Solar Energy Fun

Powered by the Sun

by

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Table of Contents

Goals and Objectives

The following goals and objectives are aligned with Sunshine State Standards and are specifically designed for Science. Teachers are encouraged to design cross curricular lessons to incorporate Math, Reading and Language Arts. See "Resources" page 21, for ideas.

SC.5.P.10.0 Investigate and describe some basic forms of energy including light, heat, forms of energy including light, heat, sound, electrical, chemical and mechanical

SC.4.P.10.1 Observe and describe some basic forms of energy including light, heat, sound, electrical and the energy of motion

SC.B.1.1.1 Knows that the Sun supplies heat and energy to the Earth.

SC.B.1.1.2 Knows that light can pass through some objects and not others.

SC.B.1.1.3 Describes a model energy system.

SC.B.1.1.4 Knows that there is a relationship between force and motion.

SC.H.1.1.1 Knows that in order to learn, it is important to observe the same things often and compare them.

SC.H.1.1.5 Uses senses, tools and instruments to obtain information from surroundings.

Course Overview

Fun With Solar Energy was designed as a five to seven day hands on, collaborative lesson to celebrate Earth Day. The primary objective is to have the children explore and understand solar energy through highly engaging activities. The lesson also includes an introduction to background knowledge, extension resources and activities and assessment suggestions for science and language arts and reading. You may select to complete it as an individual class, as a grade level, or with other grade levels. We encourage you to have general education and special education students work together, as all of the students helped one another and enjoyed the activities.

On the Resources page, you will find books and websites which include literature, interactive games, additional activities and assessments for your students. If the books are not available in your school media center, they can be found at your local public library or online for purchase new or used. Much of the background information can also be accessed in your students' textbooks and science leveled readers. "The Sun" DVD is enjoyable for grades 3 – 5 and also gives suggestions for additional activities and science fair ideas.

Most of the information on the following pages will discuss in depth, the four activities that our students completed. They include designing individual pinwheels and discovering what makes them spin, constructing a solar oven, cooking in a solar oven and making solar bead bracelets. Students will be able to make observations using all of their senses, understand the vocabulary and take pride in their very own creations. When the activities are carefully planned, anticipate few, if any behavioral issues as students are fully engrossed in their projects.

Since we planned this project for the entire school, all students from Pre-K through 5th grade, both general and special education with varying exceptionalities, participated. While only Pre-K through 2nd grade (and some SPED classes) completed pinwheels, we discovered that many of the 4th and 5th grade students were extremely helpful in working with 2nd and 3rd graders to make solar ovens. Students from different grade levels and abilities were paired to cook together and enjoy their treats. Every student got to make, observe and keep their own

solar bracelet. Once students complete an activity, have them be the "teachers" for younger students or students who are having difficulty.

You will find that the students will be extremely busy working in pairs and groups. What's more is that the kids will have fun while learning.

Lesson Plans

Pinwheels (PreK-2nd Grades)

The students will understand how the Sun's radiation is the source that powers the wind by warming the air which makes it move.

Begin by reading **"I Face the Wind", by Vicki Cobb** and **"The Wind Blew", by Pat Hutchins**.

Next, have students decorate and make pinwheels.

There are several different resources to help you make pinwheels. Included in this packet (page 10) is one pattern example for you to copy. Additional resources and instructions can be found in FOSS Air and Weather Module Kits, "Wind Catchers" (FOSS kits are available in some schools. Check with your Science Coach or Administrator.), or online at http://www.magicdragonmagazine.com/Activities/how_toPinwheel.htm.

Directions for pinwheels:

1. Provide each student with a pinwheel pattern. We recommend that a teacher, volunteer or older student cut the pattern and slits before giving them to the students. (Helpful tip-Have extra available for mistakes.)
2. Students may decorate both sides of the pattern using crayons or colored pencils.
3. Use a hole punch to make holes in all four wings of the pinwheel.
4. Use a pencil to punch a hole in the center of the pinwheel. Do not use the hole punch for the center.
5. Insert the end closest to the flexible part of the straw into the center of the pinwheel leaving the pinwheel pattern above the bend of the straw.
6. Carefully insert each of the four holes on the wings on to the straw.
7. Use a small piece of transparent tape to secure the ends.

