# Wonders of the Sun

## Teacher Guide

Hands-on explorations and language arts activities that introduce elementary students to solar energy. Students will investigate and explore energy transformations and radiant energy, as well as how solar energy can be used to create electricity.

**Grade Level:**

Elem Elementary

**Subject Areas:**

Science

Social Studies

Language Arts

NEED
National Energy Education Development Project

# Teacher Advisory Board



# NEED Mission Statement

The mission of The NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

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## Teacher Advisory Board

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

## Energy Data Used in NEED Materials

NEED believes in providing teachers and students with the most recently reported, available, and accurate energy data. Most statistics and data contained within this guide are derived from the U.S. Energy Information Administration. Data is compiled and updated annually where available. Where annual updates are not available, the most current, complete data year available at the time of updates is accessed and printed in NEED materials. To further research energy data, visit the EIA website at www.eia.gov.

NEED
National Energy Education Development

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# Wonders of the Sun
## Teacher Guide

PROUD MEMBER OF

IREC
Interstate Renewable Energy Council

### Wonders of the Sun Kit

- 1 Package NaturePrint® Paper
- 1 Package clay
- 1 Radiometer
- 1 Solar balloon
- 1 Solar oven
- 1 Oven thermometer
- 4 Solar house kits
- 1 Inflatable globe
- 1 Package UV beads
- 30 Pipe cleaners
- 18 Student thermometers*
- 30 Student Guides

*Student thermometers are safety thermometers containing alcohol spirits, not mercury.

## Table of Contents

# Standards Correlation Information

**www.NEED.org/curriculumcorrelations**

## Next Generation Science Standards

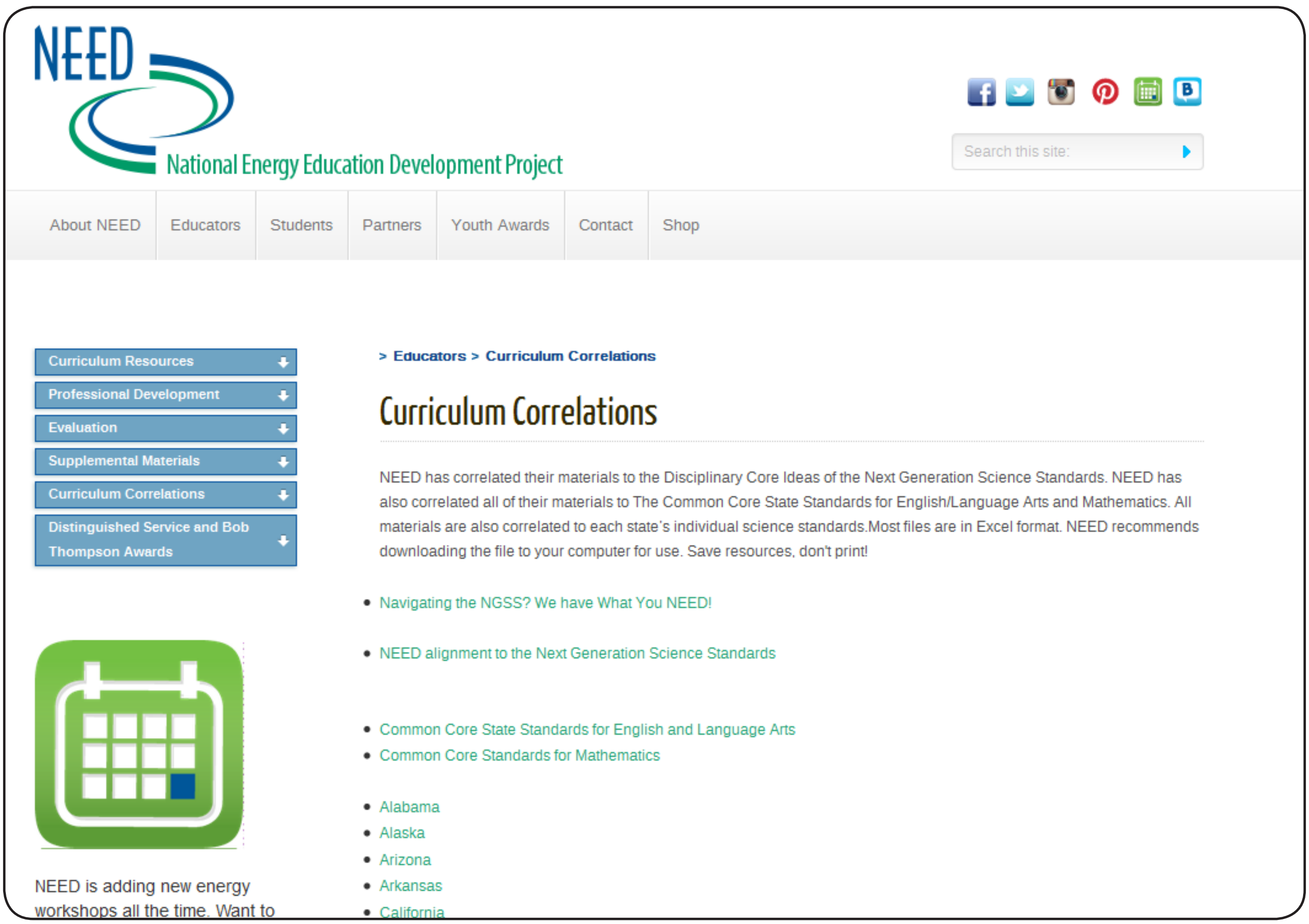
- This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum. For more details on these correlations, please visit NEED's curriculum correlations website.

## Common Core State Standards

- This guide has been correlated to the Common Core State Standards in both language arts and mathematics. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED curriculum correlations website.

## Individual State Science Standards

- This guide has been correlated to each state's individual science standards. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED website.



# Wonders of the Sun Materials

| ACTIVITY | MATERIALS IN KIT | ADDITIONAL MATERIALS NEEDED |
|---|---|---|
| *Solar Energy to Heat* | ▪Thermometers* | ▪White construction paper<br>▪Black construction paper<br>▪Tape<br>▪Lamps or sunny day** |
| *Solar Energy Can Cause Chemical Reactions* | ▪NaturePrint® Paper<br>▪UV beads<br>▪Pipe cleaners | ▪Dark colored construction paper<br>▪Shallow pan<br>▪Scissors<br>▪Objects for design (see instructions)<br>▪Sunscreen (minimum 30 SPF)<br>▪Plastic bags (gallon-sized)<br>▪Tape<br>▪Stopwatch<br>▪Water<br>▪Sunny day |
| *Radiometer* | ▪Radiometer | ▪Light source** |
| *Solar Energy to Heat and Motion* | ▪Solar balloons | ▪Sunny day |
| *Latitude and Sunlight Intensity* | ▪Inflatable globe | ▪Bright flashlight<br>▪Small figurine (1 - 1 ½")<br>▪Tape |
| *Cooking with Solar Energy* | ▪Solar ovens<br>▪Oven thermometer | ▪Food to cook in ovens<br>▪Container or dish to cook food in |
| *Transforming Solar Energy into Electricity* | ▪Solar house kits<br>▪Clay | ▪Transparency film or plastic wrap<br>▪Cardboard boxes - 12x12x12, or similar<br>▪Black construction paper<br>▪Tape<br>▪Scissors<br>▪White copy paper<br>▪Ruler |
| *PV Systems on the School* | | ▪Installed solar panels |

**Student thermometers included within the kit are safety thermometers containing alcohol spirits, not mercury.*

****NOTE:** Consider the bulbs used to complete the activity. For most heat-centered activities, energy efficient bulbs like CFLs and LEDs will not produce the amount of thermal energy needed in the time allotment.

# Teacher Guide

## Grade Level

- Elementary, grades 3–5

## Time

- Eight 30 minute class periods

## Language Arts Connection

Further integrate *Wonders of the Sun* into your reading curriculum by checking out solar energy and energy related books, both fiction and nonfiction, from your library. Have these available for students to read during silent reading or when they are finished with work. Use the books as you instruct students on reading strategies, or give a more formal assignment of having students read a book and write a report about it.

A booklist of fiction and non-fiction energy related books can be found at www.NEED.org.

## Background

*Wonders of the Sun* is a hands-on exploration unit that focuses on the radiant energy from the sun and how it is used. After completing the unit, students will have an understanding of the effects of solar radiation and the many different ways solar energy can be used. They will also have been introduced to the relationship between particle energy and states of matter.

Students explore the subjects from an energy perspective, with a Student Guide that includes informational text, vocabulary, practice formulating hypotheses, and places to record data, observations, and conclusions.

Teacher demonstration materials and masters are included in the Teacher Guide to introduce the subjects. The unit is designed so that the activities are separate and teachers can choose the activities suitable for their classrooms and objectives.

The *Wonders of the Sun* kit contains most of the materials needed to conduct the explorations, including a class set of the Student Guides. The materials not included are easily available and inexpensive. The Teacher Guide lists materials included and needed by activity on page 5.

## Concepts

- The sun produces enormous amounts of energy, some in the form of radiant energy that travels through space to the Earth.
- Most of the energy on Earth comes from the sun. Only geothermal, nuclear, and tidal energy do not.
- The sun's energy makes life possible on Earth because of the greenhouse effect.
- We use the sun's energy to see.
- Through the process of photosynthesis, plants convert the sun's energy to chemical energy to provide food for growth and life.
- Fossil fuels and biomass contain chemical energy from plants and animals that we use to produce heat and light.
- Radiant energy from the sun powers the water cycle and produces wind through the process of convection.
- It is difficult to capture the sun's energy because it is spread out—not concentrated in any one area. We can capture solar energy with solar collectors that convert the energy into heat.
- Photovoltaic (PV) cells convert radiant energy directly into electricity.

## Preparation

- Read the Teacher and Student Guides thoroughly and decide how you are going to implement the unit in your classroom. Select the activities you will use.
- Review the masters on pages 25-32. Make copies or digital versions of those you will use to project.
- Obtain the additional materials needed for the hands-on activities, using the materials list on page 5.

## Science Notebooks

Throughout this curriculum, science notebooks are referenced. If you currently use science notebooks or journals, you may have your students continue using them. A rubric and skills checklist to guide assessment of student notebooks and/or Student Guides can be found on pages 19-20 in the Teacher Guide.

In addition to science notebooks, student worksheets have been included in the Student Guide. Depending on your students' level of independence and familiarity with the scientific process, you may choose to use these instead of science notebooks. Or, as appropriate, you may want to make copies of worksheets and have your students glue or tape the copies into their notebooks.

## Additional Resources

NEED has many other resources that can be used in the classroom to extend students' learning about solar energy, and integrate the topic into other curriculum areas. Visit NEED's Curriculum Resources webpage, www.NEED.org/curriculum, and search for the following by title:

- *Energy on Stage*—Plays about energy including, *Sparkle White and the Seven Dwarfuels*.
- *Energy Live!*—Students write and perform songs about energy sources, including solar energy.
- *Energy Stories and More*—This book includes stories and supplemental activities about energy sources including two stories specific to solar energy, *Where Do You Kids Get All That Energy?* and *The Tale of Johnny Energy Seed*. Students may enjoy reading and illustrating these stories to share with younger students in their school or community.

