All possible amounts of charge are multiples of one point six times ten to the negative nineteenth Coulombs. In physics, when all amounts are multiples of some smaller amount, the smaller amount is called a quantum. What is a quantum? Let's consider money as an analogy. The smallest amount of American currency is the penny, and all money is in multiples of pennies. The penny is the quantum of American money, like the electron is the quantum of charge. So, we can say that money and charge are both quantized.

In the charging experiments that follow you will examine how electrons move and are transferred.

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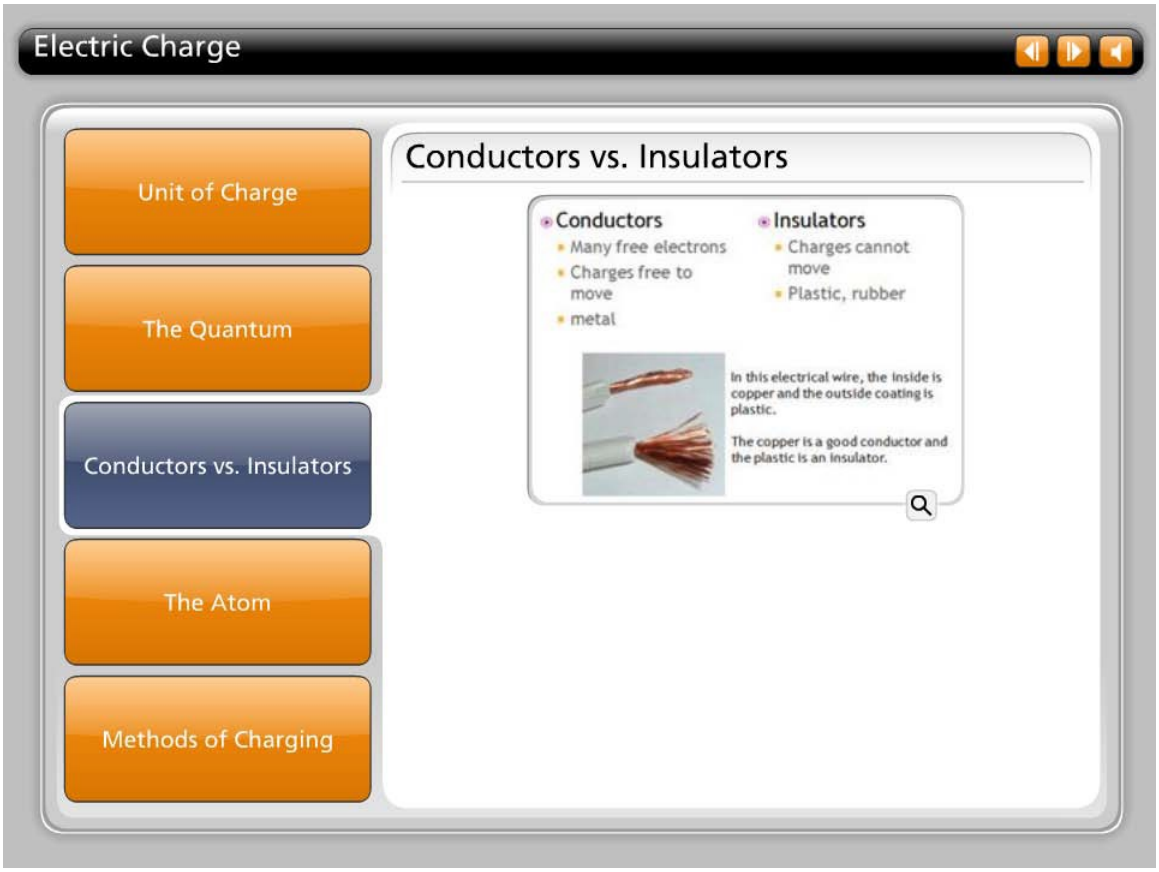


How electrons can get from one place to another largely depends on the type of materials involved in the process. You probably have learned about conductors and insulators in a previous science class. The most important thing to remember is that on a conductor, charge can move freely, but on an insulator charge stays in one place. Metals are good conductors, most non-metals are good insulators. You will see how the properties of conductors and insulators come into play in the demonstrations we will watch in this topic.

