Generate Your Own Hydropower

Objectives

The student will do the following:
1 Build a water wheel.
2 Build a simple galvanometer.
3. Build a simple hydropower generator
4. Detect the electricity generated
5 Demonstrate how water power is converted to electricity.

Subjects:
Advanced General Science, Physical Science, Physics

Time:
1-2 class periods if working in groups of four; 2-3 class periods if working in groups of two

Materials:
(for each group) compass, 2 alligator clips (optional), small spool magnetic wire (#28 or finer, insulated), 2 cardboard or masonite rectangles (about 5" x7"), glue, (2) 1-inch nails, (2) 3-inch nails, 1-inch bar magnet, (2) 1-1/2"x4" metal strips cut from tin can, electrical tape, germanium diode (for example, type1N34A), soldering iron (optional), solder (optional), 3x5" wood block, round tinker toy. (8) 3" tinker toy spokes, 8 small paper cups, student sheets (included)

Background Information

The model hydropower generator 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). The galvanometer will indicate that a small current has been produced by the generator.

Procedure

I The day before the activity is to be done, introduce it to the class

A Define and describe a turbine A turbine is a device that has a central drive shaft fitted with curved vanes or blades that cause it to whirl when force is exerted upon it by water, steam, or gas. A water wheel is a simpler, less efficient predecessor of a turbine, it can use only water. Modern turbines were developed from early water wheels.

B. Define and describe a galvanometer. A galvanometer is an instrument that measures minute electric currents. It is made of a compass wound with magnetic wire. As current is passed through the wire, the compass needle will be deflected toward the east-west axis.

C. Define generator. A generator is a machine that converts mechanical energy into electrical energy.

D. Define hydrogenerator. A hydrogenerator is a machine that converts the mechanical energy of water power into electrical energy.

II. Give each student a copy of "GENERATE YOUR OWN HYDROPOWER" (included). Assign the building of a water wheel (turbine) as homework. (You may choose to have the students build these in class.)

III. Explain the activity, then carefully supervise the students' work. The directions must be followed closely.

IV Continue with the follow-up below

Follow-Up

I Ask the students these questions

A. Describe how the apparatus used in this activity qualifies as a generator.

B. How do you know electricity is being generated?

C. What type of electricity (AC or DC) does your generator produce? (AC)

D What type of electricity does a galvanometer detect? (DC)

E. What feature of the galvanometer you built allows it to detect the current produced? (the diode)

F If your generator did not produce detectable current, what are some possible explanations? How can you test your hypotheses?

II Extension: The following are suggestions for building upon this activity. Some are especially appropriate as enrichment.

A. Different types of water wheels may be built and their effectiveness tested. Check reference books for other designs.

B Change certain variables and repeat the exercise. Compare the results when the waters velocity is changed, when suspended solids (like silt) are added to the water, or when the waters temperature is changed.

C. Build a model town complete with tiny electric lights. (Perhaps a model train sets town models could be used) Check to see if the hydrogenerator will supply enough electricity for the model town How must the system be modified to make this work?