## Web Resources

**American Solar Energy Society** www.ases.org

**Energy Schema Solar Energy Animations** www.NEED.org/solar

**Energy Information Administration** www.eia.gov

**EIA Energy Kids** www.eia.gov/kids

**National Renewable Energy Laboratory** www.nrel.gov/solar

**U.S. Department of Energy, Solar Energy** https://energy.gov/science-innovation/energy-sources/renewable-energy/solar

**U.S. Department of Energy Sun Shot Initiative** https://energy.gov/eere/sunshot/sunshot-initiative

## Activity 1: Solar Energy to Heat

### ✪ Objectives

- Students will be able to read a thermometer with Fahrenheit and Celsius scales to measure the temperature.
- Students will be able to describe or explain that radiant energy can be reflected and absorbed by objects. When it is absorbed by objects, some radiant energy is converted into heat.

### Materials

- 18 Thermometers
- White and black construction paper
- Tape
- Lamps or sunny day
- Student Guides and/or science notebooks
- *Fahrenheit and Celsius Thermometer* master (page 29)

### Time

- 30 minutes

### Preparation

- Cut black and white paper into small squares (~2"x2").
- Set up six centers with lamps, or outside in the sun. Each center should have three thermometers, three small pieces of black and white paper, and tape.
- If outside, tape or anchor the thermometers down so they do not move while unattended.
- Divide the students into six groups.

### ✔ Procedure

1. Instruct students to read the informational text on page 2 of the Student Guide, about solar energy.
2. Go to page 13 of the Student Guide. Explain or demonstrate what the stations look like. Have students predict which thermometer will be the hottest on the worksheet.
3. Use the thermometer master to explain how to read a thermometer with Fahrenheit and Celsius scales. Go to page 11 of the Student Guide. Complete one or two examples together, having the students shade or color the tube of the thermometers on the worksheet to the level of the Fahrenheit reading, then write the corresponding Celsius reading. Use the blank thermometers to have students write in the temperature of the classroom, the temperature outdoors, or a student/teacher choice. Have students cut out the thermometers, gluing them in order of increasing temperature in their science notebooks.
4. Explain the procedure for the remainder of the activity on page 13 and have the students complete the exploration in their groups.
5. Review the activity with the students and discuss the following concepts:
    - white objects tend to reflect radiant energy;
    - black objects tend to absorb radiant energy;
    - when radiant energy is absorbed by objects, some of it is converted into heat; and
    - real life connections exist with hair color and clothing colors and heat absorption.

# Activity 2: Solar Energy Can Cause Chemical Reactions—Part A: NaturePrint® Paper

## Objective

- Students will be able to describe how solar energy can cause chemical changes, citing specific examples in nature.

## Materials

- 1 Piece of NaturePrint® Paper for each student
- 5 Pieces dark colored construction paper
- 5 Copies of *Solar Cut Out* master (page 32 of the Teacher Guide, page 15 of the Student Guide)
- Tape
- Shallow pan with water
- Scissors
- Sunny day
- Various small items (leaves, flowers, stones, twigs, toys)
- 1 Gallon-sized plastic bag for each student
- Sunscreen, at least SPF 30
- Watch with second hand or stopwatch
- Student Guides and/or science notebooks

***NOTE***: Expired sunscreen will not be effective for this activity.

## Time

- 30 minutes

## Preparation

- Cut each piece of NaturePrint® Paper in half.
- Gather five sheets of the dark colored construction paper that are all the same. Label them 0 through 4.
- Tape a sun cutout on each piece of construction paper.
- Place sheets 1-4 next to one another in a sunny area on a sidewalk where they will receive equal light. Tape down the sides so they don't move. Sheet 0 should remain inside.
- After one hour, retrieve sheet 1. (Students can take notes on this as you do it, or wait until the next class period when all the sheets are in.)
- At the end of the second hour, retrieve sheet 2, continuing to collect a sheet each hour until you have all four sheets. Remove the sun cutouts from all five sheets.

## ✔ Procedure

1. Instruct students to read the informational text on page 3-4 of the Student Guide on solar energy and chemical energy.
2. Explain the set-up involving sheets 0-4. Have students write predictions on Student Guide page 14 or in science notebooks about how exposure to sunlight will affect different kinds of paper.
3. Following the procedure on Student Guide page 17, allow students time to explore using NaturePrint® Paper. Students should use Student Guide pages 18-19 or science notebooks to record observations.
4. Show students the five sheets of construction paper you prepared and exposed to sunlight for varying lengths of time. Have students make observations using Student Guide page 20 or science notebooks.
5. Discuss as a class the results of both explorations and allow students time to write conclusions on Student Guide page 21 or in science notebooks.

## Extensions

- Use bottles of sunscreen with different SPF ratings to compare and contrast the affect of the chemical changes on the NaturePrint® Paper.
- Have students compare which colors of construction paper change the most, fastest, etc.

## Activity 2: Solar Energy Can Cause Chemical Reactions—Part B: UV Beads

### Objective

- Students will be able to describe how solar energy can cause chemical changes, citing specific examples in nature.

### Materials

- UV beads—5 per student
- Pipe cleaners—1 per student
- Sunny day
- Student Guides and/or science notebooks

### Time

- 15 minutes

***NOTE***: This activity can be done along with the NaturePrint® Paper exploration.

### Preparation

- Pick and assign areas in which students will go outside to hypothesize where plants could be planted using the beads to inform their hypothesis. Assign the class areas to observe that have full-sun, partial-sun, and full-shade.
- It is important that the UV beads be kept from exposure to UV light. Students should see that they are white before going outside, and change color when they are exposed to sunlight. Putting the beads in individual small snack-size plastic bags before starting the activity can help minimize exposure if your classroom has large windows.
- If you are letting students keep the beads, they can add ribbons or buttons or put the beads on their shoelaces.

### ✔ Procedure

1. Have students string their UV beads on pipe cleaners. Twist each pipe cleaner into a loosely-fitting bracelet to be worn on their wrists.
2. Have students bring their Student Guides (pages 22-23) or science notebooks, bracelets, and the plant descriptions outside with them. They need to draw a map of the outdoor area they are allowed to explore, showing where they would plant each flower. Instruct students to use a key with symbols they have chosen to indicate each item.
3. In their Student Guides (page 24) or science notebooks, students should write a letter to the principal explaining how they used the beads to discover which plant would go in which area.
4. Review all of activity 2 (part A and B) with the students and discuss the following concepts:
    - solar energy can cause a chemical reaction when it is absorbed by objects; and
    - chemical reactions can produce a change in color.

### Extension

- Compare the effectiveness of various sunscreens, either by brand or SPF level. Cover plastic baggies with different sunscreens and place UV beads inside. Observe any differences in color or length of time required for the changes to occur.

# Activity 3: Radiometer

## Objective

- Students will be able to describe how solar energy can transform into thermal energy and motion energy.

## Materials

- Radiometer
- Student Guides and/or science notebooks
- *Top View of Radiometer* master (page 30)

## Time

- 15 minutes

***NOTE***: This activity can be done while completing Activity 4, Solar Energy to Heat and Motion, as students wait for the balloon to move. Or, it can also be done during Activity 6, Cooking with Solar Energy, while waiting for food to cook.

***NOTE***: The radiometer will work outdoors or indoors with light sources (bright window, lamp, strong flashlight, overhead projector, digital projector).

## ✔ Procedure

1. Instruct students to read page 5 of the Student Guide on thermal energy.
2. Go to page 25 of the Student Guide. Have students color in the prediction arrow they choose.
3. Demonstrate the radiometer, emphasizing that the radiometer is made of glass and can break very easily. Have the students record results and complete the activity as a class or individually.
4. Review the activity using the radiometer master to reinforce the following concepts:
    - the radiometer is a partial vacuum with few air molecules inside;
    - the black vanes absorb more light (radiant) energy than the white vanes, making them warmer;
    - the air molecules in the radiometer move around and bounce off the black vanes with more force because the black vanes have more energy and are hotter; and
    - the force of the air molecules bouncing off the black vanes is greater than the white vanes, and pushes the black vanes to make the radiometer spin in a clockwise direction.
5. As an assessment, instruct students to write about what they observed in the lab using the words white, black, absorb, and reflect.

## Extensions

- Have students explain or write about how their observations of the radiometer might influence their daily life.
- Have students write to a friend, persuading them to wear black or white using their observations as evidence.

# Activity 4: Solar Energy to Heat and Motion

## ✪ Objectives

- Students will be able to explain that air expands when it gets hotter.
- Students will be able to explain that warm air rises because it is less dense.

## Materials

- 2 Solar balloons with string
- Sunny day
- Student Guides and/or science notebooks

## Time

- 30 minutes

## Preparation

- The balloons should work on any clear, sunny day even if the temperature is cold. Avoid very windy days because it is difficult to tell whether the sun or the wind is lifting the balloons. If it is a very windy area, you may want to use a thicker string or rope with the balloons to make them easier to hold. If you are located in a northern area, this activity works best on a clear, sunny day with calm winds, using the light string supplied with the balloon. It will work best if you stand in an area paved with asphalt.

## ✔ Procedure

1. Instruct students to read the sections on the water cycle and wind on pages 6-7 of the informational text in their Student Guides.
2. Take the class outside with the balloons, string, and Student Guides or science notebooks.
3. Tie off one end of the balloons. Allow the balloon to fill with air and tie off the other end. Secure the balloons to stationary objects or allow students to hold. Observe.
4. Review the activity with the students, highlighting the following concepts:
    - black objects tend to absorb solar (radiant) energy;
    - when solar energy is absorbed, some of it turns into heat;
    - warm air is less dense and rises; and
    - solar energy creates wind as air warms and cools.

## Activity 5: Latitude and Sunlight Intensity

### ✪ Objective

- Students will be able to explain how their position on the Earth's surface (according to latitude) affects the amount of available solar energy.

### Materials

- Inflatable globe
- Tape
- Small intense light source (mini flashlight or something similar)
- Small plastic figurine, 1 - 1 ½"
- Student Guides and/or science notebooks

### Time

- 30-45 minutes

### Preparation

- Inflate the globe.
- Pick a student to help hold and/or orient the globe or light.

### ✔ Procedure

1. Instruct students to read pages 7-8 of the informational text in their Student Guides, about latitude and solar energy.
2. Put a piece of tape on the bottom of the plastic figurine. Stick it to the globe on the Equator in the western hemisphere, standing upright. Orient the globe so it will represent winter in the Northern Hemisphere (the Northern Hemisphere should be tilted away from the light).
3. Turn the lights off in the room and turn on the flashlight. From across the room, shine the light on the figure attached to the globe, aiming at or around the Tropic of Capricorn (~23°S).
4. Discuss with students how the sun is shining on the figure at the Equator. How much of the figure is in its own shadow? How hot would the figure feel during the day?
5. Rotate the globe about its axis so it is now night where the figure is taped. Is there any solar energy reaching the figure? Can you rotate the globe so NO solar energy reaches it?
6. Move the figure to Alaska and rotate the globe back to day. Discuss with students how the sun is shining on the figure in Alaska. How much of the figure is in its own shadow? How hot would the figure feel during the day?
7. Compare the two locations. Discuss the similarities and differences of the two locations.
8. Move the figure to a location near where your school is located. How does this location compare to Alaska and the Equator?

# Activity 6: Cooking with Solar Energy

## Objective

- Students will describe how solar energy can be used to cook food.