In this electrical wire, the inside is copper and the outside coating is plastic. The copper is a good conductor and the plastic is an insulator.

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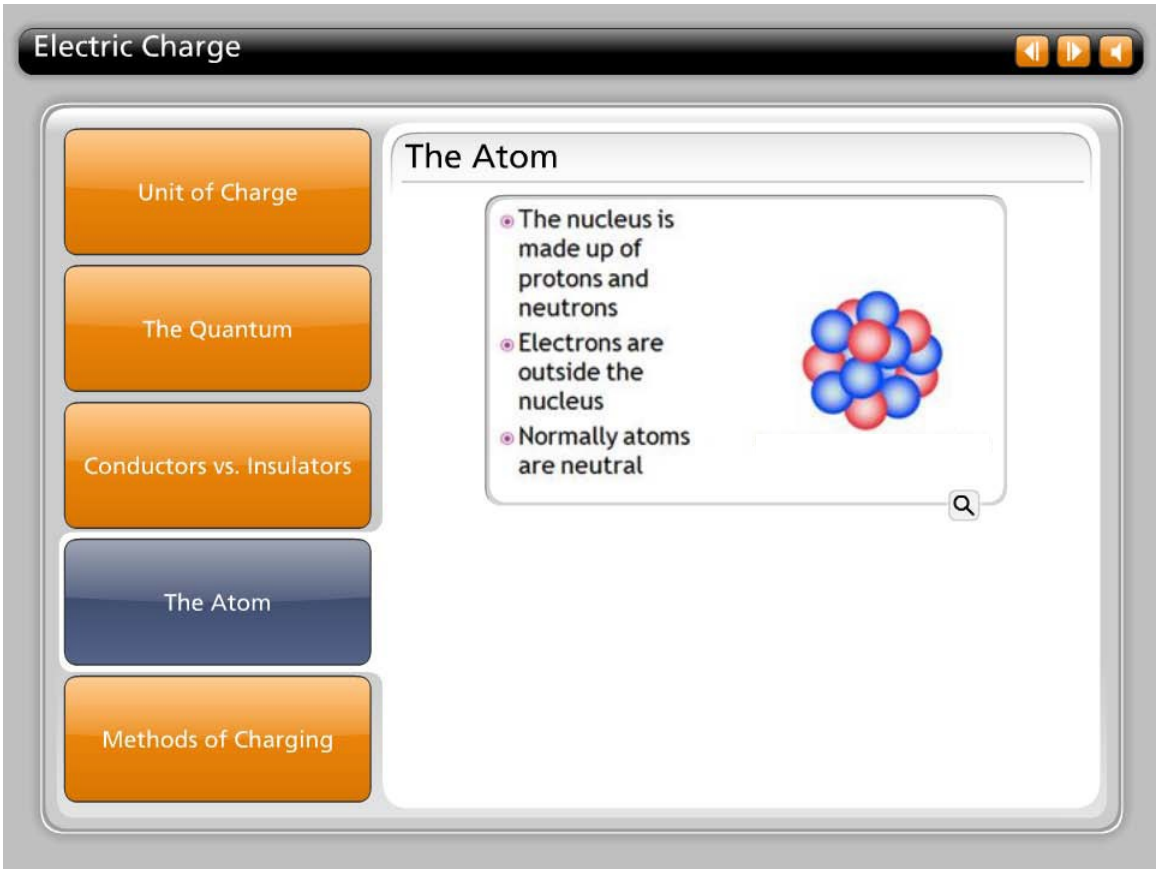


When different materials are rubbed together, the transfer of electricity the Greeks saw was due to electrons moving from one substance to another. You probably remember from Chemistry that atoms are usually electrically neutral with equal numbers of protons and electrons. If electrons are gained by the material, the charge will be negative since the electrons will outnumber the protons. If electrons are given away, the charge will be positive since the protons will outnumber the electrons. Protons do not move from atom to atom since they are contained inside the nucleus of the atom.

