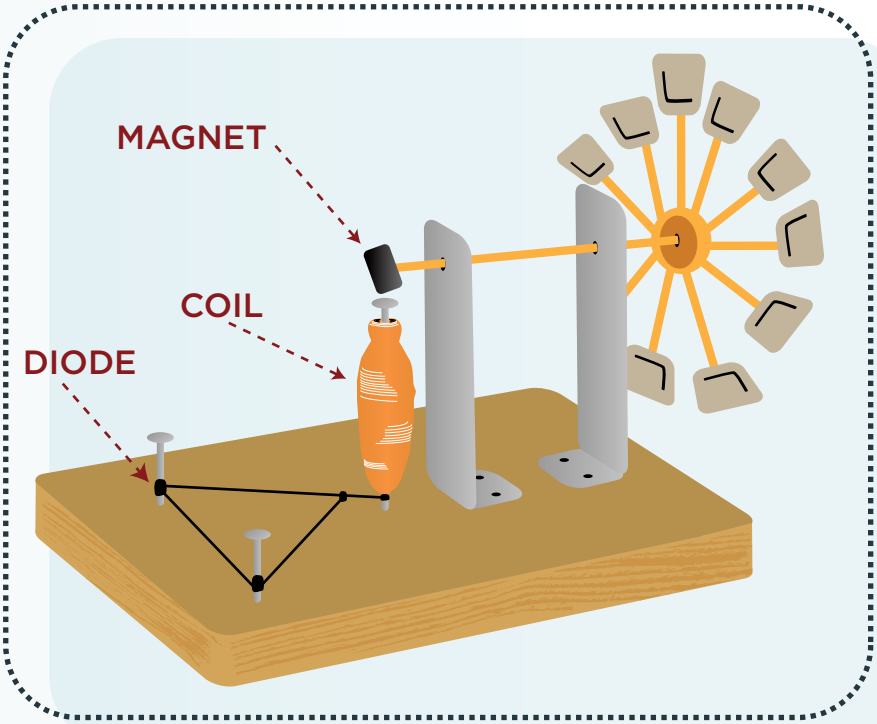
POWER FOR EMBER

Hydroelectric power plants use turbines similar to Ember's to generate electricity we use every day to perform all types of work, including heating, cooling, and refrigeration. Build your own waterwheel like those that generate power for Ember.

A waterwheel is a simple turbine – a device with buckets, paddles, or blades rotated by moving water, converting the water's kinetic energy into mechanical movement. Hydropower is a way to produce electricity using a renewable energy source that does not use fossil fuels, pollute, or produce greenhouse gases.



MATERIALS

- GLUE
- 2 1-INCH NAILS
- 2 3-INCH NAILS
- SMALL SPOOL OF MAGNETIC WIRE (#28 OR FINER, INSULATED)
- 2 CARDBOARD OR MASONITE RECTANGLES (ABOUT 5" X 7")
- 2 1-1/2" X 4" METAL STRIPS CUT FROM AN ALUMINUM CAN
- GERMANIUM DIODE (FOR EXAMPLE, TYPE 1N34A)
- SOLDERING IRON (OPTIONAL), SOLDER (OPTIONAL)
- 1-INCH BAR MAGNET
- HAMMER
- ELECTRICAL TAPE
- 3" X 5" WOOD BLOCK
- ROUND TINKER TOYS (8)
- 3" TINKER TOY SPOKES
- 8 SMALL PAPER CUPS

POWER FOR EMBER

BUILD A HYDROPOWER GENERATOR

A. Wrap 1,000 turns of magnetic wire around one of the 3-inch nails. The coil should be 2 inches long, measured from the head end. Leave a few inches of wire for the connections. Twist them so they will not unwind.

B. Drive this nail into the center of the wooden block.

C. Drive in the 2 smaller nails to make a triangle. (See the diagram to determine their location.)

D. Scrape the enamel insulation off the ends of the coil wires.

E. Wrap the ends around the heads of the 2 nails.

F. Hook the diode across the nails and make all connections secure.

G. Fix the bar magnet on the head of the other large nail. The magnet should be centered on the head of the nail. If you use glue, give it plenty of time to set. This nail will be the water wheel shaft.