## Materials

- Solar oven
- Oven thermometer
- Sunny day
- Dish on which to cook food, such as a paper plate (do NOT use foam plates, as they will melt!)
- Food to cook, such as cookie dough, carrots, nacho chips and cheese—experiment a bit to find out which food will actually cook, being careful to avoid foods that can cause illness if undercooked, and paying attention to student allergies
- Student Guides and/or science notebooks

## Time

- 30 minutes

## Preparation

- Assemble the solar ovens.
- Scout a sunny spot outdoors that will remain in the sun for a few hours, unshaded.

***NOTE:*** The ovens will work even in really cold weather if you cover the ovens with clear plastic wrap. It may be helpful to set up the oven in advance to allow it to "preheat" or to give the food a head start on cooking.

## ✔ Procedure

1. Explain the procedure to the students (page 33 of the Teacher Guide, page 26 of the Student Guide), and go outside to cook a snack!
2. Have the students measure the temperature of the solar oven with the thermometer.
3. Review the activity with the students, reinforcing the following concepts:
    - the shiny sides of the oven reflect the solar energy onto the food; and
    - the food absorbs the solar energy and turns it into heat that cooks the food.

# Activity 7: Transforming Solar Energy into Electricity

## ✪ Objectives

- Students will be able to explain that photovoltaic (PV) cells turn solar energy into electricity.
- Students will be able to describe examples of how electricity can produce light and motion.

## Materials

- 4 Solar house kits
- Transparency film or plastic wrap
- Clay
- 4 Cardboard boxes - 12x12x12 or similar
- Black construction paper
- 2 Sheets of white copy paper for each group
- Ruler
- Tape
- Scissors
- Student Guides and/or science notebooks

## Time

- 30-45 minutes

## Preparation

- Set up four centers, each with one solar house kit, a piece of transparency film, a small piece of clay, scissors, and tape. If you desire, art supplies can also be included at each center, allowing for students to decorate the boxes to look like houses.
- Divide the class into four groups.

## ✔ Procedure

1. Instruct students to read the informational text on pages 8-9 of the Student Guide explaining that solar energy is renewable and can make electricity. Review the *Photovoltaic Cell* diagram, in the Teacher Guide on page 34, for more specifics.
2. Explain the procedure to the students (page 35 of the Teacher Guide, page 27 of the Student Guide), emphasizing that all of the students in the groups should have an opportunity to help with the activity. (As an alternative, every student can prepare his/her own box house and take turns installing the PV equipment.) Assign each group of students to a center and have them complete the activity using pages 28-29 of the Student Guide or their science notebooks. For younger students, it is recommended that adult or older student helpers at each center assist students with this activity.
3. Review the activity with the class, reinforcing the following concepts:
    - a solar collector turns solar (radiant) energy into heat;
    - a PV cell changes solar (radiant) energy into electricity; and
    - electricity can produce light and motion.

## Activity 8: PV Systems on the School (Optional)

### ✪ Objective

- Students will explain how PV systems are used on schools to generate electricity.

### 🕒 Time

- 30-45 minutes

### ✔ Procedure

1. Have the school energy/facility manager or a local expert show the students a PV system on the school or local building, and explain how the system helps the building reduce its energy costs. If the system is separately metered, older students can monitor the electricity use to determine how much electricity the system is producing, keeping a journal of weather conditions and output each day. See NEED's *Schools Going Solar* guide for more information and activities that incorporate data collection and analysis.

## ☑Assessment and Evaluation

- Copy and assign students the vocabulary worksheets on pages 37 and 38 of the Teacher Guide. Answer keys can be found on page 17.
- Sample prompts for formative or summative assessment can be found on page 39 with sample answers on page 18.
- A multiple choice assessment can be given at the close of the unit. Copy and distribute pages 40-41. Answers can be found below. This assessment could also be given at the start of the unit as a pre-assessment if you choose.
- A rubric and skills checklist to assess student work can be found on pages 19-20.
- Evaluate the unit with your students using the evaluation form on page 43, and return to NEED as indicated on the form.

### Solar Energy Assessment Answers, page 40

1. b  2. c  3. a  4. a  5. c  6. b  7. d  8. b  9. d  10. c

# Solar Energy

**Fill in the blanks using the words in the box at the bottom of the page. Each word will be used only once.**

1. Solar comes from the word ___**sol**___, which means sun.
2. The word ___**photo**___ means light.
3. ___**Volt**___ is a measure of electricity.
4. ___**Radiant energy**___ is energy that travels in rays.
5. Plants ___**absorb**___ , or take in, radiant energy.
6. White and shiny objects ___**reflect**___ radiant energy.
7. A ___**solar collector**___ takes in solar energy and turns it into heat.
8. Solar energy is called a ___**renewable**___ energy source, because it will always be there.
9. A ___**photovoltaic**___ cell turns light into electricity.
10. Plants take in solar energy and store it in their leaves and roots as ___**chemical energy**___.

**reflect absorb chemical energy photo volt sol renewable photovoltaic solar collector radiant energy**

# Water and Wind

**Fill in the blanks using the words in the box at the bottom of the page. Each word will be used only once.**

1. Water is gas from is called ___**water vapor**___.
2. Rain and snow are called ___**precipitation**___.
3. The air around the Earth is the ___**atmosphere**___.
4. When water turns into a gas, it ___**evaporates**___.
5. Near the shore, the air over ___**land**___ heats up faster than air over the water.
6. A ___**wind turbine**___ is a machine that captures the energy in moving air.
7. Warm air ___**rises**___ into the atmosphere.
8. Moving air is called ___**wind**___.
9. ___**Gravity**___ moves water from high to low ground.
10. Wind turbines and hydropower dams turn the energy in moving air and moving water into ___**electricity**___.

**evaporates rises water vapor precipitation gravity wind turbine electricity land atmosphere wind**

# Assessment Prompts Sample Answers

1. Pretend you are a drop of water. Tell your story as you travel through at least four steps of the water cycle. *Refer to the illustration of the water cycle on page 25 of the Teacher Guide.*
2. Draw and label the water cycle. *Refer to the illustration of the water cycle on page 25 of the Teacher Guide.*
3. Which is more important, heat or light? Explain your thinking. *Either answer is correct as long as the student uses evidence to support his/her opinion.*
4. Explain at least five ways the sun is important. *Some examples: electricity, photosynthesis, wind, water cycle, light, heat, fossil fuels, food web, warms the Earth, etc.*
5. Explain the role the sun plays in food webs, the water cycle, and the creation of wind. *Refer to Student Guide text pages 3, 6, and 7.*
6. Describe in words or pictures how plants use solar energy. *Refer to photosynthesis diagram on page 31 of the Teacher Guide.*
7. Illustrate and explain a food chain with at least four steps leading back to the sun. *Example: The sun provides the energy to plants for photosynthesis and corn grows. The corn ear worm moth lays her eggs on an ear of corn. The baby larvae hatches and eat the corn. It transforms into a moth and is eaten by a bat. The bat, in turn, is eaten by an owl.*
8. Name at least two sources of renewable energy and explain how the sun powers them. *Refer to Student Guide text: wind power (page 7), hydropower (page 6), solar power (pages 8-9).*
9. Name at least one source of nonrenewable energy that traces back to the sun. Illustrate and explain how it can be traced back to the sun. *Refer to Student Guide text (page 4): any of the fossil fuels would be correct.*
10. Give a real life example that illustrates how different colors absorb radiation and produce heat differently. *You leave a candy bar in a black car with a black interior and it melts really fast. You leave a candy bar in a car with a white interior and white exterior and it is not as hot. Wearing different color shirts.*
11. Imagine you were building a perfect solar oven. Draw a diagram of it, explaining your choices. *Student should indicate a dark bottom that is enclosed to hold in the heat and possibly include reflective surfaces.*
12. Explain an everyday use of UV beads. *Answers could include: using beads to show how much sunlight is available, or wearing beads as a reminder to use sunscreen.*

# Grading Rubric

## Student Guide or Science Notebook Rubric

| GRADE | SCIENTIFIC CONCEPTS | SCIENTIFIC INQUIRY | PRESENTATION |
|---|---|---|---|
| 4 | Student demonstrates thorough understanding of concepts through pictures, writing, and verbal communication. | Student is able to follow all steps of the scientific process: predicting, observing/recording data, and drawing a more complex conclusion related to his/her data. Student shows higher level thinking by asking his/her own questions. | Handwriting is legible. Pictures are realistic and include labels. All parts of the assignment are complete. |
| 3 | Student demonstrates understanding of concepts through pictures, writing, and/or verbal communication. | Student is able to predict, observe/record data, and draw a basic conclusion. | Handwriting is legible. Pictures are realistic and include most labels. All parts of the assignment are complete. |
| 2 | Student demonstrates a beginning understanding of concepts, may have a couple of lingering misconceptions. | Student is able to do two of the following: predict, observe/record data, draw conclusions. | Words and/or pictures may be hard to decipher at times. Pictures are present but are missing labels. The notebook has some missing components. |
| 1 | Student demonstrates confusion about concepts. Many misconceptions remain. | Student is able to do one or fewer of the following: predict, observe/record data, draw conclusions. | Words and/or pictures are hard to decipher. They may not be connected to the investigation. The notebook has many missing components. |

# Science Skills Checklist

Designed to be a formative assessment tool, you may find this checklist useful as you work with students. Put all of your students names down the left hand side. When you look at a child's notebook or Student Guide and see a skill demonstrated, put a dot in the box. Decide how many times (typically 3-5) you want to see the student use the skill independently before checking off the box as a sign that the student has mastered this skill.

| Student Name | **Drawings** | Picture is realistic (colors, shape, size) | Includes appropriate labels | **Notes and Observations** | Uses senses to record observations | Observations are "big picture" | Observations focus on details | **Graphs and Charts** | Data is accurate | Includes appropriate labels | Clear presentation | **Communication** | Communicates verbally | Communicates in writing | Makes predictions | Makes predictions with reasoning | Uses evidence to support reasoning | Compares and contrasts | Communication is personal |
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# Solar Energy BINGO Instructions

## Get Ready

Duplicate as many *Solar Energy Bingo* sheets (found on page 36) as needed for each person in your group. In addition, decide now if you want to give the winner of your game a prize and what the prize will be.

## Get Set

Pass out one *Solar Energy Bingo* sheet to each member of the group.

## Go

**PART ONE: FILLING IN THE BINGO SHEETS**

Give the group the following instructions to create bingo cards:

- This bingo activity is very similar to regular bingo. However, there are a few things you'll need to know to play this game. First, please take a minute to look at your bingo sheet and read the 16 statements at the top of the page. Shortly, you'll be going around the room trying to find 16 people about whom the statements are true so you can write their names in one of the 16 boxes.
- When I give you the signal, you'll get up and ask a person if a statement at the top of your bingo sheet is true for them. If the person gives what you believe is a correct response, write the person's name in the corresponding box on the lower part of the page. For example, if you ask a person question "D" and he or she gives you what you think is a correct response, then go ahead and write the person's name in box D. A correct response is important because later on, if you get bingo, that person will be asked to answer the question correctly in front of the group. If he or she can't answer the question correctly, then you lose bingo. So, if someone gives you an incorrect answer, ask someone else! Don't use your name for one of the boxes or use the same person's name twice.
- Try to fill all 16 boxes in the next 20 minutes. This will increase your chances of winning. After the 20 minutes are up, please sit down and I will begin asking players to stand up and give their names. Are there any questions? You'll now have 20 minutes. Go!
- During the next 20 minutes, move around the room to assist the players. Every five minutes or so tell the players how many minutes are remaining in the game. Give the players a warning when just a minute or two remains. When the 20 minutes are up, stop the players and ask them to be seated.