The pinwheel should spin when the student blows on it.

After all of the students have created their pinwheels, take them outside to watch them spin.

<u>Constructing Solar Ovens</u> (Recommended for 3rd-5th grades, may be completed in primary grades with the assistance of teachers, volunteers or older students)

If you choose to use additional resources to construct solar ovens, keep in mind that instructions may vary. This was a concern for some of our teachers at our school as they were not sure if they were constructing correctly. For example, some classes attached the black construction paper (for heat absorption) to the bottom outside of the pizza box, and some classes attached the black paper to the bottom inside of the box. Remember that these are the variables in conducting science experiments. Your students can discover the answers to these questions.

<u>Materials</u>

A sunny day, temperature above 70 degrees

Pizza box
Black construction paper
Aluminum foil
Plastic wrap
Glue
Tape
Ruler, pen or pencil
Scissors

Directions for solar oven:

1. On the top flap of the pizza box, draw a square with a marker with edges spaced 1" from the four sided of the box.
2. Cut along **three** lines of the box on the sides and front edges of the box. **Leave the fourth line uncut.** Fold back the top of the box at the fourth line.
3. Cut aluminum foil to fit on the inside of the lid and to line the inside of the box including the sides. Glue foil into place.
4. Tape plastic wrap to the underside of the cut opening on the top of the box. The plastic should be tightly sealed as to not let any air in. This will be the window.
5. Glue black construction paper to the bottom of the inside of the box on top of the foil.

Solar Cooking

Take students outside with ovens and s'mores ingredients. It is best to use a hard surface such as a basketball court for cooking. Discuss vocabulary from "Solar Matters" (page 16). Students may work in pairs or small groups. Ovens should be placed so that the inside top, when opened, is facing the Sun.

Additional recipes are listed on the Florida Solar Energy Center site. We chose to make S'mores. Remember to ask about any food allergies prior to cooking and eating.

S'mores

Ingredients: Chocolate bars, Graham Crackers, Mini Marshmallows

You may want to place s'mores on a small piece of tinfoil, as a tray, so that you can reuse your oven.

Cook no more than four to five s'mores in one oven at a time.

-Place graham cracker in the solar oven.
-Break a portion of the chocolate bar, and place it on top of the cracker.
-Place marshmallows on top of the chocolate. The chocolate will melt, and the marshmallow will get warm.

-Close the oven lid, and have a student gently hold back the top of the lid so that the foil on the inside of the lid is facing the Sun. Students can observe the s'mores cooking through the window (plastic).
-(Optional) Place an oven thermometer inside the box to record the change in temperature inside the oven.
-When done, take another cracker, and put it on top of the cooked portion (like a sandwich). Smash and enjoy!

