Wave Energy Generator

Summary

Kinetic energy is the type of energy that exists within motion. Waves are in constant motion and therefore possess a consistent form of energy. Wave-energy devices are being developed to harness that energy and convert it to electricity. In this lesson you will do an internet search of wave energy generators and then design your own.

Engineering Connections

Students will make observations and produce data to serve as the basis for evidence which explains a phenomenon or tests a design solution. The scientific ideas will be applied to solve design problems. Students will ask questions that can be investigated within the scope of the classroom, outdoor environment, museums and other public facilities using available resources. When appropriate, students will frame a hypothesis based on observations and scientific principles.

Objectives

Students will be able to describe a variety of wave-energy devices and design their own.

Standards

4.PS3.2
4.PS3.4
4.PS4.1
4.ESS3.1
5.ESS3.1
7.ESS3.3
7.PS3.5
8.PS4.1

Vocabulary

Amplitude
Generator
Kinetic Energy
Magnet
Multimeter
Voltage
Wavelength
Wave Power

Materials List

- Wave Energy Generator Handout
- Materials for drawing and explaining device
- Internet for research

Worksheets and Attachments

- Lesson Document (pdf)
- Vocabulary Sheet
- Student Activity Worksheet (pdf)
- Wave Energy Generator Handout

Teacher Information/Background Information

Kinetic energy is the type of energy that exists within motion. Waves are in constant motion and therefore possess a consistent form of energy. Wave-energy devices are being developed to harness that energy and convert it to electricity. Do a google search and you will find many types being investigated. When developing devices for the ocean, engineers must consider:

- The cost of building and maintaining the device
- Using materials that will withstand the harsh ocean environment
- Effective anchoring and mooring systems
- Devices that will produce electricity efficiently
- Environmental and social impact.

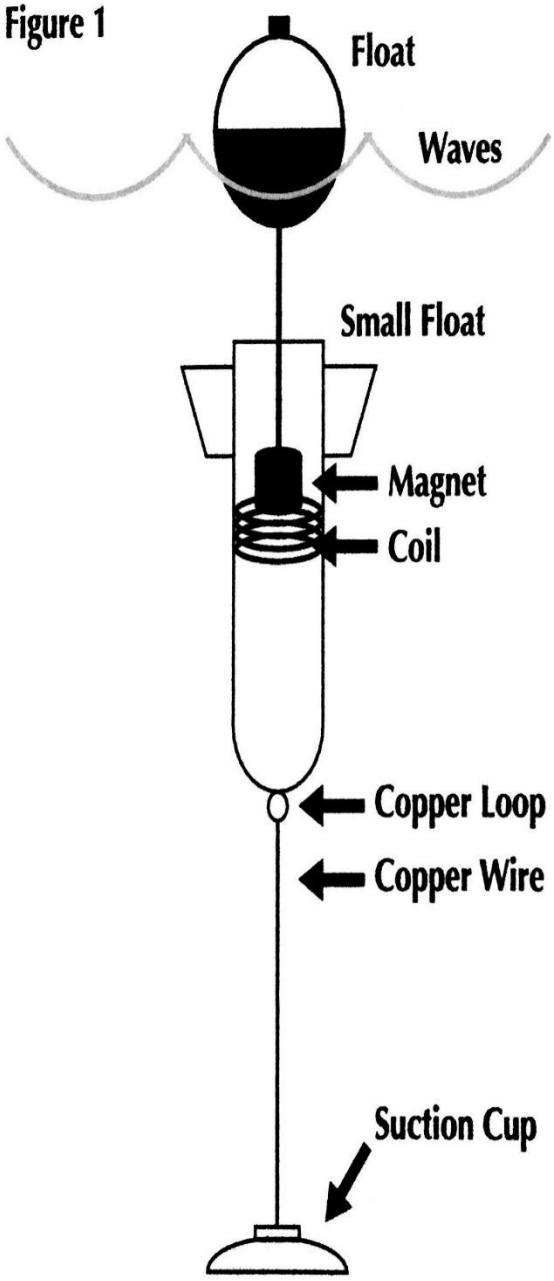
Engagement

1. Look with the students at various wave energy devices.
2. Review with them The Motion of the Ocean Wave
3. Review How a Generator Works

Exploration

1. Have students discuss ways that ocean waves could be used to produce electricity.
2. Have them do an internet search of wave- energy devices.
3. Have the students draw and explain a wave- energy generator.

The following is an example of one way to construct a model device. Part of this activity is about finding innovative approaches, so it's a good idea to allow for as much trial and error as possible throughout the construction process.



Step 1. Create a coil by winding the wire around the test tube. Generally, a minimum of 100 coils is needed to produce a measurable electrical current. Fasten the wire to the tube with transparent adhesive tape, leaving a couple feet of wire free on both ends of the coil to make connections. To ensure effective connections, remove the insulation from the ends of the wire. This can be done by sanding the end of the wire with medium- grit sandpaper. When the wire end becomes a bright copper color, the insulation is removed. This can be tested with the multimeter. If there is zero resistance between the ends of the coil wire, the insulation has been stripped and your wire is ready.

Step 2. Attach a loop of copper wire to the bottom of the test tube(copper is not magnetic). This will attach to a suction cup on the bottom of the wave tank and keep the tube from drifting out of position.

Step 3. To keep the tube upright in the tank, attach a flotation collar. Wrap the top of the tube in buoyant material and secure with tape.

Step 4. Cut a piece of fishing line about a foot long. Tie one end to the magnet necklace clasp. Then stick the clasp to a magnet(s). The magnet clasp makes it easier to change magnets when doing comparative tests. The other end is tied to a fishing bobber.

Factors Affecting the Voltage Produced

- Number of turns in the coil
- Length of the coil: as the coil is “stretched out” with the number of turns remaining the same, the voltage will be reduced
- Diameter of the coil: as the diameter of the coil grows larger, the voltage is reduced
- Strength of the magnet
- Wave height
- Wave period

EXPLANATION

1. How is electricity produced with a generator? Generators use magnets and wire coils to produce electricity. The electricity is produced by rapid rotation of wire coils between the poles of strong magnets. Turbines provide the spinning power.

2. What causes the magnet to move through the wire coil? The up and down motion of the waves.

3. Would the speed of the wave affect the electrical output? Why or why not? Yes. The faster the wave then the more electricity would be made because the movement of the magnet through the coil would be faster.

EXTENSION

Design an experiment looking at one variable (use the factors affecting voltage) or look at the following link and have students design something similar.
https://spectrum.ieee.org/news-from-around-ieee/the-institute/ieee-member-news/worlds-first-ocean-hybrid-platform-converts-tidal-waves-into-energy

EVALUATION

Have students explain their design and experiment to the class.

Adapted from: Wave Energy Engineer - Building a Model Wave-Energy Generator, Oregon State University
https://seagrant.oregonstate.edu/sites/seagrant.oregonstate.edu/files/sgpubs/onlinepubs/e13004.pdf