**PART TWO: PLAYING BINGO**

Give the class the following instructions to play the game:

- When I point to you, please stand up and in a LOUD and CLEAR voice give us your name. Now, if anyone has the name of the person I call on, put a big "X" in the box with that person's name. When you get four names in a row—across, down, or diagonally—shout "Bingo!" Then I'll ask you to come up front to verify your results.
- Let's start off with you (point to a player in the group). Please stand and give us your name. (Player gives name. Let's say the player's name was "Joe.") Okay, players, if any of you have Joe's name in one of your boxes, go ahead and put an "X" through that box.
- When the first player shouts "Bingo," ask him (or her) to come to the front of the room. Ask him to give his name. Then ask him to tell the group how his bingo run was made, e.g., down from A to M, across from E to H, and so on.

***Solar Energy Bingo* is a great icebreaker for a NEED workshop or conference. As a classroom activity, it also makes a great introduction to an energy unit.**

## Preparation

- 5 minutes

## Time

- 45 minutes

**Bingos are available on several different topics. Check out these resources for more bingo options!**

- Biomass Bingo—*Energy Stories and More*
- Change a Light Bingo—*Energy Conservation Contract*
- Coal Bingo—Coal guides
- Energy Bingo—*Energy Games and Icebreakers*
- Energy Efficiency Bingo—*Monitoring and Mentoring* and *Learning and Conserving*
- Hydropower Bingo—Hydropower guides
- Hydrogen Bingo—*$H_2$ Educate*
- Marine Renewable Energy Bingo—*Ocean Energy*
- Nuclear Energy Bingo—Nuclear guides
- Offshore Oil and Gas Bingo—*Ocean Energy*
- Oil and Gas Bingo—Oil and Gas guides
- Science of Energy Bingo—*Science of Energy* guides
- Transportation Bingo—*Transportation Exploration*
- Wind Energy Bingo—Wind guides

- Now you need to verify the bingo winner's results. Ask the bingo winner to call out the first person's name on his bingo run. That player then stands and the bingo winner asks him the question which he previously answered during the 20-minute session. For example, if the statement was "can name two renewable sources of energy," the player must now name two sources. If he can answer the question correctly, the bingo winner calls out the next person's name on his bingo run. However, if he does not answer the question correctly, the bingo winner does not have bingo after all and must sit down with the rest of the players. You should continue to point to players until another person yells "Bingo."

# SOLAR ENERGY BINGO

## ANSWERS

A. Has used a solar clothes dryer

B. Knows the average conversion efficiency of PV cells

C. Knows the nuclear process in the sun's core

D. Knows how radiant energy travels through space

E. Can explain how solar energy drives the water cycle

F. Has used a photovoltaic cell

G. Rides in a solar collector

H. Can explain how solar energy produces wind

I. Knows how plants convert solar energy into chemical energy

J. Uses passive solar energy at home

K. Has seen a solar water heater

L. Has cooked food in a solar oven

M. Can name two advantages of solar energy

N. Knows the energy conversion that a PV cell performs

O. Can explain why dark clothes make you hotter in the sun

P. Owns solar protection equipment

| | | | |
|---|---|---|---|
| **A**<br>Has hung clothes outside to dry | **B**<br>13-30% | **C**<br>Fusion | **D**<br>In electromagnetic waves (or transverse waves) |
| **E**<br>Sun evaporates water in lakes and oceans, water vapor rises and becomes clouds, rains to replenish | **F**<br>ask for location/description | **G**<br>Car without tinted windows is a solar collector-like a greenhouse | **H**<br>Sun heats the Earth's surface unevenly-hot air rises and cooler air moves in |
| **I**<br>Photosynthesis | **J**<br>Allows sun to enter through windows for light and heat-has materials that retain heat (masonry, tile, etc.) | **K**<br>ask for location/description | **L**<br>ask for description |
| **M**<br>Solar energy systems do not produce air pollutants or carbon dioxide, minimal impact on environment, sun's energy is free | **N**<br>radiant energy to electrical energy | **O**<br>Dark colors absorb more radiant energy and turn it into thermal energy | **P**<br>Sun screen, sunglasses, etc. |

# Teacher Information

## What is Energy?

Energy is the ability to do work, the ability to make a change. Everything that happens in the world involves a change of some kind, the exchange of energy in some way. The total amount of energy in the universe remains the same. When we use energy, we do not use it completely. Instead, we convert one form of energy into other forms. Usually the conversion of energy produces some heat, which is considered the lowest form of energy, since it dissipates into the surroundings and is difficult to capture and use again. Energy is categorized in many ways—by the forms it takes and by what it does, the changes it makes and the effects we can see or feel or measure.

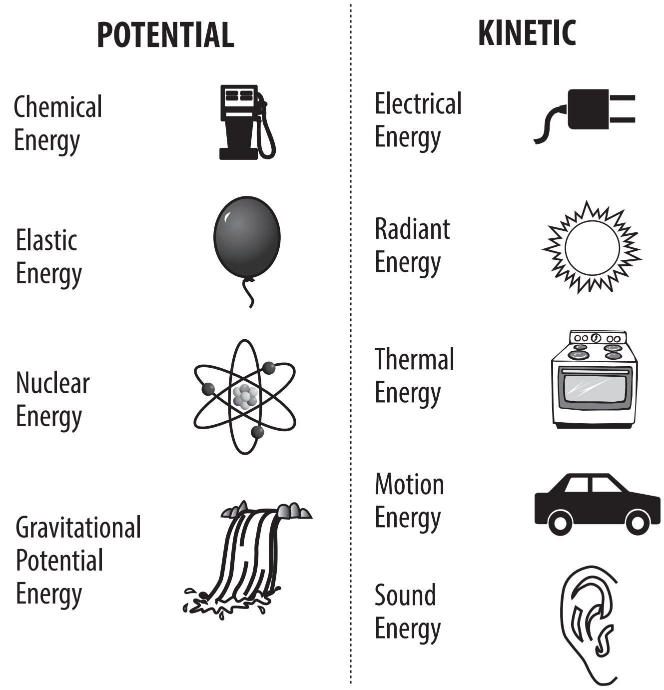
**What Energy Does—energy is recognized in many ways.**

- Light is energy, and the transformation of energy produces light—the movement of energy in transverse waves or rays is called radiant energy.
- Heat is energy, and the transformation of energy produces heat—the movement of atoms and molecules within substances is called thermal energy. Thermal energy is often referred to as heat for younger students.
- Sound is energy, and the transformation of energy produces sound—the back-and-forth vibration of substances in longitudinal waves is called sound energy.
- Motion is energy, and the transformation of energy can produce motion—energy of motion is called kinetic energy.
- Growth requires energy, and the transformation of energy within living things can produce growth—the energy needed for plants to grow comes from radiant energy and the energy needed for everything else to grow is stored in the bonds of substances and is called chemical energy.
- Electricity is energy, and the transformation of energy can produce electricity—when electrons move through a substance it is called electricity.

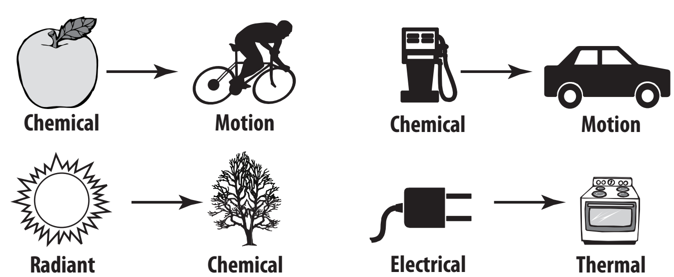
**Forms of Energy—energy is recognized in many forms, all of which are potential or kinetic.**

- Radiant Energy (Light, X-rays, Microwaves)
- Thermal Energy (Heat)
- Sound (Echoes, Music)
- Motion Energy (Wind)
- Chemical Energy (Energy in Wood, Fossil Fuels)
- Electrical Energy (Electricity, Lightning)
- Nuclear Energy (Fission, Fusion)
- Gravitational Potential Energy (Hydropower)
- Elastic Energy (Springs)

### Forms of Energy




### Energy Transformations




For more information and activities about energy transformations, download *Primary Science of Energy* (grades 1-3) or *Elementary Science of Energy* (grades 3-5) from www.NEED.org.

## Solar Energy

Solar energy is energy from the sun. The sun is a giant ball of hydrogen and helium gas. The enormous heat and pressure in the interior of the sun cause the nuclei of hydrogen atoms to fuse, producing larger helium atoms in a process called fusion. During fusion, nuclear energy is converted into thermal (heat) and radiant energy. The radiant energy is emitted from the sun in all directions and some of it reaches Earth. Radiant energy is energy that travels in electromagnetic waves or rays. Radiant energy includes visible light, x-rays, infrared rays, microwaves, gamma rays, and others. These rays have different amounts of energy depending upon their wavelength. The shorter the wavelength, the more energy they contain.

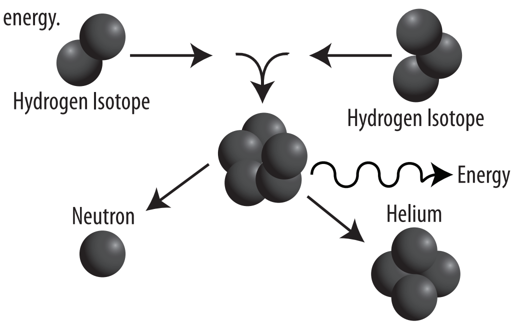
## Photovoltaic Cells (See page 34 for diagram)

Photovoltaic (PV) comes from the words *photo* meaning light and *volt*, a measurement of electricity. PV cells are made of a thin piece of silicon, the substance that makes up sand and the second most common element on Earth. One side of the silicon has a small amount of boron added to it, a dopant which gives it a tendency to attract electrons. It is called the p-type because it has a positive tendency. The other side of the silicon has a small amount of phosphorous added to it, a dopant which gives it an excess of free electrons. This is called the n-type because it has a tendency to give up electrons—a negative tendency. After the two sides of silicon have both been chemically modified, some electrons from the n-type flow to the p-type and an electric field forms between the layers. The p-type now has a negative charge because it attracted negatively charged electrons. The n-type has a positive charge because it lost its negatively charged electrons.

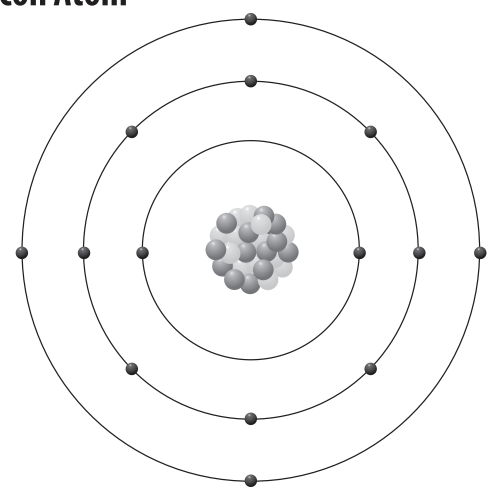
When the PV cell is placed in the sun, the radiant energy energizes the free electrons. If a circuit is made connecting the sides, electrons flow from the n-type through the wire to the p-type. The PV cell is producing electricity—the flow of electrons. If a load such as a light bulb is placed along the wire, the electricity will do work as it flows. The conversion of sunlight into electricity takes place silently and instantly. There are no mechanical parts to wear out.