Solar Bracelets

Materials

Solar Beads

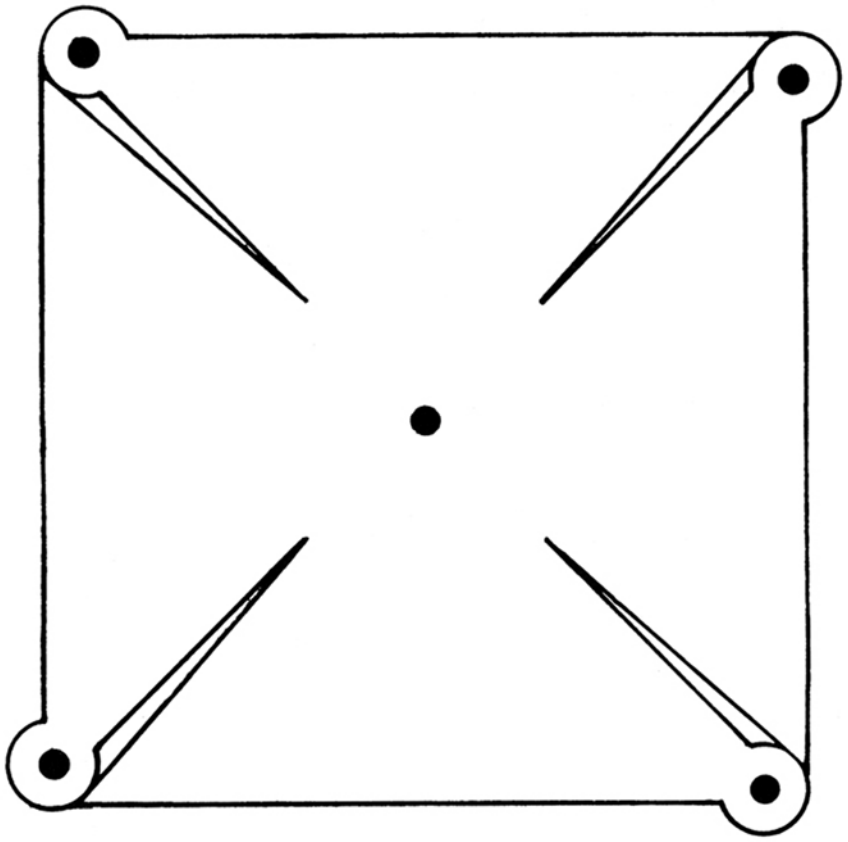
Pipe cleaners, laniard or string

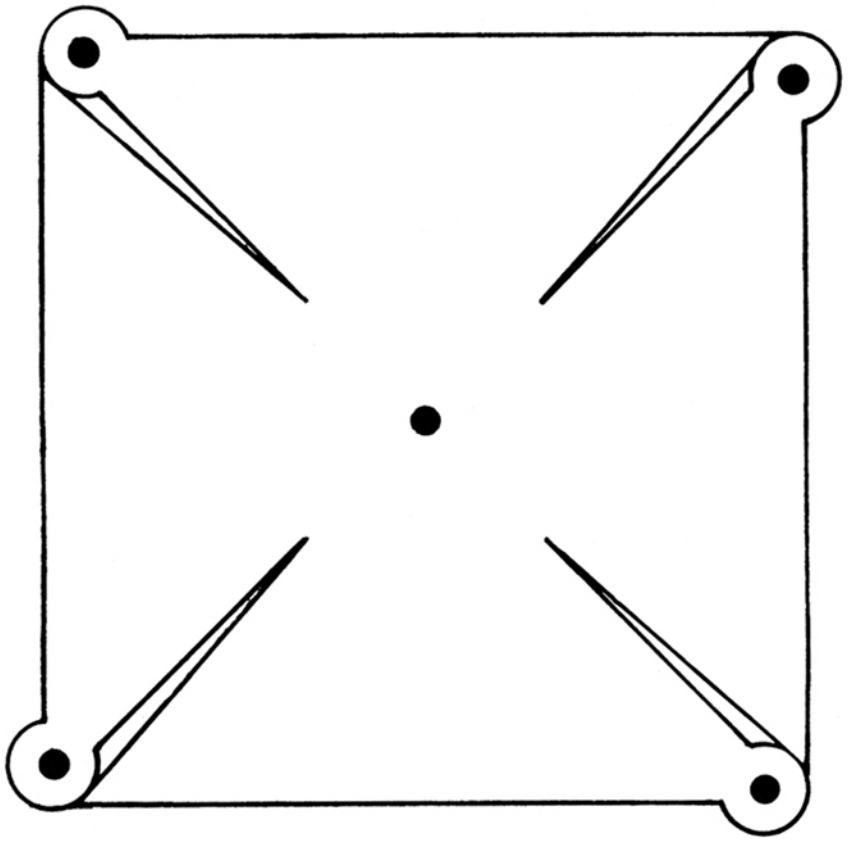
Scissors

<u>Directions for solar beads:</u>

1. String some of your beads on a pipe cleaner, laniard, or string and tie it loosely to your wrist.

Make sure all shutters or blinds are closed to keep the Sunlight out of the classroom while making bracelets. Take students outside. Have them observe the colors of the beads as the ultraviolet radiation in sunlight reacts with a chemical in the beads. Then take them back in the classroom to see the colors fade back to white. Have them record their observations in their science journals.





Wind Watching

Student Objective
The student:
- understands how the Sun's radiation, is the source that powers the wind
- will be able to explain how nature is designed to make use of solar energy.