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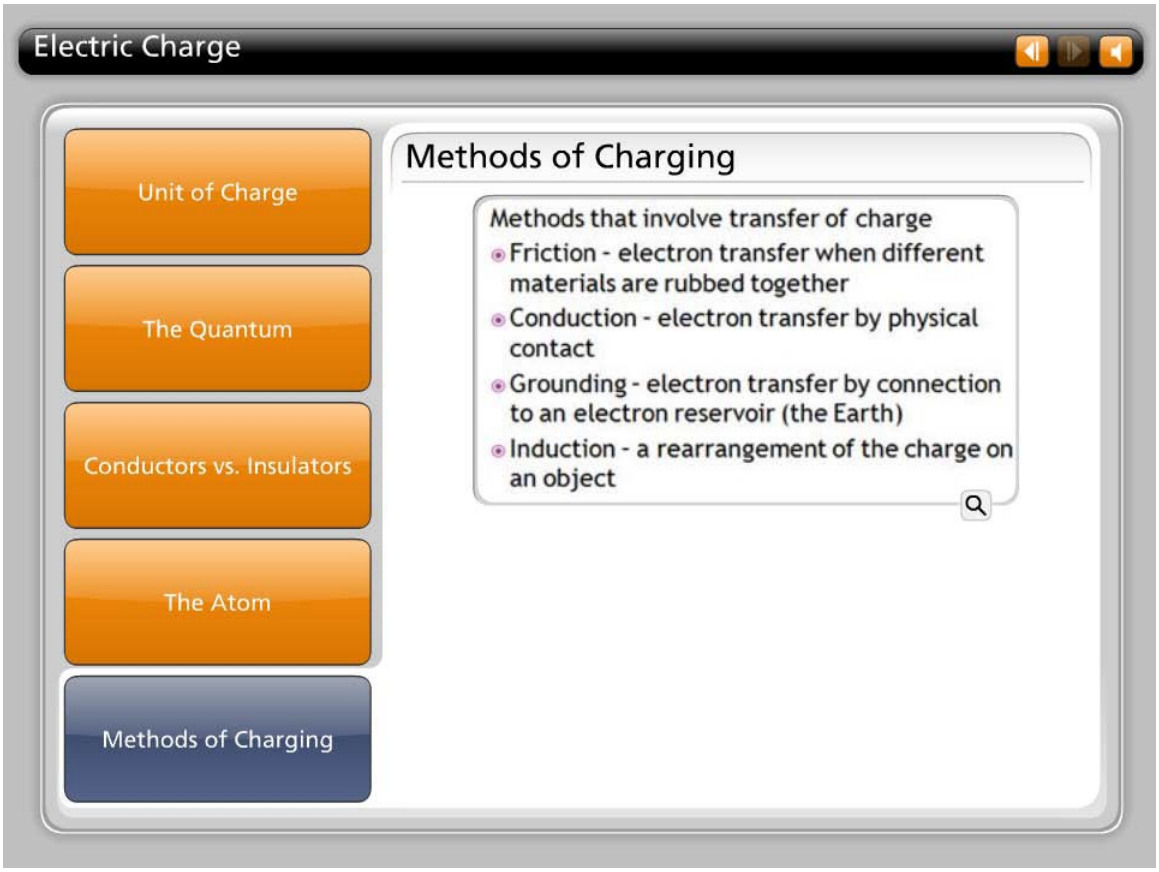