## Fusion

The process of fusion most commonly involves hydrogen isotopes combining to form a helium atom with a transformation of matter. This matter is emitted as radiant energy.

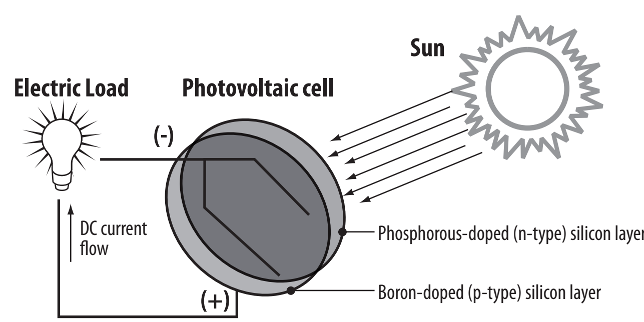



## Silicon Atom

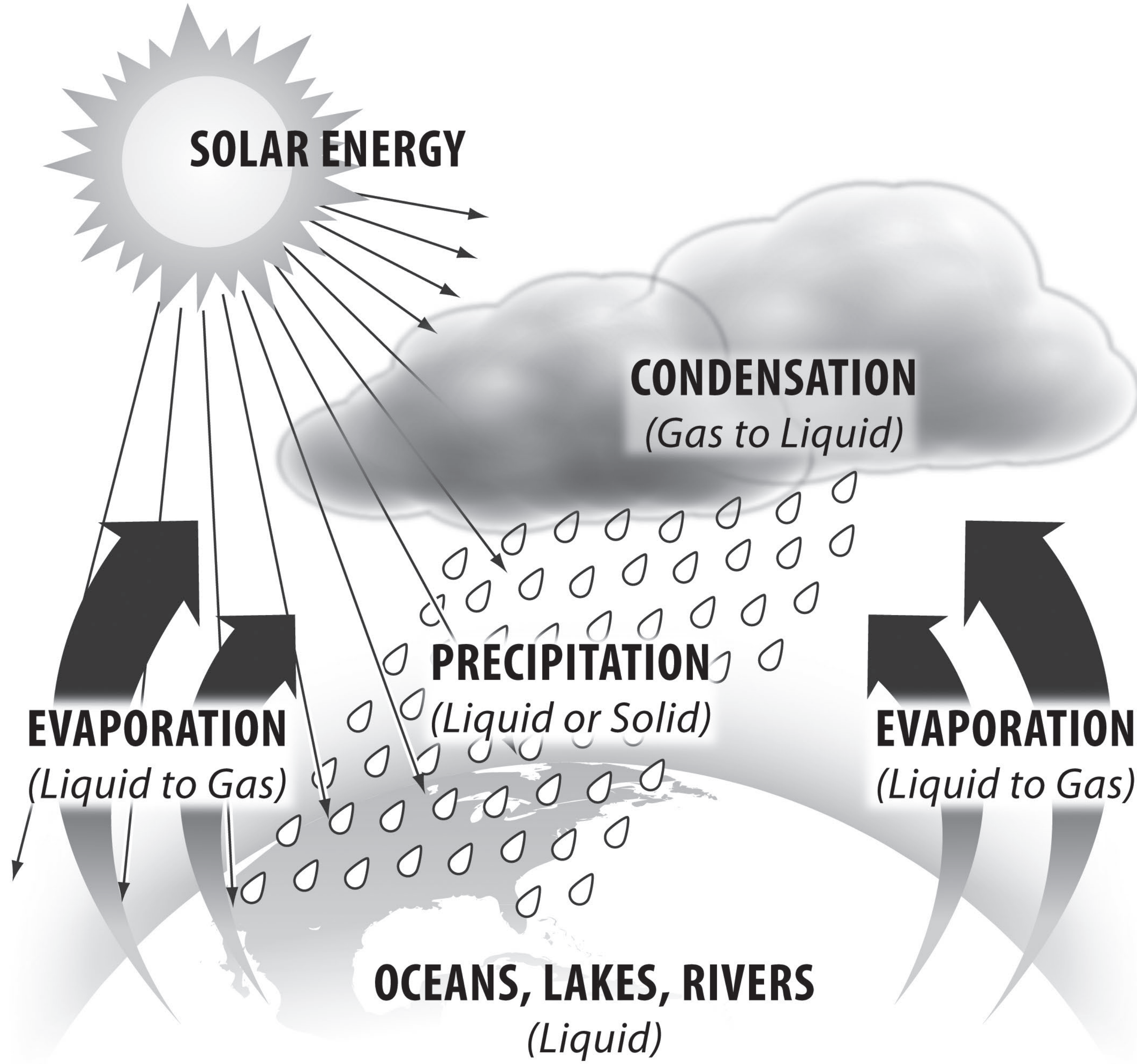


**Silicon is used as a semiconductor because it has four valence electrons and does not want to lose or gain electrons. Therefore, the electrons flow across it from the boron side to the phosphorus side without the silicon interfering with the movement.**