Key Words:
solar radiation
wind

Time:
30 minutes

Materials:
- outdoor area with grass and trees
- blanket or tarp for sitting

Background Information

Wind is caused by the sun heating the earth and its effect on the atmosphere. The Sun heats the surface of the Earth unevenly, so some places are warm while other places are cold. As the air in an area gets warmer, its particles spread out. This makes the air less dense (lighter), so it rises. As warm air rises, air from cooler areas flows in to take the place of the heated air. This process is called convection and causes air to move. The differential heating of the Earth's surface and the resulting convection is what causes wind on this planet.

Procedure:
1. Take the class outside and form a circle.
2. Tell the students to take 20 steps away from the circle, stop, and look for something being moved by the wind. When they spot something, they are to return to the circle, without saying what they observed.
3. Ask the children one at a time to stand in the center of the circle and move like the object that they spotted. The rest of the class is to try and guess what they observed.
4. After everyone who wants to participate has a turn, have the children create a 'wind dance' together. Each child should do the wind movement that they liked the best.
5. As they do their wind dance, call out different wind conditions such as 'gentle breeze', 'strong gust', 'still air' and 'tropical storm'.
6. After a few minutes of their wind dance, have the children sit in the circle, and lead a discussion on their personal experiences with wind. You may include hurricane experiences here if you wish, however, have the students limit their observations to the effects of the wind.
7. Points to cover and questions to ask may include:
   - What is wind? (*Air moving*)
   - What moves the clouds? (*The wind*)

- Is there wind up high in the air where the clouds are? (*Yes*)
- Is there wind on the Moon or in space? (*No, there isn't any air on the Moon or in space*)
- When the wind blows over your body, do you feel hotter or colder? (*Colder*)
- When the wind moves something, is it using energy? (*Yes*)
- Does the wind in a hurricane have more energy than a gentle breeze? (*Yes*)
- Where does the energy to power the wind come from? (*The Sun*)
- How does the Sun power the wind? (*The Sun warms the air which makes it move*)

Further Activities

1. Make pinwheels with the class. Take them outside and watch them spin for three or four minutes. Take the pinwheels inside and have the students imitate the wind by blowing on their pinwheels. Tell them to keep them spinning as long as they can. When they finally give up, lead a discussion on how the wind can keep their pinwheels spinning long after they get tired, and how we can use wind as an energy source.
2. 'Fly' a Solar Bag. A Solar Bag is a thin plastic bag, 50 feet long and 30 inches in diameter, that will rise in the air and float powered by the thermal energy of the Sun. Solar Bags are available from science suppliers such as Educational Innovations.
3. Fly kites!
4. Discuss wind direction. Have the students guess (hypothesize) which way the wind is blowing, then blow bubbles to see if they are correct.

Related Reading

- ***I Face the Wind*** by Vicki Cobb and Julia Gorton (HarperCollins, 2003)
  This book explains the properties and characteristics of wind in an easy-to-read format. The writing is clear and the explanations are age-appropriate. "Air is made of a gazillion tiny balls floating in space. These balls are so small that they can't be seen. They have to be imagined." A young girl gets pushed by it, has her umbrella turned inside out, watches leaves shake on a tree, and engages in lots of other activities that illustrate the movement of air.
- ***The Wind Blew*** by Pat Hutchins (Aladdin, 1993)
  The wind blew, and blew, and blew! It blew so hard, it took everything with it: Mr. White's umbrella, Priscilla's balloon, the twins' scarves, even the wig on the judge's head. But just when the wind was about to carry everything out to sea, it changed its mind. With rhyming verse and colorful illustrations, *The Wind Blew* takes us on a merry chase.

EnergyWhiz

Be an EnergyWhiz Superstar Class! Submit a photo of your class 'wind dance' or pinwheel experiment to http://energywhiz.com/ and receive recognition for your class and school.

