

Solar, Wind, and Hydroelectric Power

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Description:

In this lesson, you will explore a method for creating your own solar cell, find a way to measure wind speed and explore the use of wind energy, and create your own hydropower model.

Objectives:

Explore the process involved in a solar cell (or photovoltaic cell).

Create a working solar cell

Investigate how wind energy is used and the devices that harness wind energy

Create an Anemometer to measure wind speed

Explore circular motion and circular speed

Convert units

North Dakota State Standards:

9-10.1.2. Describe the interaction of components within a system

9-10.2.1. Explain how scientific investigations can result in new ideas

9-10.2.2. Use appropriate safety equipment and precautions during investigations

9-10.2.6. Design and conduct a guided investigation

9-10.2.7. Maintain clear and accurate records of scientific investigations

9-10.2.8. Analyze data found in tables, charts, and graphs to formulate conclusions

9-10.6.1. Use appropriate technologies and techniques to solve a problem

9-10.6.3. Explain how emerging technologies may impact society and the environment

11-12.2.2. Select and use appropriate instruments, measuring tools, and units of measure to improve scientific investigations

11-12.2.5. Use technology and mathematics to improve investigations and communications

11-12.6.2. Identify examples of how new technologies advance science

Schedule:

9:00-9:30 Cultural Connection

9:30-11:00 PowerPoint and Activity 1: Homemade Solar Cell

11:00-11:30 Activity 2: Sun Jars

11:30-12:00 PowerPoint over Activity 3: Wind Anemometer

12:00-12:45 Lunch

12:45-1:00 Activity 3: Wind Anemometer

1:00-2:45 PowerPoint and Activity 4: Hydro Power: The Force of Water

2:45-3:00 Wrap-up

Activity 1 – Homemade Solar Cell

This activity will explore how a solar cell converts solar energy into electrical energy. A homemade solar cell will be used to investigate this process first hand.

Materials Needed (per group):

Two flat copper sheets (2" by 2 ½" and 1/2" by 2 ½"), copper wire, wire stripper (or a sharp knife to remove part of insulated sleeve), sand paper (or steel wool), hot glue, hot glue gun, distilled water, salt, plastic CD case, soldering gun and solder, tin snips, Alligator clips, 1 cup measuring cup, teaspoon, portable light source.

Assembly:

The instructor will give you two sheets of copper, one will be a larger sheet, which is copper (I) oxide and the other is regular copper.

Step 1: Cut two pieces of copper wire to a length of about 1 foot.

Step 2: Using a wire stripper, remove about 1" of the sleeve and sand one end of the copper wire.

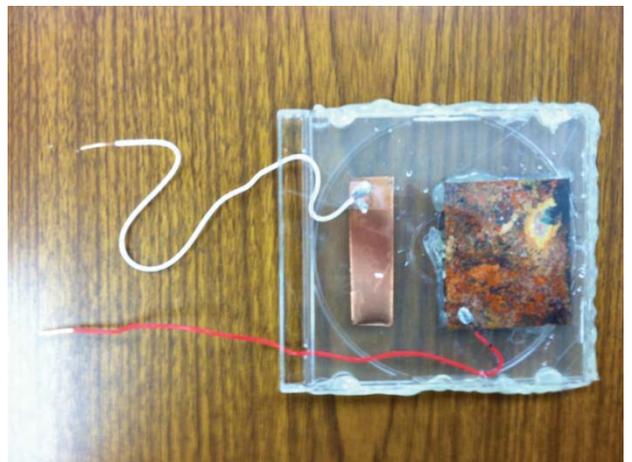
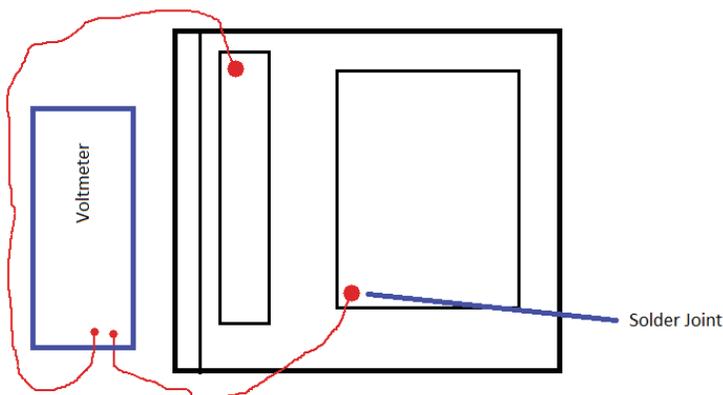
Step 3: Use two wood blocks to suspend the copper sheets so that you do not burn the lab table.

Step 4: Using the soldering gun and solder, solder the cleaned end of the copper wire to the corner of the large plate of copper by creating a hooked end and soldering inside the loop.

Step 5: Repeat step 2 for a second piece of wire and solder the cleaned end of the copper wire to the corner of the smaller plate of copper.

Step 6: Remove the inner plastic from the CD case.