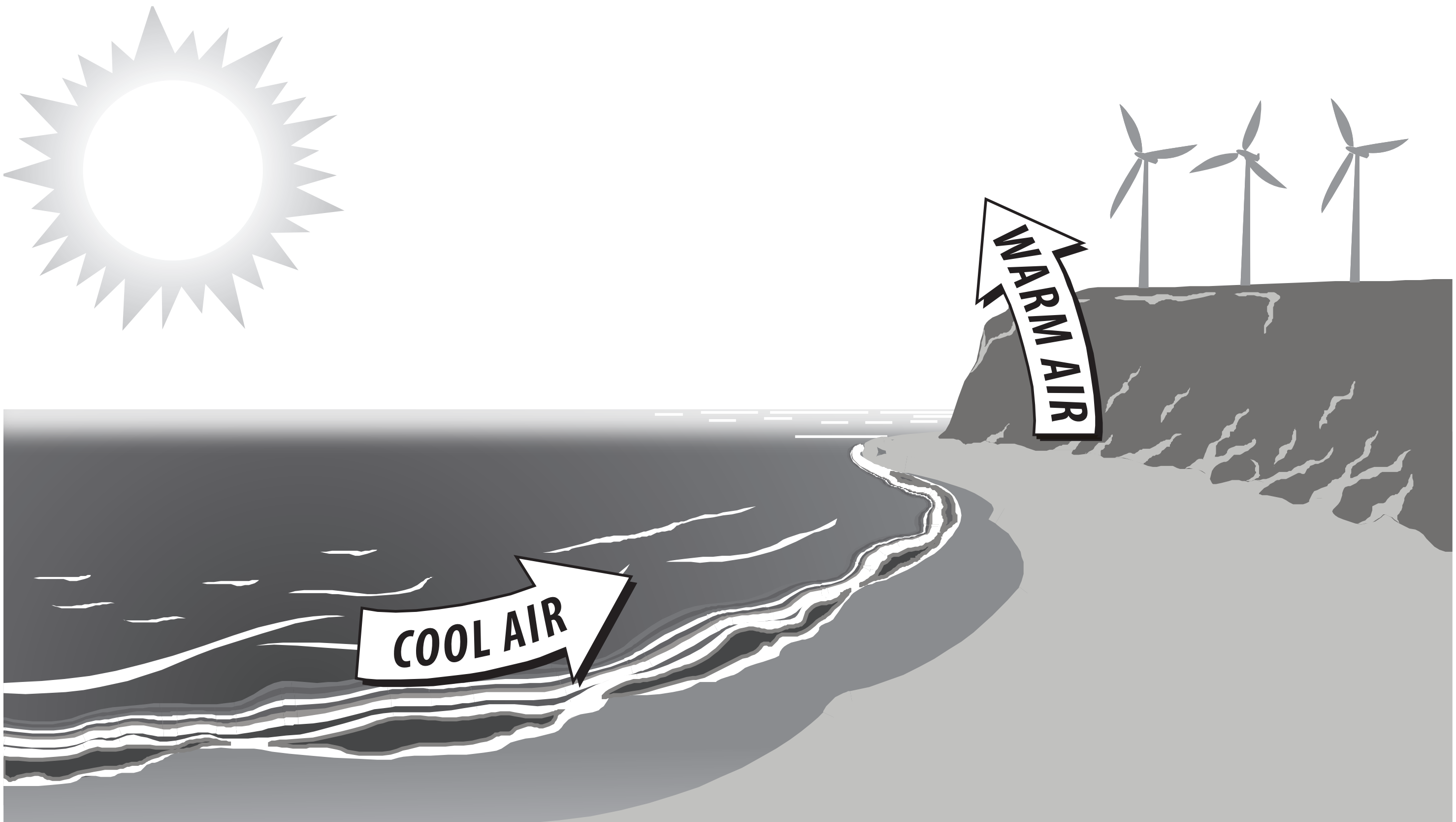
## Sunlight to Electricity



# The Water Cycle

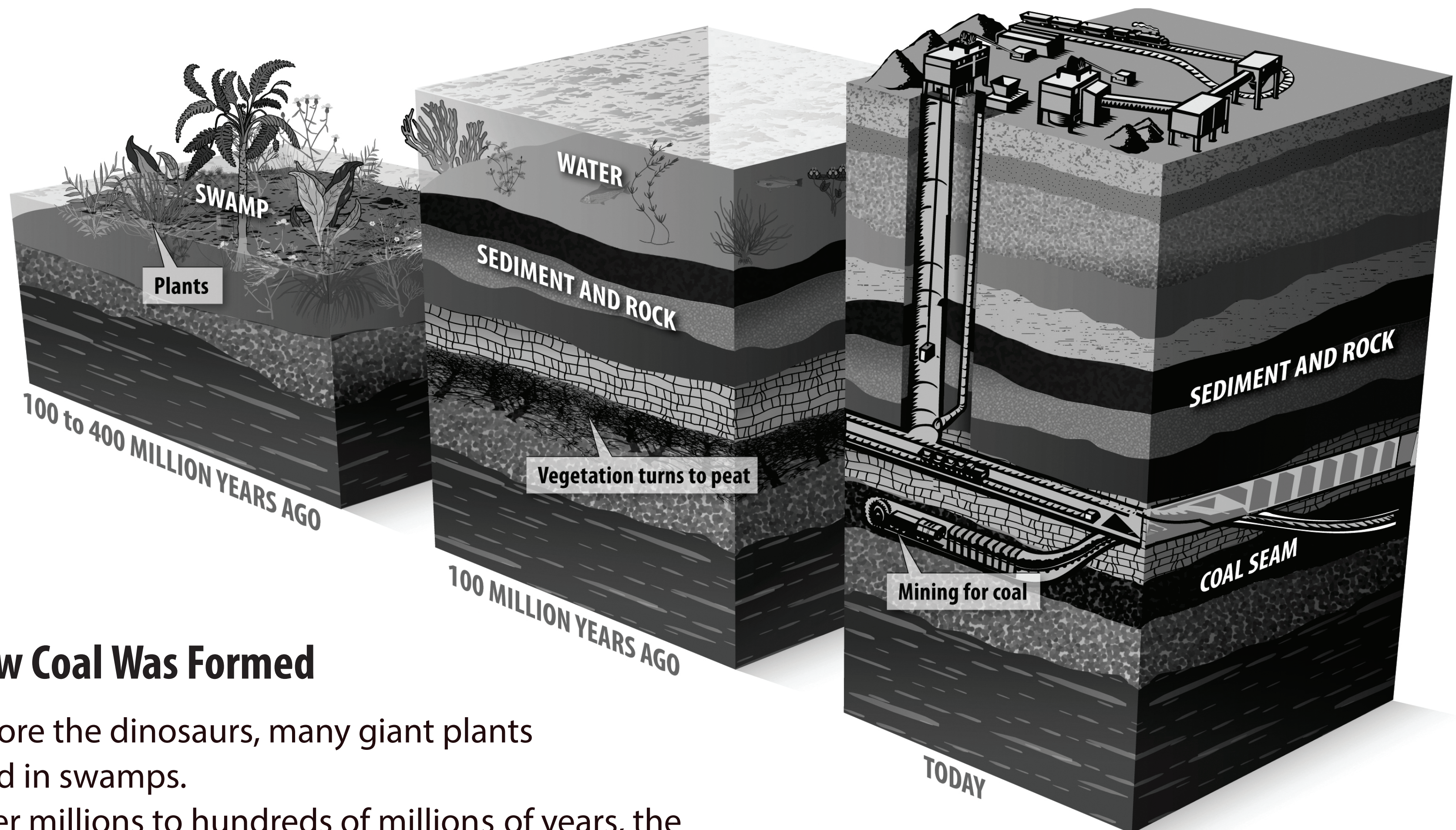


# How Wind Forms Where Water Meets Land




1. The sun shines on land and water.
2. Land heats up faster than water.
3. Warm air over the land rises.
4. Cool air over the water moves in.

# How Coal Was Formed

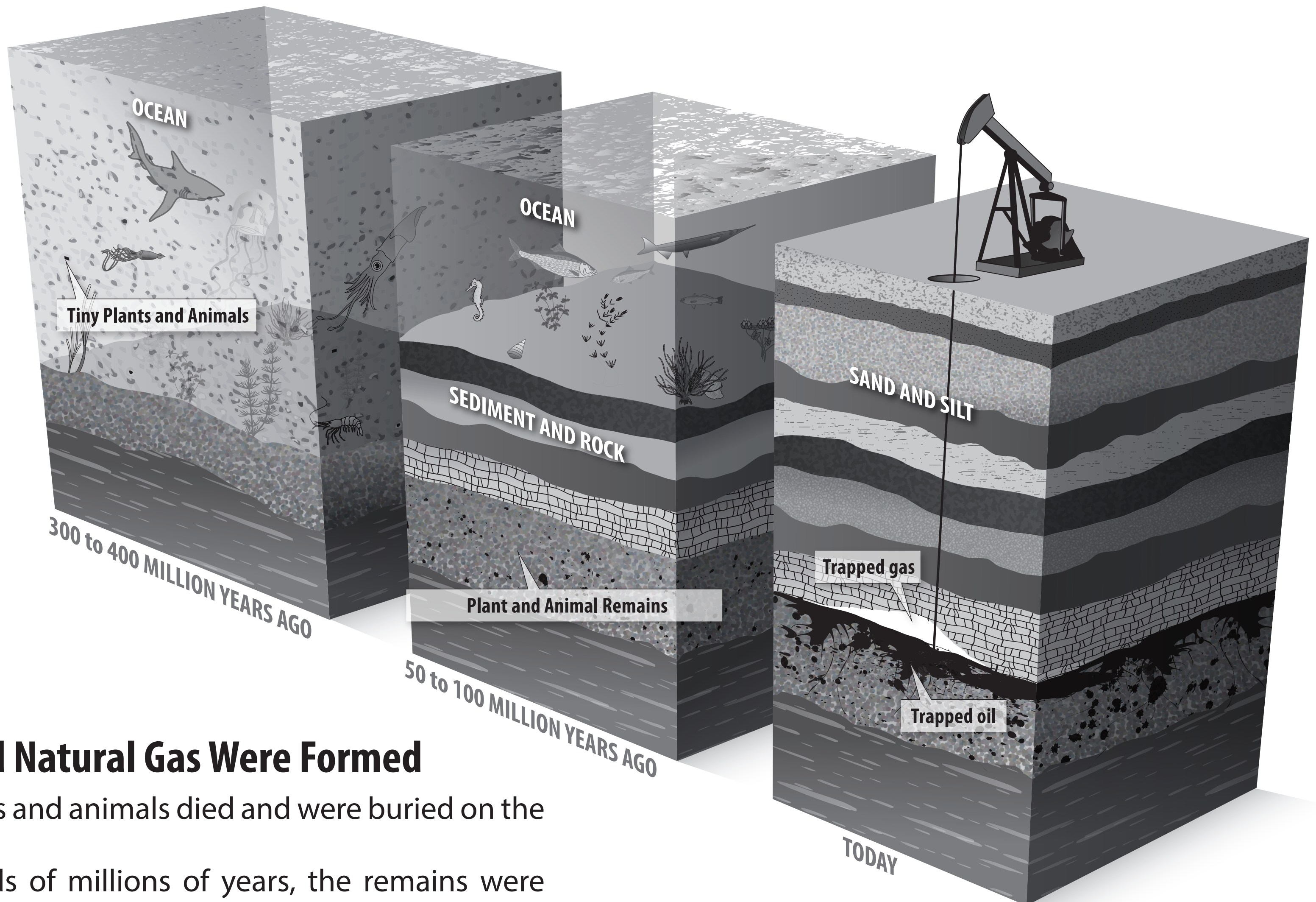



Note: not to scale

## How Coal Was Formed

Before the dinosaurs, many giant plants
died in swamps.
Over millions to hundreds of millions of years, the
plants were buried under water and dirt.
Heat and pressure turned the dead plants into coal.

# How Oil and Natural Gas Were Formed

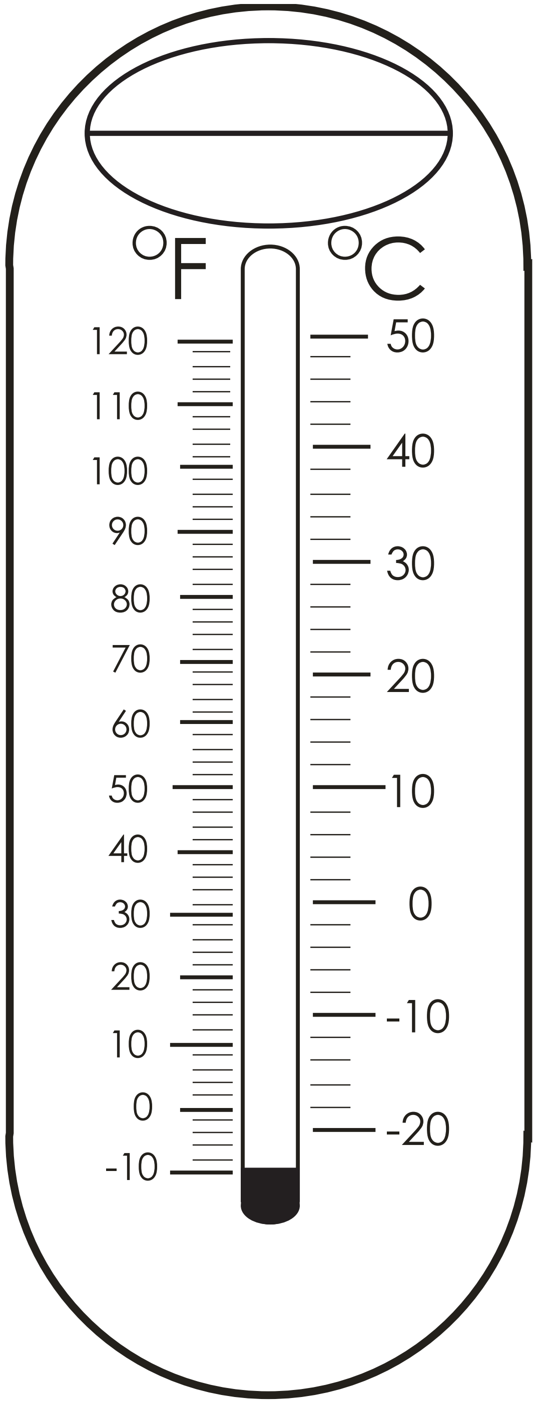



Note: not to scale

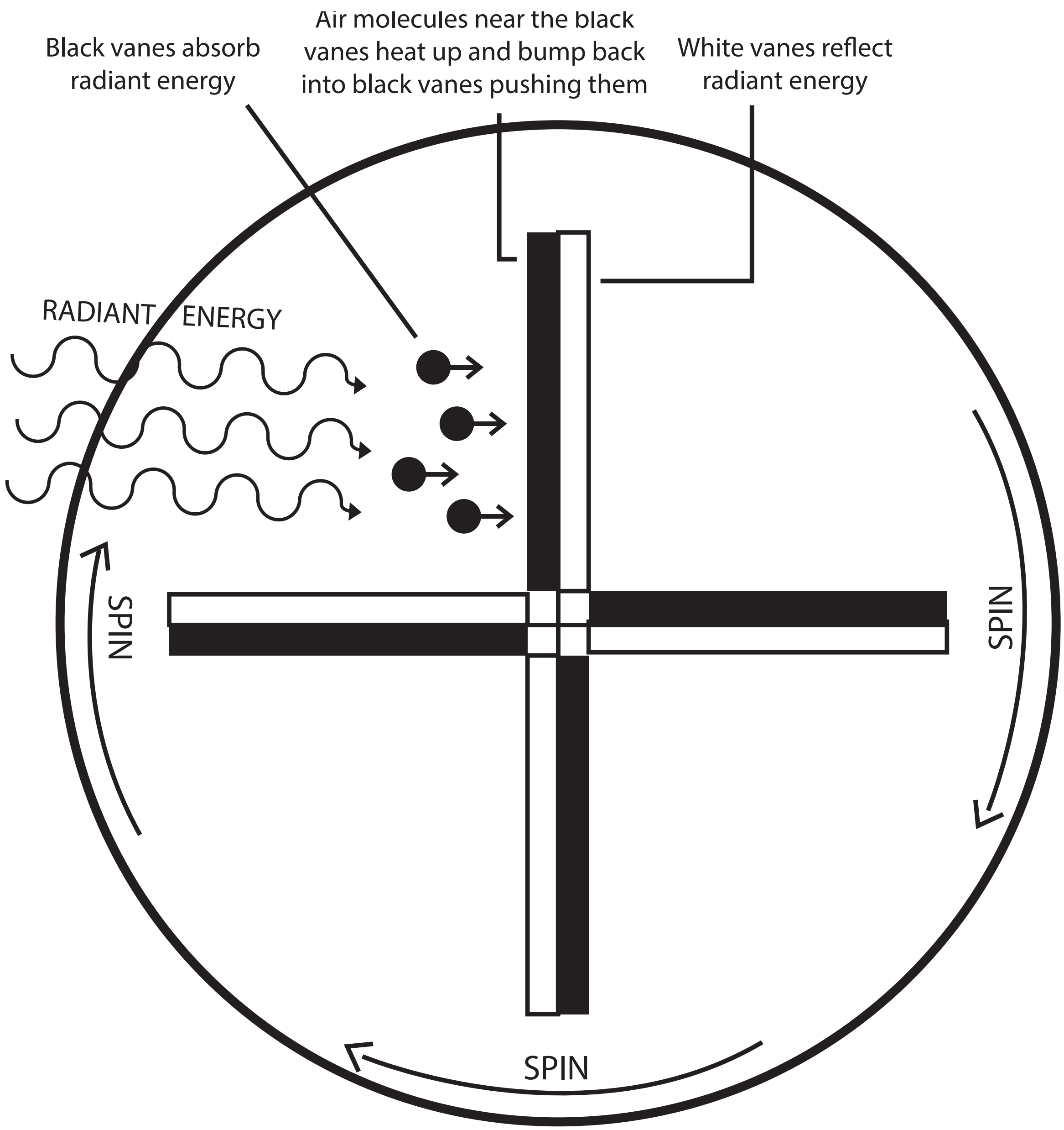
## How Oil and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor.
Over hundreds of millions of years, the remains were burried deeper and deeper.
Heat and pressure turned the plant and animal remains into oil and gas deposits.