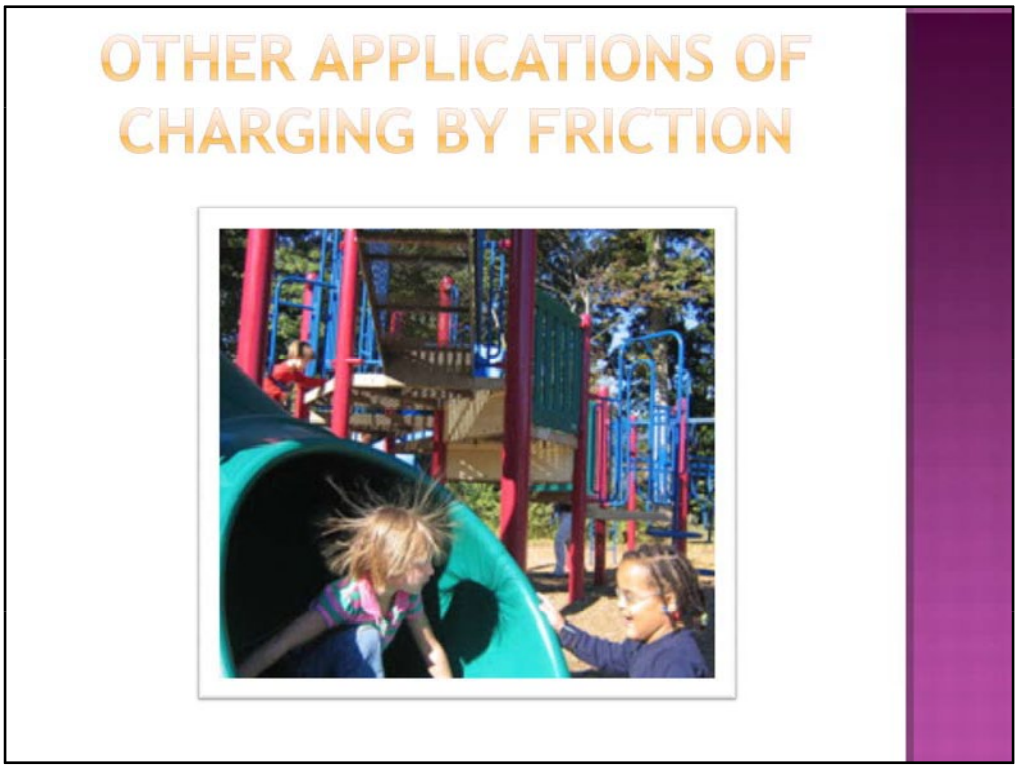
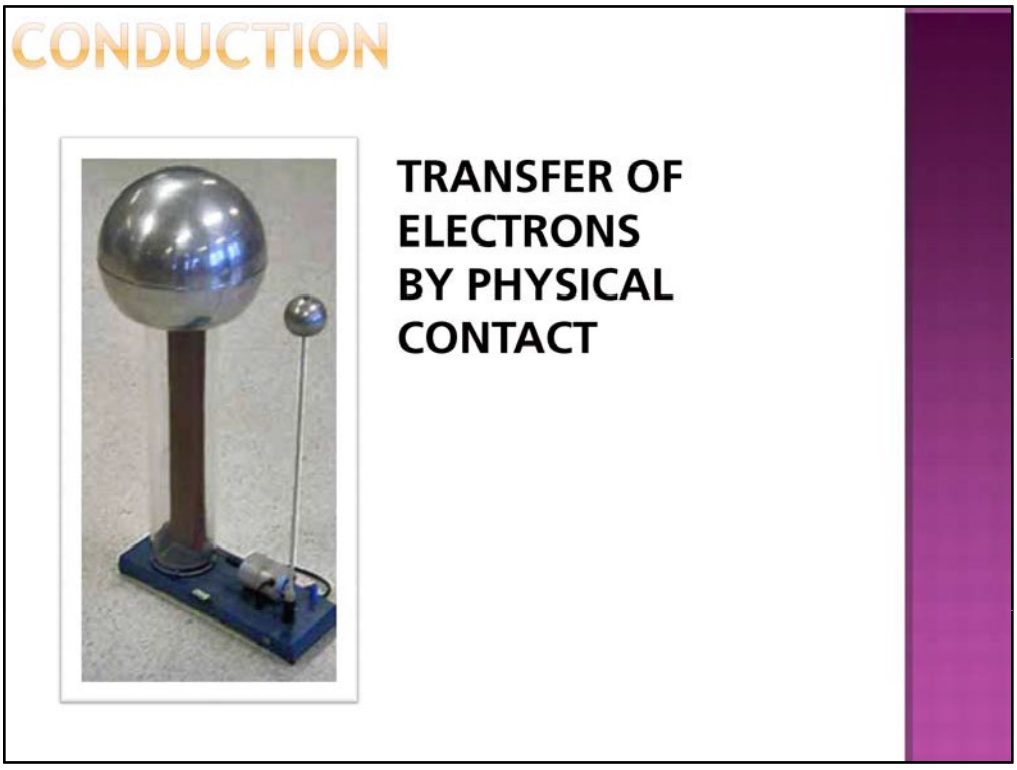