Wind Watching

			.1	.2	.3	.4	.5
Energy	**Standard 1**	**SC.B.1.1-**	X				
	Standard 2	**SC.B.2.1-**	X				
Force and Motion	**Standard 1**	**SC.C.1.1.**	X	X			
	Standard 2	**SC.C.2.1.**					
Nature of Science	**Standard 1**	**SC.H.1.1-**	X				X
	Standard 2	**SC.H.2.1-**					
	Standard 3	**SC.H.3.1-**					

Benchmark SC.B.1.1.1 - The student knows that the Sun supplies heat and light energy to Earth.
Grade Level Expectations
The student:
Kindergarten
- knows the effects of sun and shade on the same object.

First
- knows that heat from the Sun has varying effects depending on the surface it strikes.

Benchmark SC.B.2.1.1 - The student knows that the Sun supplies heat and light energy to Earth.
Grade Level Expectations
The student:
Second
- understands ways energy and matter interact.

Benchmark SC.C.1.1.1 - The student understand that different things move at different speeds.
Grade Level Expectations
The student:
Kindergarten
- understands that different things move at different speeds

Second
- knows that objects exhibit different kinds of motion.

Benchmark SC.C.1.1.2 - The student knows that there is a relationship between force and motion.

Grade Level Expectations
The student:
First
- knows that various things move at different speeds when different forces are applied

Second
- knows that the amount and direction of the force exerted on an object determines how much the object will move.

Benchmark SC.H.1.1.1 - The student knows that in order to learn, it is important to observe the same things often and compare them.
Grade Level Expectations
The student:
Kindergarten
- knows that learning can come from careful observation

Benchmark SC.H.1.1.5 - The student uses the senses, tools, and instruments to obtain information from his or her surroundings.
Grade Level Expectations
The student:
Kindergarten
- knows that the five senses allow us to take in and respond to information in order to learn about our surroundings.

Wind Watching

solar radiation - the heat energy that comes from the Sun

wind - the movement of air from one area to another caused by the Sun heating the Earth and its atmosphere

What's Cooking?

Student Objective
The student:
- will understand how the Sun's radiation, as heat, can be captured and used
- will be able to name the parts of a solar oven and can explain their function.

Key Words:
glazing
insulation
solar collector
solar thermal

Time:
15 minutes for discussion
Cooking & eating time will vary

Materials:
- solar oven (see note in procedure)
- oven thermometer, or thermometer that has a range to at least 300°F
- pot holders
- disposable aluminum cooking pans ('brownie' size works well) with plastic wrap, clear glass covered casseroles, or oven roasting bag
- Science Discovery Sheet

Background Information
1. A solar cooker is a type of solar thermal collector. It 'collects' and traps the Sun's thermal (heat) energy. For example, on a sunny day your car with the windows rolled up becomes a collector. The glazing lets in the Sun's energy, traps the thermal (heat) energy, and the air inside your car becomes hot. As more light enters the car, the air gets even hotter, until we say that it feels like an oven inside!
2. Solar ovens are improving the quality of life for many people around the world. Solar ovens have been introduced in parts of South America, Africa and India. In these areas, it is typical for a woman to spend nearly half her workday looking for and collecting firewood. Also, respiratory problems in the children of these areas have been linked to fumes created by the burning of poor quality wood. The use of solar ovens helps to reduce the dependency on firewood. In addition, some women have turned their talents for building cookers into businesses--building and selling cookers for added income.
3. Besides cooking, solar ovens can be used to purify water. This is beneficial for areas where obtaining safe drinking water is a problem.
4. There are many types of cookers, and ways to build them. Each cooker must have 3 elements or components:

- Glazing that allows the radiant energy to enter (glass, clear plastic wrap, etc.)
- Insulation to retain heat and maintain temperature (styrofoam, cardboard, feathers, paper, etc.).
- Reflectors to concentrate more sunlight into the cooker (foil, mirrors, etc.).

5. There are three basic types of solar ovens on the market today – box, parabolic reflector and multi-reflector (truncated cone or pyramid). Box ovens produce lower temperatures, but are the least expensive and the most portable. Parabolic reflector ovens produce the highest temperatures but must be constantly adjusted to focus directly on the Sun. Multi-reflector ovens combine a good temperature range and can be designed to have a large cooking capacity.

Procedure (prior to class)

1. For this cooking demonstration, you will need either a commercially manufactured solar oven, or one that you construct yourself. Florida schools may borrow a solar oven from the Florida Solar Energy Center. Construction directions for a easily constructed box oven are on the following pages.