# Fahrenheit and Celsius Thermometer

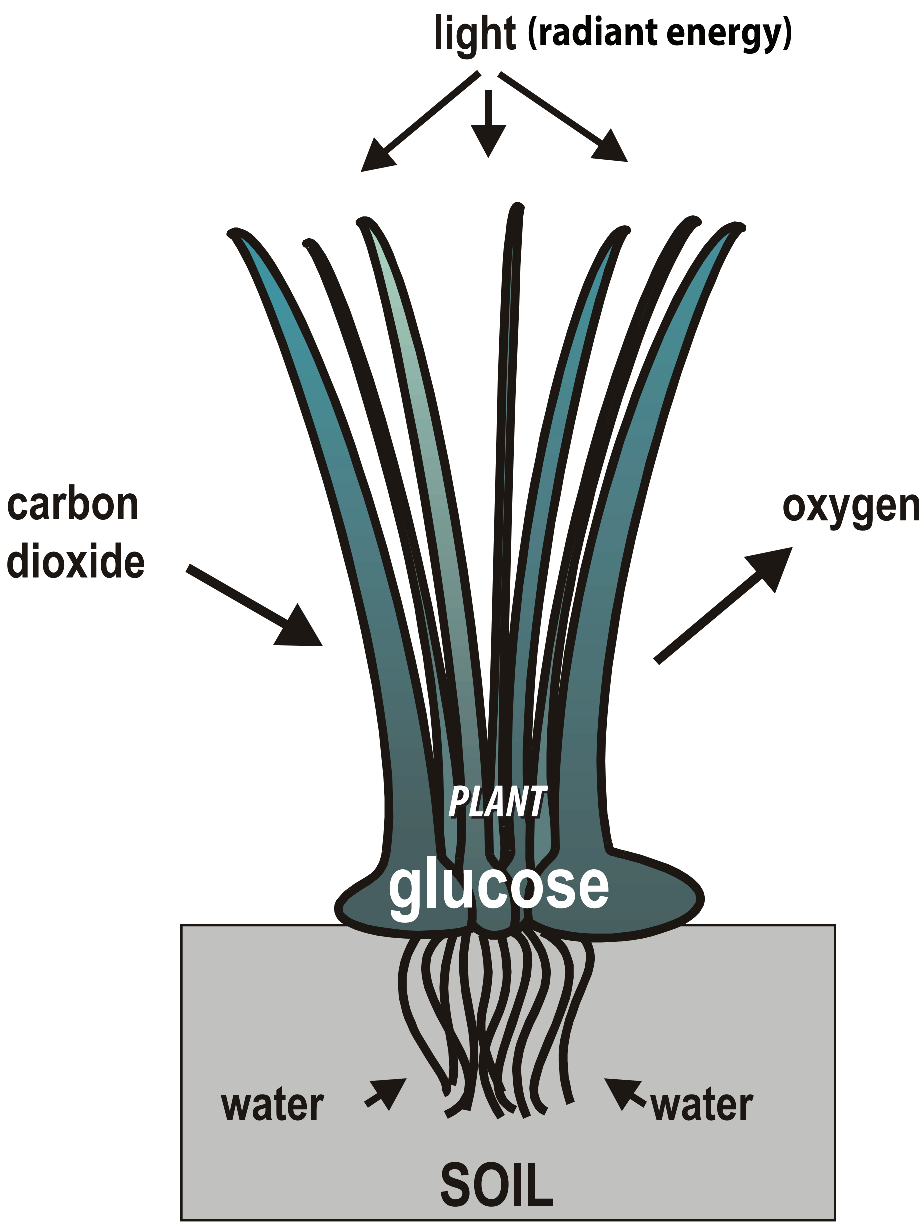


# Top View of Radiometer




When the air molecules hit the white sides of the vanes, they push a little. When the air molecules hit the black sides of the vanes, they push a lot. Since there is more of a push on one side than the other, the vanes begin to turn.

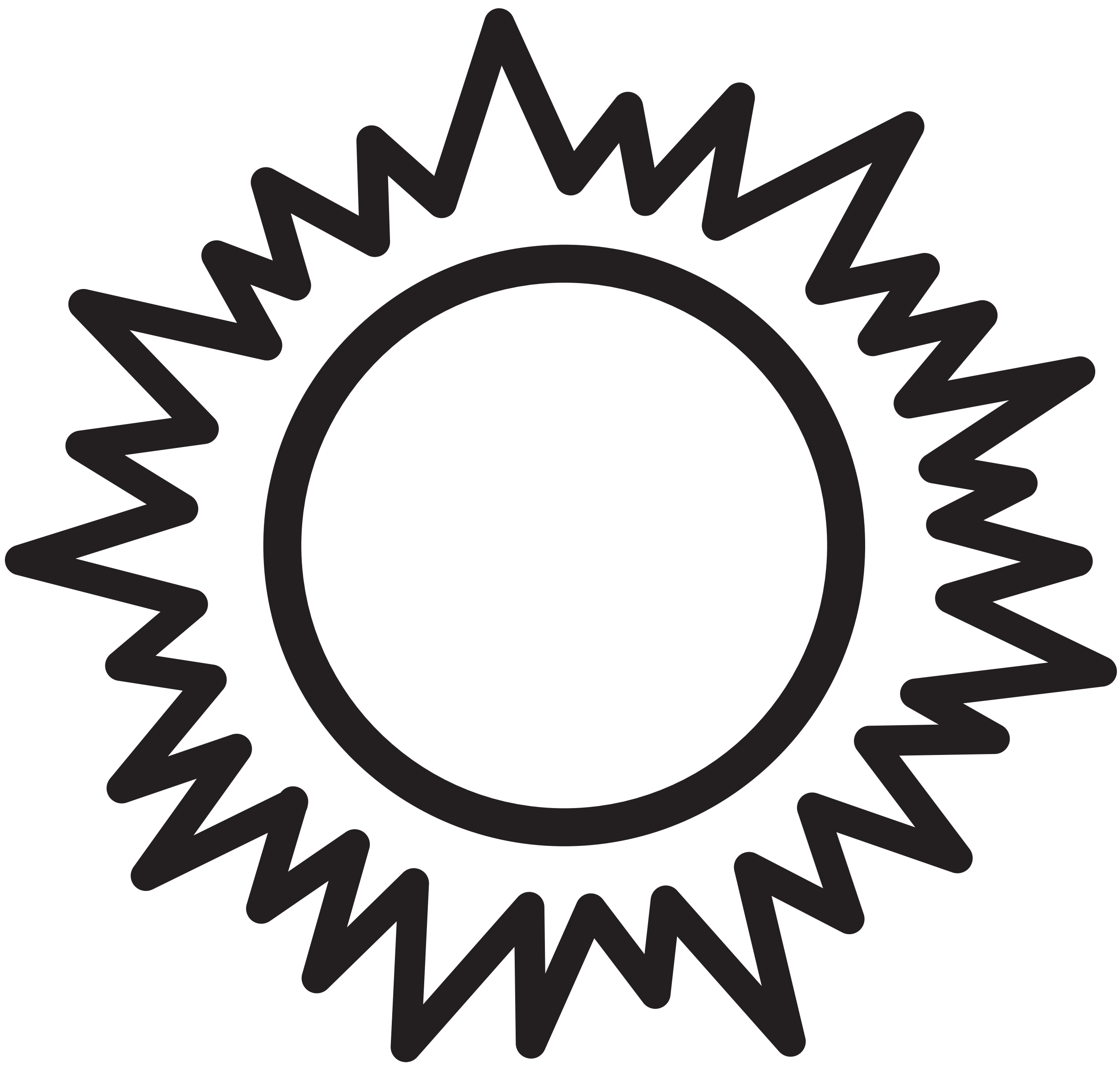
# Photosynthesis




water + carbon dioxide + light → oxygen + glucose (sugar)

$6H_2O$ + $6CO_2$ + light → $6O_2$ + $C_6H_{12}O_6$

# Solar Cut Out



# Solar Oven Activity

## Question

How can solar energy be used to cook food?

## Materials

- Solar oven
- Oven thermometer
- Dish on which to cook food
- Food to cook

## Procedure

1. On a very sunny day, take the solar oven outside and put it in a sunny place.
2. Place the food and thermometer in the oven.
3. Observe how long it takes to cook the food and how warm the oven becomes.

## Observations

Draw a diagram of the solar oven. Use arrows to show how solar energy cooks the food.