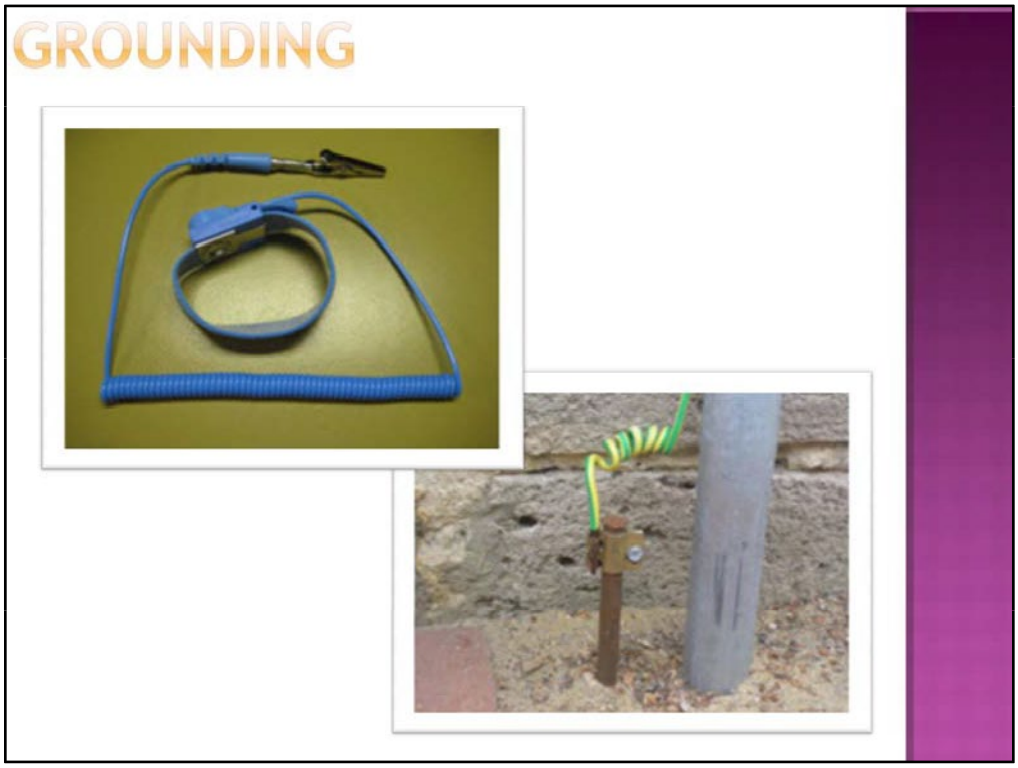

There are four basic ways for something to become positively or negatively charged. Those methods are friction, conduction, grounding and induction. You will examine some demonstrations to see which methods are used and how they work.



