# GO WITH THE FLOW

GRADES 4–8

SUSIE HUSTON

## OVERVIEW:

This lesson focuses on the relationship between magnetism and electricity. Students will make their own electric current detectors using easily obtainable materials. Additionally, they will produce electricity with a magnet and a coil of wire. Then, electricity will be converted into magnetism by making an electromagnet. This lesson is a continuation of the study of electricity/magnetism.

**Note:** The pre-viewing and viewing activities may be done as a demonstration.

## ITV SERIES:

Dr. Dad's $Ph^3$: Electromagnetism

## LEARNING OBJECTIVES:

The students will be able to
- describe the principle of the generator
- explain the principle of the electromagnet

## VOCABULARY

electromagnetic induction
generator
electromagnet
turbine

## MATERIALS:

dry cell
a roll of insulated wire (3' per group)
masking tape
4" square of heavy cardboard or lightweight wood
small compass
thumbtacks
magnets
2 different size large nails
paper clips or small nails

## BACKGROUND:

Historically, our knowledge of magnetism and our knowledge of electricity were two separate entities which only began merging in the 1800's. In nature magnetism and electricity are, however, closely related forms of energy, each one capable of producing the other.

The phenomenon of magnetism has been known for centuries. The fact that certain kinds of iron or iron ore had the power to attract other bits of material containing iron was known in ancient Greece. It is said the ancient Chinese found that if a magnet was suspended so that it could turn freely, it would swing into a north-south position. Further, it was known that when pieces of steel were rubbed against a magnet, the steel became magnetized for a time.

The history of the study of electricity dates back to about 600 BC when Thales, a Greek philosopher, experimented with static electricity. Experiments with electric charges and currents began in earnest in the 1700's. During that century such notables as Ben Franklin, Charles de Coulomb, Luigi Galvani, and Alessandro Volta made great discoveries in that field.



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But it wasn't until 1820 that Hans Christian Oersted, a Danish professor of physics, found (quite accidentally) that electricity had a magnetic influence; that a wire carrying electricity had a magnetic field around it. Influenced by Oersted's discovery, English physicist Michael Faraday found in 1831 that under certain conditions magnetism could produce electricity. Moving a magnet near a coil of wire or a coil near a magnet caused a movement of electrons in the coil. Only three things were needed: a magnet, a coil of wire, and motion.

In the years following Faraday's discovery, scientists found how to use the rush of falling water and the pressure of steam to provide the motion needed to turn huge coils of wire near huge magnets. Today, from hundreds of stations all over the country, power from water or steam turbines is converted into electricity which, a split second later, is cooking our dinner or powering our lights.

## PRE-VIEWING ACTIVITIES:

Ask the students what they think life would be like without electricity. On a chart list all of the uses of electricity on which we rely daily. Discuss how pioneers would have managed cooking, washing clothes, entertaining themselves in the olden days.

Tell the students that today we are going to produce some electricity from magnetism and magnetism from electricity. But, first we will need an electric current detector. This is a device that can find, or detect, even small amounts of electric current.

Divide the class into groups with two people in each group. Give each group a roll of about 3 feet of insulated bell wire, several inches of masking tape, a 4 inch square of heavy cardboard or wood, a small compass, two thumbtacks and a battery.

Coil the wire six or seven times around so that the diameter of the coil is 2 $^1/_2$– 3". Unwind abut 12" of wire from each end of the coil. Wrap masking tape around the coil at three different places to keep the coil from unwinding. Strip the insulation from each end of wire so that one inch of copper is exposed.

Set the coil upright on the cardboard near one edge and tape it to the cardboard so it will remain upright. Push 2 thumbtacks into the cardboard near the opposite edge and about 2" apart. Do not push them all the way in.

Wrap one end of wire once around one tack, leaving about 10" of wire sticking out past the tack. Push the tack the remainder of the way in, so that the wire is securely in place. Do the same with the other end of wire using the other tack.

Set the compass inside the coil so that it is level. To test the current detector connect the two wires to the poles of the battery. Observe what happens to the compass needle. (It will swing suddenly, as electricity passes through the coil).

The detector has detected the presence of electric current flowing from the battery. The swinging of the compass needle indicates electrical current.

## FOCUS FOR VIEWING:

**Begin** tape at "In the early days..." **Stop** when Dr. Dad says, "and it sparked him to build the first electric generator." Discuss and record the term "electromagnet induction."

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## VIEWING ACTIVITIES:

Tell students that like Michael Faraday they will produce electricity using their electric current detector, another coil of wire and a magnet. Make another coil of wire similar to the one made for the current detector. Unwind about 1' of wire from each end of the wire coil. Scrape the insulation from the ends and connect them to the wires from the current detector by twisting the bare copper wires from each end together. Hold the coil in one hand and push a magnet into the center of the coil. As the magnet passes the coil watch the needle of the compass. See how it moves as an electric current is produced by the moving magnet. If possible, try different size magnets. Discuss what has occurred.

**Resume** viewing the video, **pause** when Dr. Dad says, "I have a friend at an electric power plant."

Discuss with class how Dr. Dad's generation was different from theirs (The coil was inside the magnet.)

**Watch** to learn how the electric power plant generates electricity. What is used to cause the motion to generate electricity? What other power sources could be used?

**Resume** viewing until the conclusion of the video.

## POST-VIEWING ACTIVITIES:

Have students review the different components of a generator and its power sources. How could greater amounts of electricity be generated at a time? Point out that different power sources simply provide different ways to turn the turbine.

## ACTION PLAN:

Have students take Olivia's Challenge to build an electromagnet. Give each student group 2 different size large nails, wire, a battery, and several paper clips or small nails. Have them build an electromagnet using the 2 different nails. Wrap the larger nail with more wire. Compare the strength of each electromagnet by comparing the number of paper clips or small nails each is capable of picking up.

Invite an expert from the local utilities company to discuss generators and the power source used to generate electricity in your community.

## EXTENSIONS:

### MATH

Learn how to read an electric meter and an electric bill. Have students bring in electric bills. Work in groups of 4 to compare amount of electricity used in each household, using a bar graph or pictograph. Solve problems involving cost per kilowatt hour and time of use of electricity.

### LANGUAGE ARTS

Write a letter to your local congressional representative stating your views on how electricity in your area is generated and how it can be conserved.

### READING

Provide students with a list of people famous for their contributions to the development of electrical energy production. Read biographies of these people and report to the class on their lives.

### SOCIAL STUDIES:

Create a time-line highlighting important discoveries in electricity in conjunction with major historical events.



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