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# Wimshurst Machine Economy
# #4-509

**Warning:**

- **Not a toy; use only in a laboratory or educational setting.**
- **California Proposition 65 Warning: This product may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.**
- **High voltage. Can cause electrical shock.**

## Introduction

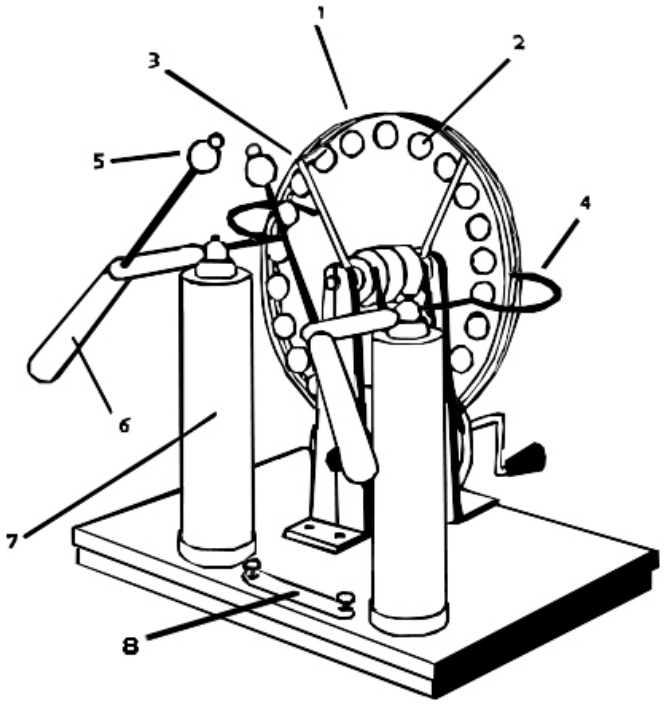
The first form of electricity that humans discovered and began experimenting with is static electricity. Electricity refers to the physical processes associated with the movement of free electrons to produce electrical charges and their relationship to magnetism.

Unlike current electricity, which flows through a conducting material via magnetic fields, static electricity is instead the physical transfer of free electrons from one object to another. With electricity, like charges repel each other and opposite charges attract, meaning that matter tries to maintain a neutral charge. Static electricity forms when friction between two (or more) objects causes the free electrons on one object to be transferred to another, giving it a negative charge until it discharges those electrons and returns to a neutral state.

We've known about static electricity for a long time. In fact, "electron" and "electricity" both come from the Greek word for amber, "elektron." The ancient Greeks noticed that, when rubbed with fur, amber would attract small objects. Though static electricity eventually fell out of mainstream interest in favor of studying current electricity, understanding static electricity is still essential in understanding phenomena such as lightning, as well as technologies like xerographic copying, X-ray imaging, pollution control, and more.

The Wimshurst Machine was developed between 1880 and 1883 by James Wimshurst as an electrostatic generator for producing high voltage static charges. While an important part of physics research around the time of its creation, today the Wimshurst Machine serves as a fantastic demonstrator of electrostatic principles.

The Wimshurst Machine's ability to generate electricity can be very dependent on the weather and cleanliness of the machine itself. For care and maintenance instructions, go to page 4.




## Components

1. **Two Insulating Plates** – These two plates are spun in opposite directions via a hand crank and a couple of pulleys.

2. **Conducting Sections** – A conducting material (often aluminum) is placed around the rim of each plate in evenly spaced intervals. Electrons from this material are physically transferred by the machine to be stored in its two Leyden jars.

3. **Two Metal Rods with Brushes** – These metal rods, which are positioned at a 90° angle to each other, have fine wire brushes on their ends. These brushes induce charges on the conducting sections of the opposite plate.

4. **Electricity Conducting Arms** – These curved arms point small needles towards the spinning plates (though the needles do not come into contact with them). They serve as the point where the induced charges jump from the plates to be stored in the Leyden jars.

5. **Metal Discharge Balls** – Discharge wands are attached to each Leyden jar. The metal balls at the end of each rod act as discharge points to form the spark gap.

6. **Insulating Handles** – Insulating handles are important so that you can manipulate the size of the spark gap without getting shocked yourself or accidentally discharging the charge in an unintended way.

7. **Leyden Jars** – Leyden jars are used to store electrical charges. They are covered in a conductive coating and are attached via a connector switch.

8. **Connector** – This switch allows the user to connect the conductive surfaces of the Leyden jars to each other. When the jars are connected, the outer layer of the jar becomes charged allowing the inside of jar to have a larger capacity for charge. This, in turn, creates larger, brighter, and less-frequent sparks.

## Experiments

The Wimshurst Machine is a very versatile machine for teaching electrostatics. Experiments are limited only by your imagination. Below are a few suggestions:

**Basic Sparks Demonstration**

1. Turn the handle to begin to observe sparks between the metal discharge balls on the electrodes.
2. Slowly increase the distance in the spark gap and observe as the sparks become longer and less-frequent.
3. Cut off the capacitors of the Leyden jars by opening the connector switch. As you spin the handle, you will realize that the sparks appear more frequently, but with less brightness.
4. Reconnect the Leyden jars. While spinning the handle, insert a piece of paper inside the spark gap. You will be able to see small holes in the paper when held up to the light. These holes can be difficult to observe. Look under a microscope and you will see the burnt edges around the tiny micro-holes.

**Flame Ionization Action**

1. Turn the handle and adjust the spark gap until sparks are no longer able to pass between the discharge balls.
2. Insert a flame from a candle into the spark gap. You should see the sparks flow through the flame and complete the discharge to the opposite ball.

**Physiological Action of Gap (WARNING:** This experiment involves subjecting yourself to electric shocks.)

1. Form a chain of people by holding hands.
2. With the Leyden jars connected, have the person at the end of the chain touch the charged spark gap. Each person along the chain should feel a spark pass through them.
3. Now disconnect the Leyden jars and touch the spark gap once more. Notice that the shock is hardly perceptible without the Leyden jars being connected.

**Visible Light Effects in a Dark Room**

1. Shut the lights off in the room that you are experimenting in. Disconnect the Leyden jars and separate the discharge electrodes to prevent sparks between them. This will allow you the best set up to see the light coming from the metal rods with brushes.
2. Crank the handle and observe the metal rods with brushes. You should see light on both sides of each brush. The sides with the negative charges should have brighter points of light, while the sides with positive charges will be comparatively dimmer.

**Lighting a Gas Filled Tube**

1. To prepare for this experiment, make sure the Leyden jars are connected, switch off the lights in the room, and set up the discharge rods so that sparks pass between them.
2. Locate a gas filled tube. These tubes are not included with the machine, but our Neon Wand #1401 works great for this experiment.
3. Place the exposed electrode of the tube into the spark gap. As the machine sparks and discharges through the tube, the gas within the tube will light up, much like a neon sign.

## Care and Maintenance

The Wimshurst Machine is a great machine to experiment with, though humidity, radiation, lint, and general wear can cause it to function poorly or not at all. Use the tips below to keep your Wimshurst Machine working its best:

- Humidity and moisture can hinder the collection and discharge of charges with the machine. Lint and dust can also cause unwanted discharge points. Clean the machine with distilled water and allow it to dry all the way in the sun or with a dry dishcloth.

- The **two metal rods with brushes** can be knocked out of alignment or worn down. To realign the brushes, set them to 45° angle to the vertical and make sure that they are perpendicular (90°) to each other. Make sure the wires on the brushes are making full, sufficient contact with the spinning plates.

- Using near flames and other radiating or ionizing sources can interfere with the use of this machine.