ACTIVITY RE5

RENEWABLE ENERGY

Generators

SECTION A

Where does electricity come from? Electricity on a large scale is seen in nature as lightning, but lightning is not "harvested" to light buildings, run air conditioning or heaters, or power computers and mobile devices. Instead, electricity has to be generated by converting it from another form of energy.

Converting fuels to electricity involves several steps. For example, to get electricity from nuclear fuel (the energy released when atoms split), the energy is converted to thermal energy, and it is used to boil water. The steam produced by the boiling water creates high pressure, which is used to move the blades of a turbine connected to a generator. The kinetic energy of the moving turbine blades is converted to electrical energy as the driveshaft moves a coil of wire in a magnetic field or spins one or more magnets past one or more coils of wire. Spinning a generator with steam is just one method used. Can you think of others?

Generators have three main components–coils of wire, magnetic fields, and motion. The wire or the magnets have to move relative to one another in order to induce electrons in the wires to move. In this activity, you will build a simple generator and explore how different variables affect generator performance. It is easy to generate small amounts of electricity, but it can be challenging to generate enough power to light a bulb, turn a motor, or power a house.

SECTION B

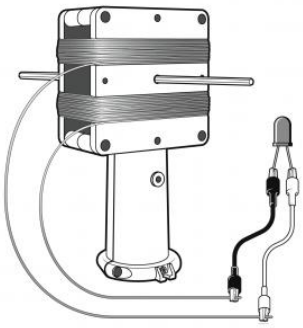
Experiment

Aim

Generate electricity using magnets and coils of wire

Materials

- Computer with Logger Pro
- Vernier data collection interface
- Vernier Energy Sensor
- Small incandescent light bulb
- Red LED
- Tape
- 100 Ω Resistor
- 2 wire leads with clips
- Drill
- SimpleGen Kit or strong magnets
- Magnet wire/enameled copper wire
- Axle rod
- Open box (cardboard or PVC) with tape
- Center holes for axle



Preliminary Questions

1. What are the primary sources of energy that are converted to electricity in South Africa? Can you think of some sources that are not thermally driven and do not require the burning of fuels?

2. What components make up a typical electrical generator? What are some variables that affect generator performance?

3. What are some of the ways we can move magnets and coils relative to one another?

Procedure

Part I Preliminary activity

1. Set up the equipment.
   a. Tape one end of the wire to the housing.
   b. Wrap the wire so it creates a clean coil, winding the wire in the same direction each time (see the diagram).
      Note: Your instructor will tell your group how many "wraps" or "windings" of wire to use on your generator. Different groups will use a different number of windings.
   c. Sand the ends of the wire until they are a bright copper colour.
   d. Insert the magnets into the magnet holder.
   e. Position the magnet holder inside the housing and slide the rod through the housing and magnet holder so the magnet holder can spin freely.
   f. Connect the red LED to the free ends of the coil.
2. Spin the axle by hand so that the magnet assembly turns inside the coils of wire. Does the LED bulb light when you spin the magnet? Replace the LED bulb with the small incandescent holiday-light style bulb. Can you light the incandescent bulb? Record your answer in the data table.
3 If you have access to a drill, connect the drill chuck to the axel rod. Spin the drill, starting slowly. Can you light either bulb using the drill? Record your answer in the data table.

Part II Quantitative analysis

4. Connect the Vernier Energy Sensor Voltage connector to the data-collection interface.
   Note: You are going to use only the Voltage Probe within the Energy Sensor for this experiment. You do not have to connect the Current connector.
5. Set up data collection.
   a. Choose Data Collection from the Experiment menu.
   b. Change the Rate to 60 samples/second. Click Done.
6. Zero the Energy Sensor.
   a. Connect the Energy Sensor Source terminals to each other with a wire lead in order to create a short circuit in preparation for zeroing.
   b. Choose Zero from the Experiment menu. Select OK. The readings for potential (voltage) should be close to zero.

7. Use two wire leads to connect your copper coil to the Energy Sensor Source terminals. Make sure the metal clips are attached to the area of the copper wire that you sanded in Step 1c.
8 Connect the Energy Sensor Load terminals to a 100Ω resistor.
9. Click ▶ Collect to start data collection. Data will be collected for 30 seconds. Spin your generator by hand several times over the course of data collection
10. When data collection is complete, click the voltage vs. time graph to select it. Choose Statistics from the Analyse menu. Record the maximum and minimum voltage in the data table.
11. If you have access to a drill, repeat Steps 9–10, spinning the generator with the drill instead of by hand.

Results table

Number of coil windings _____

	Hand-spin	Drill-spin
Light LED bulb?		
Light incandescent bulb?		
Minimum voltage recorded	V	V
Maximum voltage recorded	V	V

Processing the data

Share your results with the class to compare the generators used by each group.

Questions

1. Does the number of coil windings affect the voltage output of the generator? Support your answer with your data.

2. Does the speed at which the magnets rotate affect the voltage output of the generator? Support your answer with your data.

3. What other factors may affect the power output of an electric generator?

4. If you were able to light the LED bulb, why did it flicker on and off?

SECTION C

Further Questions:

1. Using your own materials, make a homemade generator that will light more than one bulb wired in series. Document your project and compare it to the generators made in this exploration.
2. Turn your generator into a motor.
3. Turn your generator into a wind turbine. Create a hub that attaches to the axel rod, and some blades that attach to the hub. Can you get your device to spin and generate electricity when the wind blows on it?
4. Test generators with smaller or larger gauge wire. Does it affect voltage output of the generator?
5. Test different magnets in the generator. How does that affect voltage output?