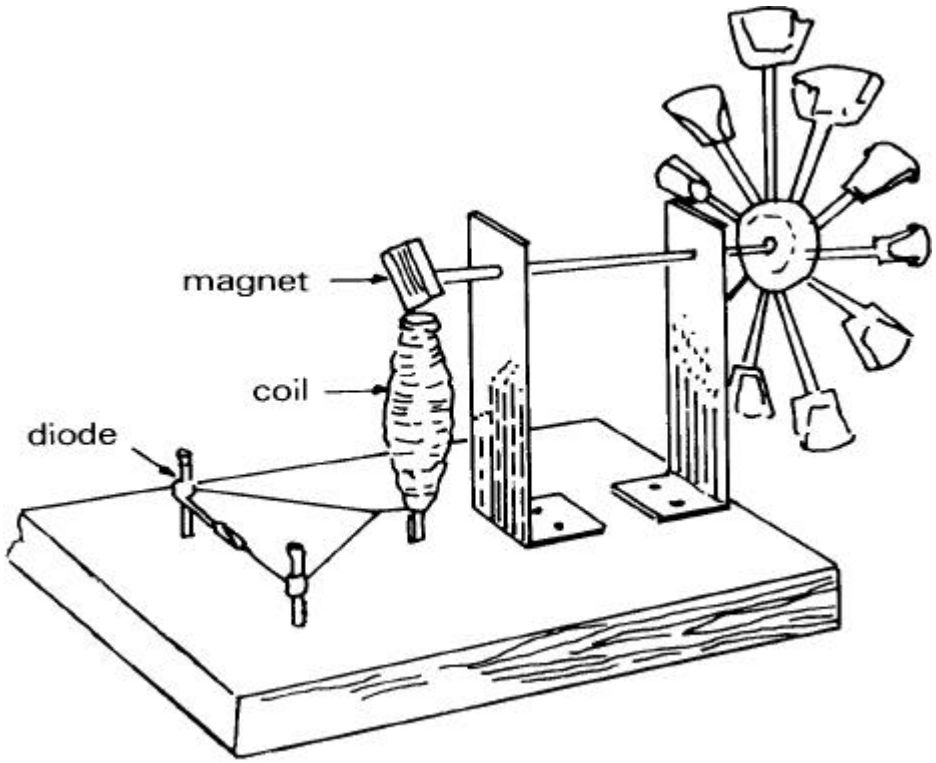

Diagram 1: Hydropower Generator

1. Build a hydropower generator (See Diagram 1).

a. Wrap 1,000 turns of magnetic wire around one of the large 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. (Refer to the diagram for their placement).

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. (Soldering is optional)

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 using glue, give it plenty of time to set This nail will be the water wheel shaft.

h. Support the shaft with the 2 tin 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 so that the shaft is not prevented 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.

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

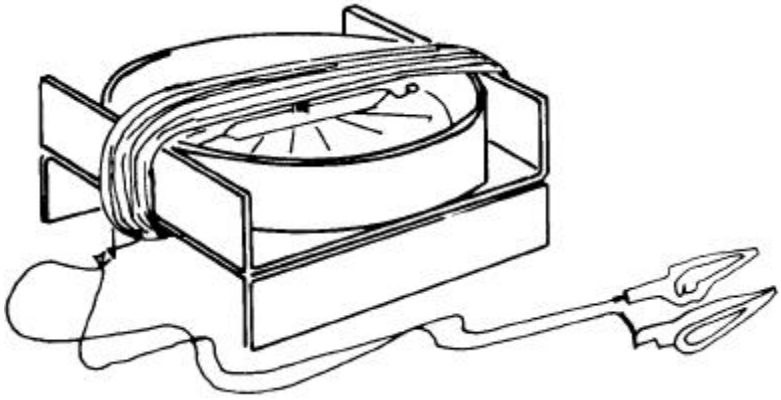

Diagram 2: Galvanometer

2 Build a galvanometer (See Diagram 2)

a Build a base for the compass by folding the ends of each of 2 squares of stiff cardboard and stacking them back-to-back as shown in the diagram.

b Place a compass on the base and wind magnetic wire around the north-south axis, making about 100 turns

c. After winding the coils of wire, twist the free ends a few times to prevent unwinding.

d. Connect the free ends to the two alligator clips. (This step is optional. You may connect the wires directly to the nails where the diode is located on the hydropower generator apparatus.)

e. The galvanometer is now complete. Whenever electricity flows through the coil, the compass needle will be deflected toward the east-west axis.

3 Test the hydrogenerator.

a. Connect the galvanometers alligator clips (Or wire if not using alligator clips) to the 2 nail terminals.

b. Keep the compass about a foot away from the magnet.

c. Line the galvano meter compass needle up with the coil.

d. Hold the water wheel at the edge of the sink and run a stream of water over the wheel. As the wheel turns, it will power the generator. A small current will be detected by the galvanometer When the shaft turns,

the compass needle will be deflected. This demonstrates that electricity is being produced by the hydrogenerator.

Source: Tennessee Valley Authority, Energy Sourcebook: High School Unit