H. Support the shaft with the 2 aluminum can strips. Fold them in half lengthwise for added stiffness. Bend out about 3/4 of an inch at the ends for the base. Nail them to the wooden block in line with the large nail.

I. Decide how high the shaft holes should be. Locate the holes so the magnet end of the shaft is close to the upright nail head, but do not prevent the shaft from spinning freely. Make the holes for the shaft.

J. Insert the shaft in the supports until the magnet is directly over the nail head. Two collars of electrical tape (applied to the shaft just inside the supports) will keep the shaft in place.

K. Using the tinker toys and paper cups, construct the water wheel. Cut the cups as shown in the diagram and glue the bottoms to the spokes.

HOW IT WORKS: TURNING THE MOTION OF WATER INTO ELECTRICITY

The model hydropower generator you made in this activity works much like hydropower plants for generating electricity. When the propeller (water wheel or turbine) spins, the magnet whizzing past the nail head generates a tiny amount of alternating current (AC) in the coil wound around the nail. The small germanium diode connected across the two nail terminals converts the AC into DC (direct current).

L. Fit the water wheel onto the shaft, making sure that the wheel fits snugly on the nail.

M. Create a flow of water to turn your waterwheel.

N. Discuss how to measure the rate of rotation of the waterwheel (use the Waterwheel Worksheet). Discuss what it means for the waterwheel to slow down. Does it have to completely stop?

O. Create a procedure to accurately count the turns of the waterwheel during a given period of time. Will you need to mark a paddle? For example, as the waterwheel spins, you could count the number of turns by noting how many times the marked catcher passes the top of the wheel.

P. Have one team member keep track of the elapsed time using the second hand on a clock or watch. As soon as the wheel is spinning, start timing while other team members count the number of turns the waterwheel makes. *Stop counting turns and keeping track of the time when the waterwheel slows down.*

Q. Change roles and repeat until every member has counted or you have a consistent measurement for the rate at which the waterwheel spins. Record your data on the worksheet.

Record your data on the worksheet on the next page. Compare each team's results and discuss these questions:

- What happened to the waterwheel as you poured water on it?
- What patterns do you see in the results?
- Why do teams have different average rates of rotation?
- To improve your waterwheel, how might you re-design your water catchers to work better?
- Compare the results when the water's velocity changes,when you add solids (like silt) to the water, or when the water's temperature is different.

VELOCITY: SPEED; *A HIGH WIND VELOCITY.*

Activity adapted from The Alliance to Save Energy—Promoting Energy Efficiency Worldwide.
For more activities and information about the Green Schools Program, please see: http://www.ase.org/.

POWER FOR EMBER

NAME _____ DATE _____

TEAM MEMBERS _____

1. What happened to the waterwheel as you poured water on it?

_____

_____

_____

_____

2. In the table below, record your waterwheel data.

	Start Time	End Time	Elapsed Time (End Time-Start Time	Number of Turns	Rate of Rotation (Number of turns ÷ elapsed time)
1					
2					
3					
4					
5					

3. What is the average rate of rotation?

(Hint: To find the average rate of rotation, add up the 4 rates of rotation above and divide by 4.)

_____

_____

_____

_____

_____

_____

_____

_____

POWER FOR EMBER

NAME _____ DATE _____

Even though you might not be building your own waterwheel, see how well you understand how it works. Answer these questions, using the POWERING EMBER reference pages if you need them.

1. What is a waterwheel? Explain it in your own words.

2. What is a diode? (You may need to use a dictionary for this one.)

3. In four panels, illustrate how a waterwheel converts the movement of water into electricity.

4. What do you think would happen if the water hitting the waterwheel got colder? Got hotter? Became filled with silt?

5. What is velocity? Why is this an important word when thinking about a waterwheel?

6. What's the most interesting thing you learned about waterwheels and generating electricity?