Step 7: Using the hot glue gun, glue the large copper piece on one side of the case and the small copper piece on the other side. Refer to Illustration 1 for the setup. For ease of connection, it is easiest to make sure that the solder joint for one piece of the copper metal is on the top and the other is on the bottom. Make sure that the two pieces of copper metal are not touching!!



Step 8: Create a small hole for each wire in the CD case so that the non-connected end of the wire can be fed through to connect with the voltmeter on the outside. Make sure the holes are toward the hinge end of the CD case. A pair of scissors can be used to take out a small piece of plastic for this.

Step 9: Using the hot glue gun, seal the edges of the CD case and any other holes except for 1 of the holes that the one of your wires are fed through.

Step 8: Mix 1 teaspoon of salt with 1 cup of water.

Step 9: Connect the free end of the copper wire leading from the larger piece to an alligator clip and then to the positive lead and connect the other copper wire leading from the smaller piece to the second alligator clip and connect this to the negative lead of the Voltmeter.

Step 10: Make sure the Voltmeter is set for mV and DC. When the reading is fairly stable, record this value in the table below step 11.

Step 11: Using your portable light source, turn it on directly above the CD case about 1 foot from the surface. Wait until the number on your voltmeter stabilizes and record the mV value in the table below. Turn off the light source and repeat steps 8 and 9 three more times.

Data Collection and Observations:

| Light off 1 | Light on 1 | Light off 2 | Light on 2 | Light off 3 | Light on 3 | Light off 4 | Light on 4 |
|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|
| | | | | | | | |

Using your data in the chart above, record the mean of the lights off and lights on below.

Mean of lights off: _____ mV

Mean of lights on: _____ mV

Group Comparison:

Record the means of lights off and lights on for your group in group 1 and the other groups below.

| Light off Group 1 | Light on Group 1 | Light off Group 2 | Light on Group 2 | Light off Group 3 | Light on Group 3 | Light off Group 4 | Light on Group 4 |
|----------------------|---------------------|----------------------|---------------------|----------------------|---------------------|----------------------|---------------------|
| | | | | | | | |

Question 1: What was the purpose of pouring salt water into the CD case?

Question 2: List at least 3 possible reasons why your results for lights on/lights off were different than the other groups.

1.)

2.)

3.)

Activity 2 – Solar Energy (Sun Jars)

In this activity, students will create their very own solar power light source. The solar power will charge a battery during sunny days and shine during the nights.

Materials:

Glass jar (Wal-Mart)

Solar garden light (Wal-Mart)

Glass frosting spray (Wal-Mart)

Loctite Stik’N Seal (Outdoor Adhesive)

Assembly:

1. Take the lid off the jar and set to the side.
2. Take the jar, and spray the inside with a lite coat of the glass frosting spray.
3. Set the jar aside for a couple minutes.
4. Take the solar light, and unscrew the top of the light from the stem.
5. Take the Loctite and put small amounts on the inside of the lid in a N-S-E-W direction.
6. Grab the solar light top and put it in the inside of the lid, solar cells facing up. (If you were to put the lid back on the jar, the light should be inside of the jar.)
7. Set the lid with the solar light top off to the side to dry.
8. Grab your jar, and apply another lite coat of glass frosting spray to the inside.
9. Wait ten minutes for everything to dry and put the lid on. Set the solar cell under a light

Questions:

1. What are three advantages for solar power?

2. What are three disadvantages for solar power?

3. What are three uses for your sun jar?

Computer Activity (While sun jars dry):

Online solar game

<http://www.wonderville.ca/asset/solarenergydefenders>

Activity 3 – Wind Anemometer

An anemometer is a device that tells you how fast the wind is blowing. Your model will give you an approximation of how fast the wind is blowing in miles per hour. Wind speed is important for determining if wind generators are a practical source of energy in a region.

Materials:

Scissors, 4 small paper cups, pen, 2 strips of corrugated cardboard of the same length, ruler, stapler, push pin, sharpened pencil with eraser on the end, modeling clay, a watch that shows seconds

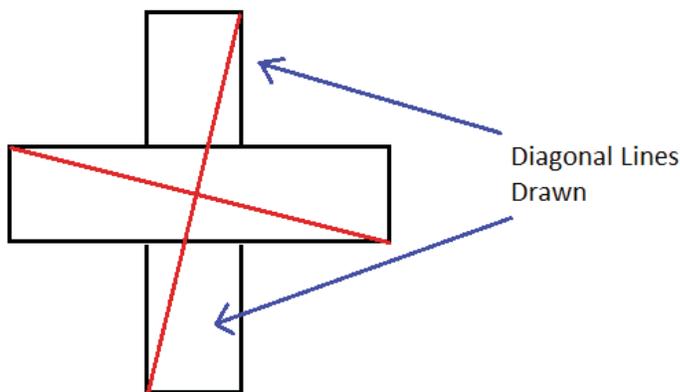
Assembly:

Step 1: Cut off the rolled edges of the paper cups to make them lighter.

Step 2: Color the outside of one cup with the marking pen.

Step 3: Cross the cardboard strips so they make a plus (+) sign. Staple them together.