Procedure (cooking day)

1. Mix or prepare the food to be put in the oven according to the recipe.
2. Put the food in a covered dish, place in a baking bag, or cover tightly with plastic wrap.
3. Lift glazing, set the dish and an oven thermometer on the bottom of the oven, and replace the glazing.
4. Set the oven facing the Sun.
5. Adjust the tilt of the oven (objects can be placed under one edge), and the tilt of the reflector (if necessary) so that the Sun's rays are directed into the body of the oven.
6. When food is done, be sure to use a pot holder to remove the glazing and also the food. **Solar Cookers can get extremely hot!**
7. Lead classroom discussion about how the heat from the Sun (solar thermal energy) was trapped in the oven (solar collector) to cook the food. Have the students brainstorm other foods that could be cooked by the Sun. Questions that could be asked in classroom discussion are:
   - Where did the heat come from? *(the energy of the Sun)*
   - How did the Sun's energy get in the oven? *(through the glazing)*
   - What parts of the oven help to hold the heat in? *(the insulation and the glazing)*
   - When we open the lid to get the food out, what happens to the heat? *(it escapes)*
   - Did it get hotter inside the oven than it did outside the oven in the sunlight? *(yes)*
   - Why did it get hotter inside the oven? *(the glazing and insulation trapped the heat from the Sun's energy and held it inside. The Sun kept shining in with more energy which kept increasing the temperature)*
8. Have the students complete their Science Discovery Sheet. They should draw the food that they are cooking inside the solar cooker. Younger students can color the picture, older students should label the parts and be able to explain their function.

Further Activities

1. Study food preparation in other times and in other places. Was the Sun used in food preparation and food storage? How?
2. Discuss the benefits of solar ovens for people who live in areas that cook over wood fires. *(less pollution and pollution caused diseases, less time spent collecting firewood and tending a fire, less threat to forests)*
   Discuss how solar ovens might be used in our country. *(after a disaster like a hurricane, for recreational use–boating or camping)*
3. Invite another class to a solar tea party featuring solar tea and cookies baked in their solar oven.

Related Reading

- Cooking With The Sun: How to Build and Use Solar Cookers by Beth Halacy and Don Halacy
  A classroom resource for those who want additional cooker designs and recipes.

EnergyWhiz

Submit your class' favorite recipe or a picture of them cooking to the EnergyWhiz website at **http://energywhiz.com/.**, Get recognition for your class and school as solar chefs!

DAY 3—ACTIVITY: SOLAR BEADS—LIGHT CAN MAKE A COLOR CHANGE.

Materials: 5 solar beads and 1 pipe cleaner for each student

- Make sure the classroom blinds are closed so that sunlight does not enter.
- Distribute five beads and a pipe cleaner to each student. Instruct the students to string the beads on the pipe cleaner and make a loose bracelet out of it by twisting the ends together.
- Ask the students to observe the colors of the beads.
- Open the blinds or take the students outside on a sunny day to observe the colors of the beads in sunlight.
- **CONCEPT**: The ultraviolet radiation in sunlight reacts with a chemical in the beads to cause a change in color.

DAY 3—EXPLORATION: NATUREPRINT PAPER—LIGHT CAN MAKE A COLOR CHANGE.

Materials: 1 piece of NaturePrint paper for each student.

- Take the students outside on a bright sunny day. Instruct each student to find a leaf with an interesting shape, a twig, or other small, flat natural object with which to make a print. *(You can also have students cut designs from construction paper before going outside.)*
- Find a large, flat area. Distribute one piece of NaturePrint paper to each student. Instruct the students to place their paper flat on the ground and place their objects in the center of the paper—do not move them. Direct the students to observe the color of the paper that is exposed to the sun for two to three minutes, until it fades to a pale blue.
- Take the papers inside quickly without further exposing them to direct sunlight. Soak the papers in a container of water for one minute and dry flat. Observe the image on the paper.
- **CONCEPT**: The energy in sunlight changed the color of the part of the paper exposed to the sun.

DAY 4—EXPLORATION: SOLAR BALLOONS—HEAT MAKES SUBSTANCES EXPAND.

