

ACTIVITIES

Student Activities *continued*

- 12** Each group must compose a paper detailing their findings, with explanations for each result. These groups will share in front of class, peer-critique findings. Teacher should facilitate them finding the correct answers.
- 13** Advanced students may be asked to find how to calculate amount of current or voltage created.

The equivalent circuit of a generator and load can be determined the generator's V_G and R_G parameters, follow this procedure:

- Before starting the generator, measure the resistance across its terminals using an **ohmmeter**. This is its DC internal resistance R_{GDC} .
- Start the generator. Before connecting the load R_L , measure the voltage across the generator's terminals. This is the open-circuit voltage V_G .
- Connect the load as shown in the diagram, and measure the voltage across it with the generator running. This is the on-load voltage V_L .
- Measure the load resistance R_L , if you don't already know it.
- Calculate the generator's AC internal resistance R_{GAC} from the following formula:

$$R_{GAC} = R_L \left(\frac{V_G}{V_L} - 1 \right)$$

- The AC internal resistance of the generator when running is generally slightly higher than its DC resistance when idle. The above procedure allows you to measure both values. For rough calculations, you can omit the measurement of R_{GAC} and assume that R_{GAC} and R_{GDC} are equal. If the generator is an AC type (distinctly not a dynamo), use an AC voltmeter for the voltage measurements.

The maximum power theorem applies to generators as it does to any source of electrical energy. This theorem states that the maximum power can be obtained from the generator by making the resistance of the load equal to that of the generator. However, under this condition the power transfer efficiency is only 50%, which means that half the power generated is wasted as heat inside the generator. For this reason, practical generators are not usually designed to operate at maximum power output, but at a lower power output where efficiency is greater (peswiki.com 1/13/10).

Assessment: Participation, paragraph of research on relationship between weather and electrostatic charge, completed and working machine, group presentation (each student has contributed, logical scientific thought is demonstrated, findings are on the right track, accountability should be adjusted according to level of students.)



TEACHERS

GUIDE



WIMHURST MACHINE
ITEM # 3131-01

ENERGY - ELECTRICITY

For generating static electric charges and causing electric discharges. Relative to Van de Graaf it produces higher current with lower voltage which is much safer. Use the hand crank to rotate the two high resistance plastic disks in opposite directions. Disk diameter about 10" (250mm) with equally spaced metal sectors. A rapid sequence of sparks can be generated by lowering the system's capacitance. Mounted on insulated wooden base

Materials

- Wimshurst Machine
- vocabulary sheet(s)
- playing card
- items to make a home-made Wimshurst Machine (info available on many sites online)

Goals & Objectives

Students will:

- ID electrostatic charge
- explain how it can be created and harnessed
- demo the operation of a Wimshurst Machine
- discover variables that effect the charge
- use given vocabulary to discuss what they observe
- discuss the source of the smell - ions

PREPARATION

Caution: Adult Supervision!

- Never touch any metal parts on this machine without discharging! Do not place any body parts between the electrodes.
- Screw on the crank handle.
 - Check that the four brushes continuously touch the metal strips as disks spin. Adjust if necessary.
 - Adjust the Lynden Jars so when the apparatus is cranked, the metal points do not rub against the two disks or the metal strips.
- Separate the electrodes by 1½ - 2 inches.
- Make sure the safety handles are down.
- Begin turning the crank clockwise. (Sparks should be visible between the balls of the electrodes. Electrodes can be moved apart by touching the plastic handles. **When finished, touch the 2 electrodes together to discharge.**)

ACTIVITIES

- Teacher should pass out the vocabulary sheet, then demo the apparatus.
- Ask students how they think it works, what words on their sheet apply.
- Draw students to the term electrostatic charge. Ask them to offer suggestions as to where that might be found during the operation of this apparatus. (Brushes, Electrodes, Leyden Jars.)
- As a class use the vocabulary sheet to ID parts of the machine.
- Allow students to take turns operating the machine while another student places a playing card between the electrodes. **(NEVER SHOULD THEY PLACE A BODY PART BETWEEN THE ELECTRODES.)** The card should dimple.
- Discuss what causes the change in the card. (Charge)
- Students must touch the electrodes together to discharge after each operation.
- Teacher could remind that the smell resembles what the outdoors smells like before a storm. Have students discuss why until they conclude that there must be a similar electrical charge somehow.
- Assign research online, due the following day or by the end of the unit that explains how storms and electricity relate.
- Assign students to small groups of 3 or 4. (You may want to ask them to collect objects that could work as parts of a homemade Wimshurst Machine prior to starting this unit.) Ask each group to scavenge for items that they could use for discs, metal strips, electrodes, brushes, a crank, 2 Leyden Jars each.

Note

It is always best to DO an experiment ahead of time to be able to best present it to the class.



- Allow each group to build their machine, playing with variables to see what affects the amount of current collected or the size of the spark created between the electrodes. They might test the following: foil and placement, space between electrodes, size of rods, size of crank, size of discs, size of Leyden Jar.

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STUDENT HANDBOUT

Student Name: _____

- Is the smell of an incoming storm related to electricity?
- Has anyone ever harnessed the energy that causes you to shock someone when you touch him after walking across the carpet?
- What kind(s) of energy is that?

This electrical spark can reach 2 inches long or more. The Wimshurst Machine is a generator belonging to the influence machine category. That means it separates electronic charges through electrostatic induction, generating high voltage. Premium Wimshurst Machine comes with safety handles to help avoid shock, and a stabilizing bar

Two large discs rotating opposite of each other have a number of foil strips on them. If one strip is positively charged, and it passes another strip on the other plate, the positively charged one attracts the electrons in the neighbouring strip to the surface next to the positive one. This process repeats as the discs revolve until one of the strips on the other disc passes one of the brushes positioned on either side of the discs. This brush discharges the positive charge on the opposite side of the strip to where the electrons have migrated. As the strips part, this second strip is now charged negatively. This negative charge will now repel electrons on strips on the other disc as they pass. Once again, brushes dissipate the negative charge on the outside of those strips, leaving a net positive charge. The continuous sequence of induced charges accumulates and if it were not for the current drawn would continue until the insulation broke down. The positive and negative charges are collected by metal combs to charge the Leyden jars, attached by electrodes (metal bars) to the apparatus. The mechanical energy used to separate the opposing charges on the neighboring strips that develops the energy source for electrical output. (<http://en.wikipedia.org> 1/23/10)

Vocabulary

- 1 Capacitor:** a device for accumulating and holding a charge of electricity
- 2 Current:** a flow of something, like a river, or electricity
- 3 Electrodes:** a conductor, not necessarily metallic, through which a current flows
Electrostatic charge: 4. inactive electrical amount
- 4 Induction:** the process causing a body with electric or magnetic properties produces magnetism, an electric charge, or an electromotive force in a neighboring body from a distance.

5 Ions: an electrically charged atom, or group of atoms, formed by the loss or gain of one or more electrons

6 Leyden Jar: a device for storing electric charge, consisting essentially of a glass jar lined inside and outside, for about two-thirds of its height, with tinfoil. A type of capacitor.

7 Voltage: the difference between electric potential of two points in space, or of an electrical circuit, expressed in volts.

