3-5 Earth Science
3-5 Nature of Science

Southern Nevada Regional Professional Development Program

Solar Oven Unit

INTRODUCTION

The Sun is the main source of energy for our planet, Earth. Children are naturally curious about the power of the sun. They are exposed to its light and heat every day. This lesson explores one method of harnessing the power of the sun to create a solar oven.

WHERE'S THE SCIENCE?

Solar ovens work by concentrating the **radiant energy** from the Sun's rays in a cooking area by way of a reflective surface like a mirror or aluminum foil. The heat is then trapped in the cooking device by sealing the area with a protective cover, plastic wrap. Solar ovens can reach temperatures in excess of 425 degrees Fahrenheit. The concept is the same as the greenhouse effect, trapping passive solar heat in a contained unit. The light is able to pass through the glass enclosure, but the heat is trapped in the enclosure.

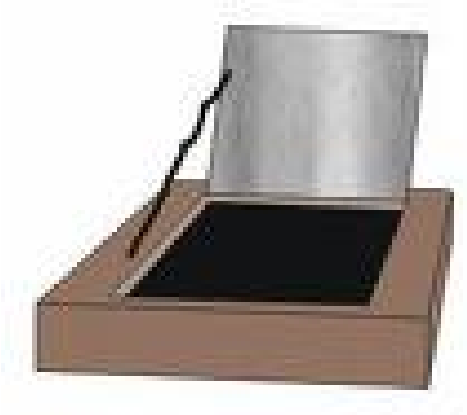
This is not a new technology. Solar cookers have been reportedly used as far back as the 18th century in Europe and India. Solar ovens are a great alternative to costly, non-renewable sources of energy. Once constructed, there is no cost to the user and no pollution to the environment. The energy produced from the Sun is a renewable resource; therefore it is available on an unlimited basis (during daylight hours). Solar ovens are being used widely today and the green movement is further spreading their use and availability. There is one

factor to keep in mind when using a solar oven, the availability of sunlight. They are only successful in sunny locations.

MATERIALS

(per group)

- 1 thermometer
- 1 100mL beaker
- Water
- Aluminum foil
- Plastic wrap
- Small box (shoe box size or pizza box)
- Black paper
- Newspaper
- 2 Dowel sticks
- Glue
- Scissors
- Index card
- Graham Crackers
- Marshmallows
- Chocolate candy bars
- Paper plates
- Napkins
- Chart paper
- Markers, Crayons, Colored pencils
- Ruler
- Science Notebooks



PROCEDURES

Lesson One

1. Call the students to the carpet area to discuss the Sun. Ask students to think about what the Sun provides for them every day. Record their ideas on chart paper to reference later.

2. Tell the students that today they will be investigating the heat energy that is given off from the Sun.
3. Introduce the **thermometer**. Explain to the students that they will use this tool in their investigation. Model how to use the thermometer by placing it in a cup of cold water and reading the recorded temperature after one minute. Tell the students that the red liquid inside the thermometer is alcohol. When the temperature is cool, the liquid condenses and lowers, recording a low temperature. When the temperature is warm, the liquid expands and rises, showing a higher temperature. **NOTE:** Do not use mercury thermometers.
4. Tell the students that they will place a cup of water in the shade and a cup of water in the Sun and record the temperatures of both cups every five minutes. Instruct the students to make a prediction in their science notebooks about what they think will happen to the temperature of both of the beakers.
5. With their group, the students should discuss what they think will happen and record their prediction. Once the students have predicted, instruct them to place 100mL of room temperature water in each of their two beakers. Next, take the class outside to find two locations for the group's beakers, one in the shade, and one in direct sunlight. Two students will be responsible for monitoring and recording the shaded beaker, and two will monitor and record the beaker in the sunlight.
6. Instruct the students to place the beakers in their respective places and take the initial reading. Every five minutes, instruct the students to take the next reading and record in their science notebooks. After each reading is taken, allow the group members to meet in order to share the data and discuss any pattern that they notice.
7. After 30 minutes, instruct the students to take their final reading and gather their materials to return to the classroom.
8. Upon entering the classroom, call the students to the carpet area with their science notebooks and discuss what the groups noticed during their investigation. Did they see a pattern? Was their initial

prediction correct? Did anything surprise them about taking the temperature readings? Introduce the concept of **radiant energy** to the students as energy given off by the sun. Ask them to record this in their science notebooks along with any further questions that they may have.