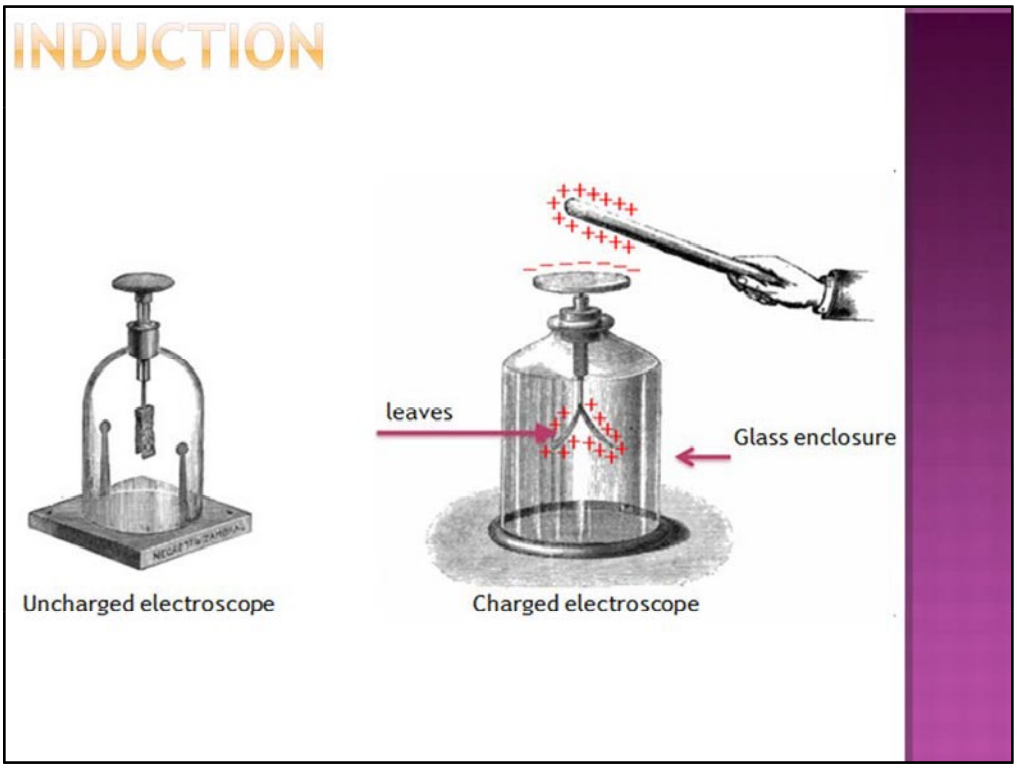

Another example is here at the playground. When the girl goes down the plastic slide, electrons are transferred from the slide to her hair. This leaves her hair charged positively. Her hair is attracted to the slide and repels other hairs.