Step 4: Take the ruler and pencil and draw lines from the outside corners of where the cardboard strips come together to the opposite corners. Where the pencil lines cross will be the exact middle of the cross. Refer to the illustration below.



Step 5: Staple the cups to the ends of the cardboard strips. Make sure the cups all face the same direction.

Step 6: Push the pin through the center of the cardboard (where the pencil lines cross) and attach the cardboard cross with the cups on it to the eraser point of the pencil. Blow on the cups to make sure the cardboard spins around freely on the pin.

Step 7: Place the modeling clay on the lab table as a stand base. Stick the sharpened end of the pencil into the clay so it stands up straight.

Step 8: Using a fan, set the fan a distance of about 2 to 3 feet away from the anemometer and turn it onto the low setting.

Step 9: Once the anemometer reaches full speed, have one person in the group count the number of revolutions until it reaches 10 revolutions. Another student will time until the student watching reaches 10.

Step 10: Record this data into the table below. Create data for 3 values on the low setting, 3 values on the medium setting, and 3 values on the high setting.

| Low Setting | |
|-------------|-------|
| Trial 1 | _____ |
| Trial 2 | _____ |
| Trial 3 | _____ |

| Medium Setting | |
|----------------|-------|
| Trial 1 | _____ |
| Trial 2 | _____ |
| Trial 3 | _____ |

| High Setting | |
|--------------|-------|
| Trial 1 | _____ |
| Trial 2 | _____ |
| Trial 3 | _____ |

Low Mean = _____

Medium Mean = _____

High Mean = _____

Converting wind speed to MPH

Part 1: Finding speed in inches and seconds

First, find the radius by measuring with a ruler or meter stick on the inches side. Measure from the center to a point that is close to the center of one of the cups. Write the result in the blank provided.

Radius = _____

Now calculate the circumference using the formula: $C = 2\pi r$

Circumference = _____

Take this value by 10 (for 10 revolutions) and write that answer below.

10 * circumference = _____

Divide the 10*circumference value by the mean for the low, medium, and high speeds. This is the wind speed in inches per second.

Low wind speed = _____ in/sec

Medium wind speed = _____ in/sec

High wind speed = _____ in/sec

Part 2: Miles per Hour

Use the chart to change your units for each wind speed to mi/hr

Low wind speed chart

| | | | | |
|----------|----------|----------|-----------|-----------|
| _____ in | _____ ft | _____ mi | _____ sec | _____ min |
| 1 sec | _____ in | _____ ft | _____ min | _____ hr |

Low wind speed = _____ mi/hr

Medium wind speed chart

| | | | | |
|----------|----------|----------|-----------|-----------|
| _____ in | _____ ft | _____ mi | _____ sec | _____ min |
| 1 sec | _____ in | _____ ft | _____ min | _____ hr |

Medium wind speed = _____ mi/hr

High wind speed chart

| | | | | |
|----------|----------|----------|-----------|-----------|
| _____ in | _____ ft | _____ mi | _____ sec | _____ min |
| 1 sec | _____ in | _____ ft | _____ min | _____ hr |

High wind speed = _____ mi/hr

Activity 4: Hydro Power (The Force of Water)

This activity will give students a better understanding how large dams use gravity to force water to spin turbines to generate electricity.

Materials:

Half-gallon milk carton/juice carton (empty and washed out)

Water to fill the carton

Nail

Duct Tape

Ruler

Paper and pencil to take notes

Procedure:

1. Open the top of the carton similar to how you would open a school milk carton. Then, repeat to the other side to the top of the carton. The top should open up to a square hole.
2. From the bottom of the milk carton, measure up 7 cm and using the nail, punch a single hole in the center of the side of the carton.
3. Measure up 10 cm from the bottom and punch another hole in the center.
4. Measure up 13 cm from the bottom and punch a third hole directly above the other two holes.
5. Measure up 16 cm from the bottom and punch a final hole in the center of the side.
6. Note: All holes should be the same size.
7. Take a long piece of tape and tape up all four of the holes.
8. Put the carton on the edge of the sink with the side with the holes pointing toward the sink.
9. Mark a line on the carton near the top. Always fill or refill the milk carton with water to that line.

10. Fill the carton up with water.
11. Quickly remove the tape that's covering all the four holes. Watch what happens.
12. Let all the water empty out. Watch what happens as the water level drops.
13. Now tape up all holes with individual pieces of duct tape. Put the carton back on the sink edge. Refill the carton and remove the first tape from the top. Measure how far out the stream goes and then place the tape back on. Record your data in the chart on the next page.
14. Refill the carton and remove the second tape from the top. Measure how far out the stream goes and then place the tape back on. Record your data in the chart on the next page.
15. Refill the carton and remove the third tape from the top. Measure how far out the stream goes and then place the tape back on. Record your data in the chart on the next page.
16. Refill the carton and remove the fourth tape from the top. Measure how far out the stream goes and then place the tape back on. Record your data in the chart on the next page.

3. Is there a connection between the amount of water and where the hole is placed? Explain.

4. What are three advantages of hydropower?

5. What are three disadvantages of hydropower?