Materials: 1 solar balloon with string

- Take the students outside on a bright sunny day.
- Tie off one end of the solar balloon with a small piece of the string.
- Open the other end of the balloon and fill the balloon as full as possible with air. If there is no breeze, walking quickly while holding the end open can help. Tie off the end of the balloon when it is full.
- Tie two strings (about four meters—or twelve feet—long) to the ends of the balloon and put the balloon in the sun. Watch as the air inside the balloon heats up and expands, it becomes less dense than the air around it, causing the balloon to rise into the air.
- **CONCEPTS**: Dark colors absorb light energy and turn it into heat. As substances get hotter, they expand. Less dense substances tend to rise, denser substances tend to fall.

DAY 5—EXPLORATION: SOLAR OVEN—THE ENERGY IN SUNLIGHT CAN COOK FOOD.

Materials: 1 solar oven with oven thermometer, 1 package of refrigerated cookie dough, dark pan

- Arrange small portions of cookie dough on the dark pan.
- Take the students outside on a bright sunny day. Set up the solar oven and place the pan inside. Place the oven in the sun so that the light is focused on the food. *(With assistance, students can make their own solar ovens by lining pizza boxes with foil or using Pringles cans with rectangle cutouts to cook hot dogs on a skewer.)*
- Cover the oven with plastic wrap and observe the cookies as they bake (ten to 20 minutes). Allow the students to sample the cookies when they are finished. Use the thermometer to measure oven temperature.
- **CONCEPTS**: A shiny surface reflects light. Reflected light can be concentrated on an object. When sunlight shines on food, enough energy is changed to heat to cook the food.

Resources

Internet Resources

www.need.org The Need Project
http://www.fsec.ucf.edu Florida Solar Energy Center at the University of Central Florida
http://fplkids.ocm Florida Power and Light

Audio/Visuals

Bill Nye The Science Guy, The Sun, DVD
Books (found at local public libraries or online and in book stores)
"I Face The Wind", Vicki Cobb
"The Wind Blew", Pat Hutchins
"Cooking With The Sun", Beth Halacy

Suppliers

SOLAR BEAD BRACELETS:

Solar Beads - Get Smart, 11751 S. Dixie Highway	$5.95/100 beads
Pipe Cleaners, Laniard or String	$1.99/50 pipe cleaners

PINWHEELS:

Straws (bend at the top)– Target, Publix	$0.59/40 straws

Pinwheel reproducible-FOSS Kit, Air and Weather Module,Part No. 542-0425 or http://www.magicdragonmagazine.com/Activities/how_toPinwheel.htm
Crayons or markers for decorating pinwheels
Scotch Tape
Hole Punch
Pencil

SOLAR OVENS:

Pizza Boxes (corrugated)-Request donations of pizza boxes from local pizza restaurants, ask students to recycle pizza boxes from home or order online at http://bizrate.com/pizza-box. $25.00/50 boxes plus shipping

The following items can be purchased at a grocery store, Target, WalMart or Kmart. Prices are estimates and vary by store:

Aluminum Foil	$3.03/75 sq. ft.
Plastic Wrap	$1.59/100 sq. ft.
Black Construction Paper	school supply
Glue	school supply
Masking Tape	school supply
Graham Crackers	$2.79/box
Chocolate Bars	$2.40/giant bar
Mini Marshmallows	$1.29/bag
Oven Thermometer	$3.79/each

Activities and Assessment Ideas

Science and Language Arts

- Students observe solar beads before and after they are exposed to Sunlight and complete a two column chart using describing words.
- Expository Writing-Write to explain how Sunlight changes the colors of the solar beads.
- Students create vocabulary cards and draw pictures to show their understanding of the definitions.
- Students draw their food cooking in the solar oven, and label the parts of the oven and the source of heat (energy) that is used to cook it.
- Narrative Writing-Write to tell about cooking in your solar oven.

Reading and Social Studies

- Have students research books and the Internet to discover where and when solar ovens may be used locally and around the world.

Math

- Using an oven thermometer, record the temperature before cooking and when the s'mores are ready to be eaten. Students calculate the change (difference) in temperature.