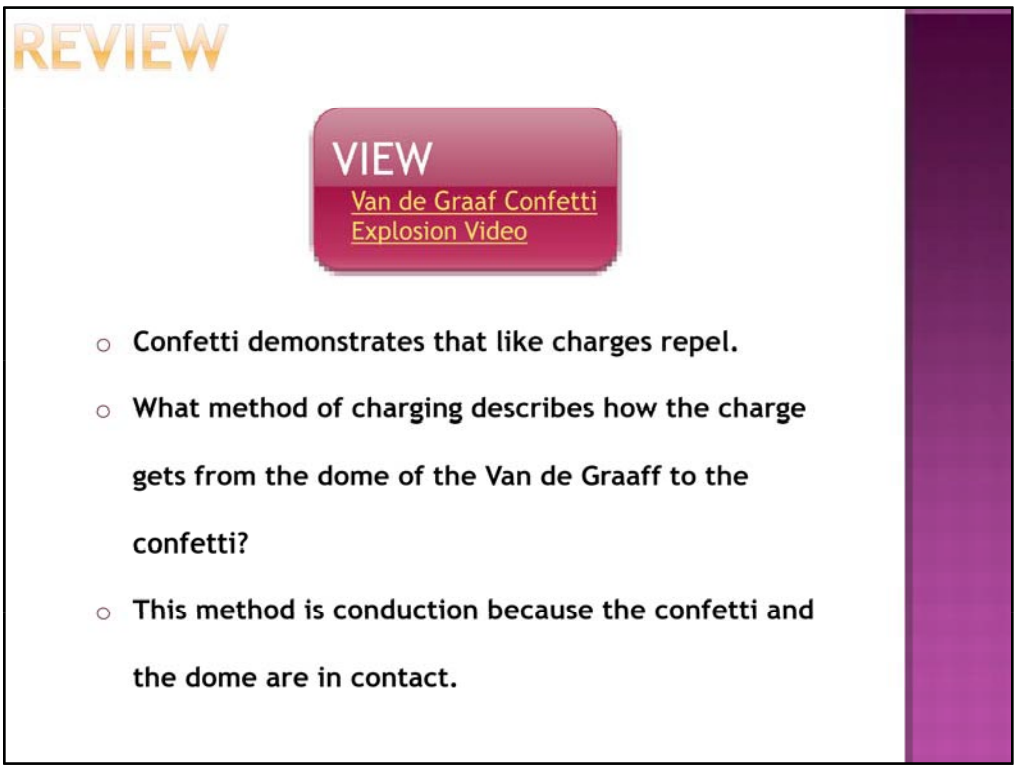

Conduction occurs when charges can move from one object to another object through physical contact. Whenever there is metal to metal contact, there is a path for electrons to follow. On the large metal sphere of this Van de Graaff generator, electrons are free to move on the surface of the metal or to any other metal object that touches the sphere. If the two metal spheres are touched, electrons will move from one to the other. Transfer of charge by conduction can occur for non metals also. If I charge a rubber rod by friction, I can transfer some of that charge to other objects by touching the objects. In the case of charging, conduction requires contact. Conduction does not require conductive materials.



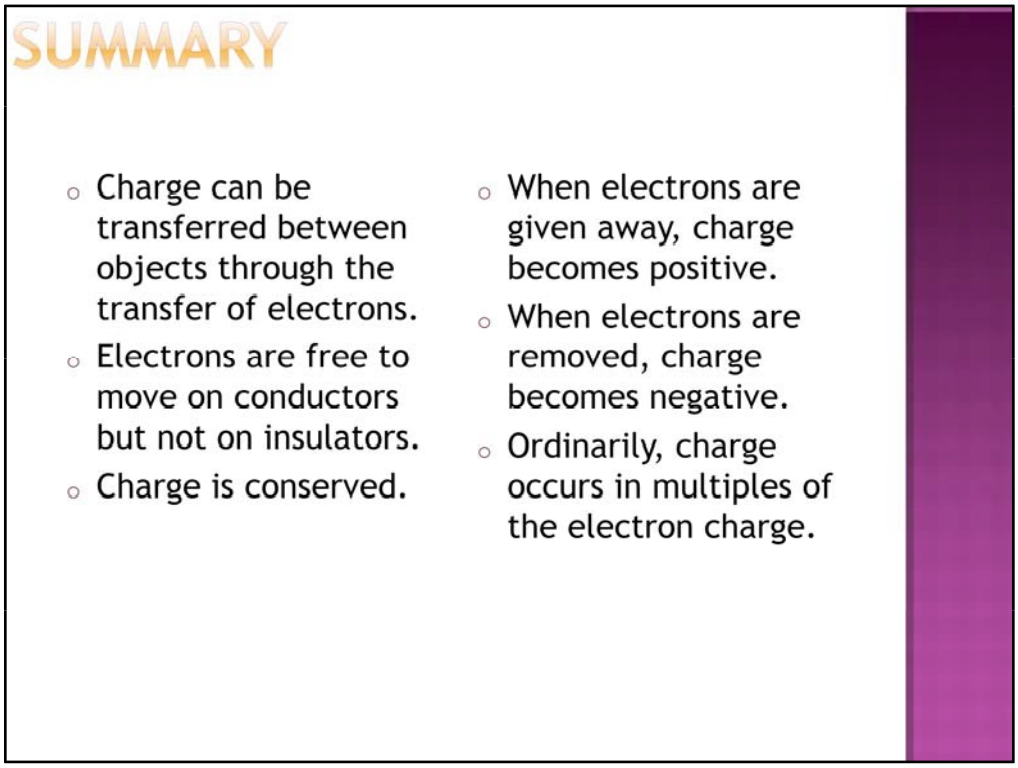

Grounding is when excess electrons are removed or a deficit of electrons is corrected by adding electrons. In our original example, when you touched the doorknob, the excess electrons were removed from your body by grounding via the doorknob. In this picture at right, the electrical system of a home is grounded to the earth by running a wire to a large spike in the ground. Excess electrons return to the Earth. Static charge can damage electronics, so technicians ground themselves to prevent the buildup of excess charge with a wrist strap and wire as shown at left