Lesson Two

1. Invite the students to the carpet area to review temperature and the concept of radiant energy. Explain that they will be creating graphs or charts to organize their data from yesterday. Ask the students how they think they might want to organize their data. Ask them how they organized their data in their science notebooks. Record their ideas on chart paper. Suggest two methods of organization; a T chart and a line graph. **NOTE:** It is ultimately the students' choice how they want to display their data; however, these two organizers will work well to represent their data.
2. Send the students back to their groups and tell them to discuss how they would like to organize their data keeping in mind the suggestions from the class.
3. Instruct each group to create a draft of their graph in their science notebooks and check to ensure all data is clear and easy to read. They must also include a written interpretation of any trend they notice in their graph.
4. Once the groups have their graph sketched out, they may get a large piece of chart paper from the materials station with the coloring tools of their choice; colored pencils, markers, or crayons, along with a ruler and begin constructing their graphs.
5. After the graphs are created, allow the students the opportunity to share these and explain their results with the class. Discuss any patterns that you see in the data represented.
6. Look at the various representations of the students' data. Discuss when to use certain graphs/charts. Keep the graphs posted in the room and allow the students the opportunity to look at each group's work.

Lesson Three

1. Start the lesson by asking the students to describe what it is like getting into a car with rolled up windows in the summer. Ask them where they think the heat came from. Continue by telling the students that today they will be exploring how to harness the heat given off from the Sun. They saw firsthand how the Sun warms objects that are directly exposed to it, so how can students use that heat? Solar ovens! Ask them what they think they know about solar ovens. Have they ever heard of them before? Seen them? Ask them why they think people use them. Where can they be used? Chart their ideas and questions and leave to reference later.
2. Show the students various photos of designs of solar cookers that are presently being used around the world. You can access these photos at http://www.solarcooking.org/plans/default.htm. Discuss features that they notice about the solar ovens. List similarities and differences. Show them a model of a solar oven that you have built from a pizza box by following the directions below. Share the directions with them and keep posted in a visible place in the room.
   NOTE: Directions taken from: http://www1.eere.energy.gov/kids/roofus/pizza_box.html

   PIZZA BOX SOLAR OVEN

   1) Make sure the cardboard is folded into its box shape and closed.
   2) Place the piece of notebook paper in the center of the lid of the box and trace its outline on the lid. Put the piece of paper aside.
   3) Carefully cut the two long edges and one of the short edges of the rectangle that you just traced on the lid of the box, forming a flap of cardboard.

4) Gently fold the flap back along the uncut edge to form a crease.
5) Wrap the underside (inside) face of this flap with aluminum foil. Tape it on the other side so that the foil is held firmly. Try to keep the tape from showing on the foil side of the flap. The foil will help to reflect the sunlight into the box.
6) Open the box and place a piece of black construction paper in so it fits the bottom of the box. This will help to absorb the sun's heat.
7) Close the box, roll up some newspaper, and fit it around the inside edges of the box. This is the insulation that helps hold in the sun's heat. It should be about 1 to 1 1/2 inches thick. Use tape to hold the newspaper in place, but only tape it to the bottom of the box, not the lid.
8) Cut two pieces of plastic wrap an inch larger than the flap opening on the box top. Open the box again and tape one piece of plastic wrap to the underside of the flap opening. After taping one side, BE SURE TO PULL THE PLASTIC WRAP TIGHT, and tape down all four sides so the plastic is sealed against the cardboard. Then close the box and tape the other piece of plastic wrap to the top of the flap opening. Again, be sure the plastic wrap is tight and tape down all four edges to form a seal. This creates a layer of air as insulation that helps keep the sun's heat in the box.

3. Challenge them to create a design to use in building their own solar oven. Brainstorm a list of necessary materials to use in creating their solar oven. Post this list in a visible location in the room. Items to include should be:

- Box (shoe box, pizza box, etc.)
- Black paper
- Aluminum foil
- Clear plastic wrap
- Wooden dowel sticks
- Newspaper (optional)
- Glue
- Scissors

4. Instruct them to work in their groups to design an oven that will trap the heat in by absorbing the sun's rays. They need a reflective surface (aluminum foil) and a method to keep the heat inside the solar oven (plastic wrap). This sketch and plan should be recorded in their science notebooks.
5. Circulate the room to look at students' plans and offer suggestions for success. Tell them they may bring in materials from home if they do not want to be restricted to the provided items from the above materials list.
6. Close the lesson by discussing what they learned about trapping the heat from the sun, passive solar heating. Tell them that they will create their ovens in class during the next lesson and to be prepared with any additional materials they may need from home.

