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## LEYDEN JAR

CAT NO. PH0906



Instruction Manual



### **LIST OF WHAT COMES WITH THE APPARATUS:**

- \* Metal Cup (outer plate)
- \* Insulating Plastic Cup (dielectric)
- \* Smaller Metal Cup with Hook and Metal Ball (inner plate)



*Figure 1: picture of the apparatus with all pieces shown*

### **ADDITIONAL MATERIALS USEFUL FOR DEMONSTRATIONS:**

- \* Van de Graaff generator or plastic comb or plastic golf tube
- \* Wool or felt fabric
- \* Water
- \* Aluminum foil
- \* Salt
- \* Pith balls

## **INSTRUCTIONS FOR SET UP:**

To charge the Leyden jar you must have some source of electric charge such as a plastic golf tube and a wool sock.

1. Stack the small metal cup with the hook inside the plastic cup and place that inside the larger metal cup as shown in the diagram below.



*Figure 2: picture of the apparatus with the cups stacked as listed above.*

2. Rub the wool sock several times on the golf tube until a static charge builds on the golf tube.
3. Hold the outside metal cup(outer plate) in your hand and be careful to touch no part of the inner metal cup (inner plate) .
4. While holding the outer plate, brush the charged golf tube against the metal ball attached to the inner plate.
5. Have a student touch the metal knob on the inner plate. He will receive a shock.
6. Ask another student to touch the top of the Leyden jar, and they too will receive a shock.
7. Repeat process until the Leyden jar has been discharged.

8. Discuss with the students that objects like a charge Van de Graaff generator or other metal charged objects lose their charge after being grounded once. What makes the Leyden jar different?

### **BACKGROUND INFORMATION:**

The Leyden Jar was a widely used tool for the early study of static electricity. Up until the use of the Leyden Jar there was no way to store electrical energy. The person credited with inventing the Leyden jar was a physicist from the Netherlands named Pieter van Musschenbroek's. Musschenbroek's bottle, also referred to as the "phial" Benjamin Franklin was used in many electricity experiments. Many of these experiments are easy to duplicate in the classroom and can be found online.

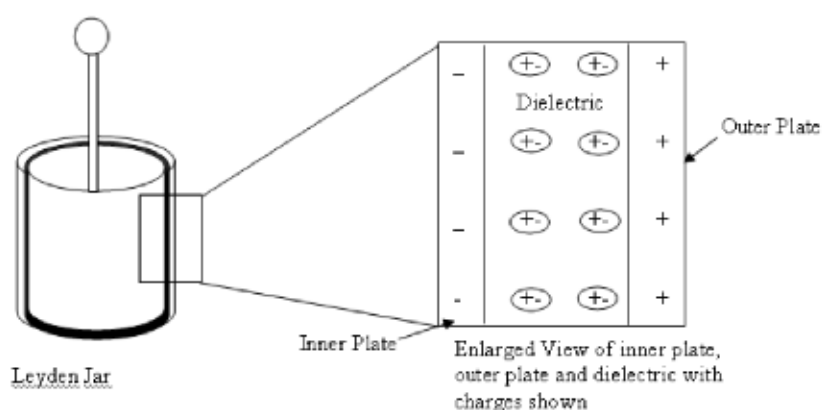
A Leyden Jar is a large cylindrical capacitor. The outside metal cup and inside metal cup make up the two plates of the capacitor. The plastic cup in between the plates is called a dielectric. A dielectric is an insulating material between two plates of the capacitor.

Capacitors are used to store electrical potential energy. Capacitors can be found in old radio tuners and television transmitters and are used in ventricular fibrillation.

### **THE PHYSICS BEHIND THE LEYDEN JAR:**

Rubbing the golf tube with the wool sock will cause the golf tube to pull electrons off the sock making the golf tube negatively charged and the sock positively charged. The negatively charged golf tube then transfers its negative charge to the Leyden jar by conduction. The inside smaller metal cup (plate) is now negatively charged. The plastic cup then is a dielectric.

Since the plastic is a non-polar dielectric, the electrons shift slightly away from the negative inner plate making a net positive charge on the inside of the dielectric and therefore a net negative charge on the outside of the dielectric. The outside of the dielectric repels the electrons in the outer plate. The outer plate is grounded by the teacher's hand and therefore electrons leave the outer plate giving the outer plate a positive charge. The charge will continue to flow until the net charge on the Leyden jar is neutral.



When a neutrally charged student touches the metal ball on the inner plate, she will cause electrons to flow from the inner plate to her finger and receive a shock. The Leyden jar will remain neutral, so as electrons are removed from the inner plate, the same amount of electrons will be transferred to the outer plate through the ground. This way the Leyden Jar can shock the student several times.

If the student touches both the outer and inner plates at the same time he provides a path for the electrons to flow directly from one plate to another and both plates are then neutral.

### **ACTIVITIES TO GO WITH EISCO LEYDEN JAR:**

- \* Try to charge the Leyden jar without grounding the outer plate.
- \* Try different materials as a dielectric such as water, salt water or aluminum foil.
- \* Duplicate some of Benjamin Franklin's Leyden Jar experiments.
- \* Use pith balls to investigate charge on the inner and outer plates.
- \* Place objects inside the charged Leyden Jar to see that there is no net charge inside the conducting plate.

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U.S. Distributor :

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