Induction is different than the first three methods because the total amount of charge on the object does not change. In induction, electrons move from one part of a conductor to another, making one part positive and one part negative while leaving the total charge the same. This type of charging is not permanent. If whatever caused the electrons to move is taken away, the electrons will return to their normal places. The picture shows an example of charging by induction. The device in the picture is called an electroscope, which is a device used to detect charge. The top disk, vertical rod and freely hanging leaves connected to the rod are all made of metal. Electrons are free to move along the metal. The leaves are encased in glass. When the positively charged rod is brought near the electroscope, electrons from the leaves are attracted to it and move to the disk. The leaves are left positively charged. The two positively charged leaves repel each other. However, no electrons have left the electroscope. If the rod is moved away, the electrons will return to their normal position and the leaves will hang straight down. We will look at some examples of charging and explain how each one works using this new vocabulary.



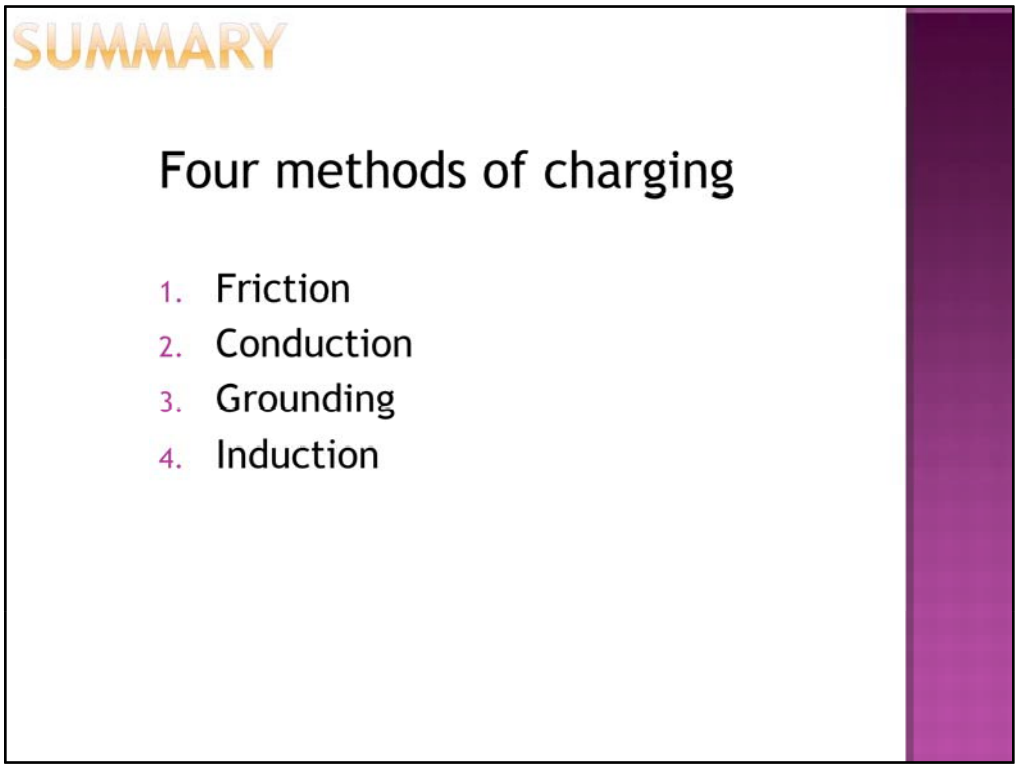

So you see from the confetti demonstration that like charges repel. What method of charging describes how the charge gets from the dome of the Van de Graaff to the confetti? This method is conduction because the confetti and the dome are in contact.




In Summary:

Charge can be transferred between objects through the transfer of electrons.

- Electrons are free to move on conductors but not on insulators.
- Charge is conserved.
- When electrons are given away, charge becomes positive.
- When electrons are removed, charge becomes negative.
- Ordinarily, charge occurs in multiples of the electron charge.




There are four methods of charging. Friction involves rubbing two different materials together. Electrons will be transferred from one material to the other. Conduction is when electrons are transferred by physical contact. Grounding is when excess electrons are removed by a connection to the Earth. Induction is different than the other three methods because electrons are not removed. Charge polarization results from a redistribution of electrons making one part of the object charged positive and the other part negative. The overall charge has not changed.