Lesson Four

1. Invite the students to the carpet area to review their blueprint for the solar oven they will create in class. Encourage them to share their ideas with each other before the construction begins. Review the concept of solar heating; the key in the construction is to reflect the Sun's rays and trap the heat in the oven to cook the food placed inside.
2. Instruct the students to return to their groups and begin construction on their ovens. Post the original pizza box solar oven directions as a template for them to follow. They may deviate from the original directions if they have brought additional materials from home. Provide all materials on the materials table

for them to access freely. They are designing their own ovens, so there is no prescribed list of materials, merely a list of suggested materials.

3. Once the ovens are constructed (may take several days) you are ready to test them by cooking in the ovens. Tell the students that they will be making S'Mores in their ovens.
4. At the beginning of the school day, place the ovens outside to collect a substantial amount of heat by lunch time. Attach a note card to the front of the oven to record the time and temperature throughout the day. **NOTE:** If it is a windy day, place rocks on top of the ovens to secure them to the ground.
5. Record the first time and temperature reading when the ovens initially are placed in the sunlight. Return to the ovens every hour to record the time and temperature as well as adjusting the ovens to make sure they are exposed to direct sunlight.
6. At lunchtime, place your S'Mores in the ovens and wait for them to cook. This typically takes about 10 minutes. Record a final temperature and enjoy your sweet treat!
7. After they are finished with their S'Mores, instruct the students to gather their ovens and return to the classroom.
8. Gather the students at the carpet area and discuss what they noticed during their investigation. How long did it take their S'Mores to cook? Did some cook faster than others? What oven recorded the highest temperature? Does design matter when trying to harness the most heat? Record their ideas and further questions.

Lesson Five

1. Invite the students to the carpet area to review their experiences with the solar ovens. Tell them their goal for today is to think about any changes that they would make to create a more efficient, hotter oven.
2. Instruct them to place their ovens on their group table tops. They will then circulate the room and observe all of the solar ovens that were created. They are to take note of how hot the oven got during the investigation. This is recorded on the note card on the front of

the oven. Encourage them to jot down ideas as they are observing the ovens.

3. Once they have observed all of the ovens, they must come up with two modifications to their oven to make it more efficient. These can come from what they observed from other student ovens, or generated ideas through group discussion.
4. Give each group a large piece of chart paper to sketch or write out their modifications. Give each group an opportunity to share what they have learned and what they will change to make a better, more efficient solar oven.
5. Close the lesson by discussing why we should use solar ovens and the benefits to our society and planet if we use this type of renewable, clean energy.

Extensions

- Allow the students to create their new and improved solar ovens based on their two modifications and test them by cooking the S'Mores again. Compare the new temperatures to their original design.
- Try cooking other food based on student ideas. Are there certain foods that cook better in the solar ovens? Investigate and find out!

Additional Resources

http://www1.eere.energy.gov/kids/roofus/pizza_box.html
U.S. Department of Energy website with guided instructions on how to build a pizza box solar oven.
http://www.ibiblio.org/pub/academic/environment/alternative-energy/energy-resources/homepower-magazine/archives/7/07pg15.txt
Information on the history of solar cookers.
http://www.solarcooking.org/plans/default.htm
Informational site on various solar cooking designs complete with instructions and photos.
www.need.org
National Energy Education Development Project's website that includes downloadable booklets and free materials.

Vocabulary

Radiant energy: The energy given off by the Sun.

Solar energy: Energy from the Sun. This energy takes several forms, including visible light and infrared light that can be felt as heat.

Solar oven: A simple, low-cost device using focused sunshine to cook rice, boil water, etc.

Sun: A star around which Earth and other planets revolve. It furnishes heat, light, and energy.

Thermometer: A tool that is used to measure temperature.

Ultraviolet radiation: High-energy, invisible radiation with wavelengths shorter than violet light and longer than X-rays.

Safety Reminders

- Do not look directly into the Sun when conducting these investigations.
- Cook food that will not spoil easily.
- Cover all solar ovens completely to keep out dirt and insects.
- Do not use mercury thermometers.

Nevada State Science Standards

E5A1 Students know the Sun is the main source of energy for planet Earth. E/S

N5A1 Students know scientific progress is made by conducting careful investigations, recording data, and communicating the results in an accurate method. E/S

N5A5 Students know how to plan and conduct a safe and simple investigation. E/S

N5A7 Students know observable patterns can be used to organize items and ideas. E/S

N5B3 Students know the benefits of working with a team and sharing findings. E/L