

Leyden Jar #510

Warning:

- **This product is not a toy. Use in a laboratory or educational setting only.**
- **California Proposition 65 Warning: This product can expose you to chemicals including lead, which is known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.**



Introduction

Static electricity has been known for many years and was one of the first sources of electricity to be investigated. Benjamin Franklin performed his early experiments in electricity with static electricity, and the Leyden Jar was developed as a means of storing and accumulating static electricity. With the development of current electricity, static electricity became mostly a matter of historical interest. However, recent developments of liquid crystal displays, medical x-ray imaging, and xerographic copying have revived interest in the phenomena.

The most easily observed electrostatic effect is lightening. Rapid air movement causes a slight static charge to accumulate on the ground and nearby objects. A similar, but opposite charge, accumulates in the air. While

the charge caused by air movement is slight, there is a lot of air and a large area for the accumulating charge. When the difference in the charge becomes great enough, the two charges (positive and negative) discharge across the gap between them, and the result is a bolt of lightning.

Another example of electrostatics is the xerographic copier. In this case a special type of material is used, which is non-conducting in darkness but conductive when exposed to light. While in the dark, the material is charged with static electricity. When it is exposed to light, the areas exposed lose the charge, while those not exposed retain the charge. After exposure to light the plate is sprayed with a fine powder of oppositely charged dry ink (toner), which adheres to the areas of the plate, which retained a charge by electrostatic attraction. Finally, a sheet of paper, which is also charged, is placed on the plate and the toner is transferred to the paper. The paper is then heated briefly to make the toner adhere permanently. The excess toner is scraped off the plate, and the entire plate is exposed to light to remove any remaining charge.

Static Electricity

The word "static" as in "Static Electricity" means at rest. This is a misleading name because static electricity does indeed move. The name static electricity differentiates between current electricity, which is produced by using a magnetic field to force the electrons over a conductor. In static electricity, the electrons are physically pushed from one place to another. This causes a temporary uneven distribution of electrons over an object. Because the natural tendency of objects is to remain in a neutral state, the electrons strive to regain that neutral balance by slowly leaking off or quickly jumping to another object with fewer electrons which causes a small spark.

Useful Tools not Provided

- Friction Rod
- Friction Pad
- Electroscope
- Neon Light Bulb-90-120 volt

The term conductor is used to refer to materials that will allow electrons to travel over it easily. Some materials act as better conductors than others, providing an easier path for the electrons to travel. The term insulator refers to material that opposes the travel of electrons. A good insulator prevents almost all passage of electrons. The air, however, which is usually considered an insulator, can conduct electricity, depending on the moisture in the air. This accounts for the fact that electrons can escape from even the best insulators by discharging through the air. The word electron comes from the Greek word, which means amber. At the time, the Greeks discovered the effects of static electricity by rubbing amber with a cloth. They thought that amber was the only material that exhibited this phenomenon. When other materials were discovered that shows similar properties, they were referred to as having the amber effect or electrica.

It is important to remember when experimenting with static electricity that like charges repel one another and unlike charges attracts one another. The electrons can transfer from one highly charged object to one that is less charged because the higher concentration of negative electrons is attracted to the object that is more positive in state.

Current electricity is generated by pushing electrons along a conducting media with a magnetic field. Static electricity is a non-moving electric charge. It is created by mechanically moving electrons from one place to another. If some material has free electrons (as most do) they will in general be evenly distributed on the surface along with positive charges in such a way the overall charge of the object is neutral. By rubbing two such materials together, however, it is possible to mechanically redistribute the electrons so they are, temporarily, unevenly distributed. When this happens the object has a slight negative charge where the electrons are concentrated. As separated, one will now have more electrons than it started out with, and the other will have less. This will result in a negative charge on the one with, and the other will have less. This will result in a negative charge on the one with more electrons and a positive charge on the one with less. This is what happens when you walk across a floor (especially during winter when there is not enough water in the air to conduct charges). As you walk, you slowly transfer electrons from the carpet to your shoes and the electrons move as far away from the carpet as possible to your fingers. When you then touch a grounded object (such as a light switch) the electrons move to the switch, so that your body is once again neutral. You get a shock as the electrons jump the gap from your finger to the switch!

How to Use

Leyden jars were created during the early phases of the discovery of static electricity as a means for storing a static charge. They work almost the same way as a capacitor. The biggest difference being that Leyden jars are designed to hold a static charge while capacitors are used more in modern current electricity. Both consist of two or more conducting plates separated by a dielectric. As one plate is charged it forces an opposite charge in the other plate. The greater the potential difference the higher the voltage stored. This potential is determined by the surface area of the plates and the insulator between them. In an effort to regain a neutral state of charge, both plates will try to restore themselves by either jumping across the dielectric or taking an easier path back through a conductor.

Rub a friction rod with a friction pad, such as fur or silk. The rod rubbed with a piece of fur takes on an abundance of electrons from the fur. The rod is then touched to the Leyden jar which takes away some of these electrons. The inside plate has more electrons than it did previously and so the protons are pushed toward the inside of the cup while the excess electrons are drawn toward the outside cup in an effort to regain a natural state. Repeated rubbing of the rod with the fur and touching the Leyden jar with the rod causes a highly disproportional distribution of positive and negative charged atoms. If left alone, the plates will eventually regain neutrality by either leaking through the insulator or by leaking through the air. However, if a path is created, a spark will occur as the plates find the easiest and quickest route to even out their unequal distribution of protons and electrons.

- Inner and outer conductors are separated by a plastic insulator cup
- Inner conductor is removable to measure the charge

Experiments

In order to become familiar with and to better understand the principles of a Leyden jar, you will need a few other items. First, you will need something to create a static charge with. There are many different materials that will work. Acrylic rods or sheets, vinyl strips, different plastics and even glass can be rubbed with material such as silk, wool, acetate, or fur to create static charges. For this experiment, we will be using animal fur and a PVC rod.

You will also need some type of electroscope, as well as a small neon lamp.

Place the Leyden jar on a non-metallic table. If you are using an electroscope, have it sitting a few feet away. Rub the friction rod with the friction pad and after a few strokes, touch the rod to the ball of the Leyden jar. Repeat this procedure several times. Now pick up the Leyden jar by holding onto the outside metal surface only. Bring the ball close to your electroscope and notice that the electroscope indicates that a strong charge is present. As you pull the Leyden jar away, note that the electroscope also indicates this.

Now, grasp the insulator cup, being careful not to touch the rod or inside the metal container, and lift it up out of the outside of the metal cup. Bring the outside cup close to the electroscope and notice what happens. Move this cup away and bring the ball of the inside cup close to the electroscope. Is there a difference? You should have noted that the ball still elicits a charge on the electroscope even though the outside can is removed. If you will replace the outside can, however, and bring the ball close to the electroscope, you should notice that the charge is greatly increased.

Next, repeat the above procedure only this time you will use a small neon lamp to indicate the charge. After initially charging the jar, hold the lamp and touch the wires to the outside can and bring it close to the ball. You should not have to actually touch the ball as a spark should jump from the ball to the electrode and light the lamp briefly.