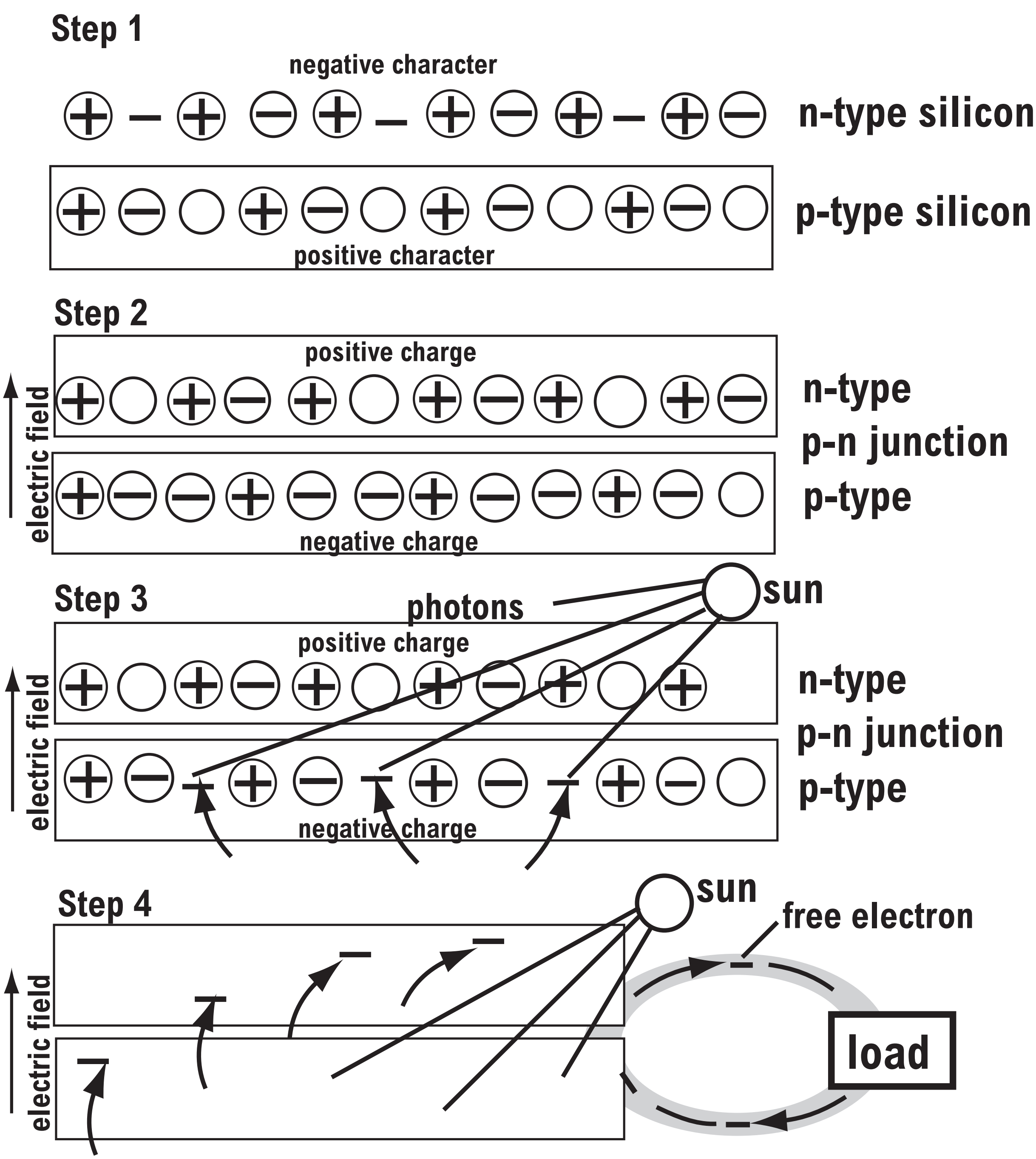
Record your observations below. How long did it take to cook the food? How did the food change in appearance or smell as it was cooking?

## Conclusion

Describe when a solar oven would be useful.

# Photovoltaic Cell

| | |
|---|---|
| ○ | A location that can accept an electron |
| − | Free electron |
| ⊕ | Proton |
| ⊖ | Tightly-held electron |



# Solar House

## Question

How can solar energy be used in your house?

## Materials

- Cardboard box
- Scissors
- Clear transparency film or plastic wrap
- Black construction paper
- 2 Sheets of white paper
- Clay
- Tape
- Solar house kit
- Ruler

## Procedure

1. Using the scissors, cut large windows and a door on one side of the box.
2. Tape clear transparency film over the windows if you have it. Use plastic wrap as a substitute.
3. Make a round water storage tank from black construction paper. Attach it to the side of the house with tape.
4. Make two holes 1 cm in diameter in the top of the box.
5. Push the shaft of the motor through one of the holes.
6. From the inside of the house, attach the fan blades to the motor. Make sure there is enough room above the blades for the fan to turn without bumping the ceiling. Use a strip of tape to hold the motor in place.
7. Push the LED through the other hole and tape it in place.
8. Attach the PV cells to the fan and LED.
9. Lay the PV cell with tubing on top of the house with the tubing extending down to the black water storage tank. Tape in place or use clay to hold it in place.
10. Carefully carry the house model into the sun. Observe the speed of the fan and the brightness of the LED. Tilt the PV cells so they are directly facing the sun. How does this affect the speed of the fan? Use a piece of clay under the PV cells to leave them in this position.
11. Simulate a bright, overcast day by placing a single sheet of white paper over the PV cells. Observe the speed of the fan and the brightness of the LED.
12. Simulate a very cloudy day by placing two sheets of white paper over the PV cells. Record your observations of the fan speed and LED brightness.
13. Simulate nighttime by placing a piece of cardboard over the PV cells. Record your observations of the fan speed and LED brightness.

# SOLAR ENERGY BINGO

A. Has used a solar clothes dryer

B. Knows the average conversion efficiency of PV cells

C. Knows the nuclear process in the sun's core

D. Knows how radiant energy travels through space

E. Can explain how solar energy drives the water cycle

F. Has used a photovoltaic cell

G. Rides in a solar collector

H. Can explain how solar energy produces wind

I. Knows how plants convert solar energy into chemical energy

J. Uses passive solar energy at home

K. Has seen a solar water heater

L. Has cooked food in a solar oven

M. Can name two advantages of solar energy

N. Knows the energy conversion that a PV cell performs

O. Can explain why dark clothes make you hotter in the sun

P. Owns solar protection equipment

| | | | |
|---|---|---|---|
| A<br>NAME | B<br>NAME | C<br>NAME | D<br>NAME |
| E<br>NAME | F<br>NAME | G<br>NAME | H<br>NAME |
| I<br>NAME | J<br>NAME | K<br>NAME | L<br>NAME |
| M<br>NAME | N<br>NAME | O<br>NAME | P<br>NAME |

# Solar Energy

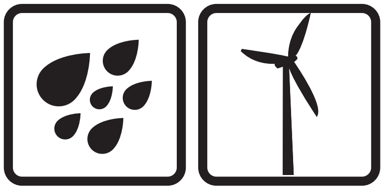
**Fill in the blanks using the words from the box below. Each word will be used only once.**

1. Solar comes from the root word ________________, which means sun.
2. The word __________________ means light.
3. ________________ is a measure of electricity.
4. ___________________________ is energy that travels in rays.
5. Plants _____________________, or take in, radiant energy.
6. White and shiny objects _____________________ radiant energy.
7. A ___________________________ takes in solar energy and turns it into heat.
8. Solar energy is called a ___________________ energy source, because it will always be there.
9. A ________________________ cell turns light into electricity.
10. Plants take in solar energy and store it in their leaves and roots as ____________________.

| | | | | | |
|---|---|---|---|---|---|
| reflect | absorb | chemical energy | photo | volt | sol |
| renewable | photovoltaic | solar collector | radiant energy | | |

**Pick one of the following to complete on the back of this sheet or on a separate sheet of paper:**

1. Find 10 other bold words from the text and write fill-in statements for a partner to solve.
2. Write a paragraph explaining how the sun affects your everyday life.



# Water and Wind

**Fill in the blanks using the words from the box below. Each word will be used only once.**

1. Water in gas form is called ____________________________.
2. Rain and snow are called ____________________________.
3. The air around the Earth is the ____________________________.
4. When water turns into a gas, it ____________________________.
5. Near the shore, the air over __________________ heats up faster than air over the water.
6. A ___________________ is a machine that captures the energy in moving air.
7. Warm air ____________________ into the atmosphere.
8. Moving air is called _____________________.
9. _________________ moves water from high to low ground.
10. Wind turbines and hydropower dams turn the energy in moving air and moving water into ___________________________.

| | | | | |
|---|---|---|---|---|
| evaporates | rises | water vapor | precipitation | gravity |
| wind turbine | electricity | land | atmosphere | wind |

**On the back of this sheet or on a separate sheet of paper:**

Illustrate how the sun affects the water or wind on Earth. Include labels and a caption with your diagram.

# Assessment Prompts

**These can be used after individual activities or at the end of the unit. You can assign specific questions or give students a choice of questions.**

1. Pretend you are a drop of water. Tell your story as you travel through at least four steps of the water cycle.
2. Draw and label the water cycle.
3. Which is more important, heat or light? Explain your thinking.
4. Explain at least five ways the sun is important.
5. Explain the role the sun plays in food webs, the water cycle, and the creation of wind.
6. Describe in words or pictures how plants use solar energy.
7. Illustrate and explain a food chain with at least four steps leading back to the sun.
8. Name at least two sources of renewable energy and explain how the sun powers them.
9. Name at least one source of nonrenewable energy that traces back to the sun. Illustrate and explain how it can be traced back to the sun.
10. Give a real life example that illustrates how different colors absorb radiation and produce heat differently.
11. Imagine you were building a perfect solar oven. Draw a diagram of it, explaining your choices.
12. Explain an everyday use of UV beads.

# Solar Energy Assessment

**Circle the letter of the best answer.**

1. The process of photosynthesis is
    a. where you take pictures of plants for school.
    b. how plants use sunlight to make their own food.
    c. how carnivores stalk their prey.
    d. what happens after precipitation.

2. Which puts the steps of the water cycle in the correct order?
    a. Evaporation, precipitation, condensation, evaporation
    b. Precipitation, condensation, ground water, condensation
    c. Ground water, evaporation, condensation, precipitation
    d. Precipitation, evaporation, precipitation, condensation

3. One way that wind is formed is
    a. during the day, the land heats faster than the water, the hot air rises, and cold air moves in to take its place.
    b. during the day, the water heats faster than the land, the hot air rises, and cold air moves in to take its place.
    c. trees moving during photosynthesis.
    d. through the water cycle.

4. A photovoltaic cell takes sunlight (radiant energy) and changes it into
    a. electricity. b. photographs. c. water. d. food.

5. Which child is using what she knows about solar energy to dress correctly?
    a. A child who wears a white coat in the winter and a black shirt in the summer.
    b. A child who wears a white coat in the winter and a white shirt in the summer.
    c. A child who wears a black coat in the winter and a white shirt in the summer.
    d. A child who wears a black coat in the winter and a black shirt in the summer.

6. What happens to the sun's energy?
    a. All of the sun's energy comes to Earth.
    b. Only a small part of the sun's energy comes to Earth.
    c. During the night the sun's energy doesn't come to Earth.
    d. None of the sun's energy comes to Earth.

7. Which list has energy sources that got their energy from the sun?
    a. Turbine, solar, wind
    b. Solar, precipitation, coal
    c. Wind, hydropower, condensation
    d. Natural gas, hydropower, wind

8. Which is an example of a solar collector and its effects?
    a. A hot pot of coffee steaming.
    b. A candy bar melting in your car on a hot day.
    c. Someone drilling for oil.
    d. Water vapor condensing to form clouds.

9. What causes day and night on Earth?
    a. The Earth's revolution around the sun.
    b. The Earth's revolution around the moon.
    c. The location of the moon.
    d. The rotation of the Earth on its axis.

10. Which correctly describes the movement of molecules in a liquid?
    a. They are tightly packed together and can't move out of their places.
    b. They are very loose, and can completely fill the container they are put in.
    c. They can move somewhat, and can take the shape of their container, but don't always fill it.
    d. There are no molecules in liquids.

# Games, Puzzles, and Activities

Looking for some fun energy activities? There are plenty of fun games, puzzles, and activities available at www.NEED.org/games.

# Wonders of the Sun Evaluation Form

**State:** ____________ **Grade Level:** ____________ **Number of Students:** ___________

| | | |
|---|---|---|
| 1. Did you conduct the entire unit? | ❑ Yes | ❑ No |
| 2. Were the instructions clear and easy to follow? | ❑ Yes | ❑ No |
| 3. Did the unit meet your academic objectives? | ❑ Yes | ❑ No |
| 4. Was the unit age appropriate? | ❑ Yes | ❑ No |
| 5. Were the allotted times sufficient to conduct the unit? | ❑ Yes | ❑ No |
| 6. Was the unit easy to use? | ❑ Yes | ❑ No |
| 7. Was the preparation required acceptable for the unit? | ❑ Yes | ❑ No |
| 8. Were the students interested and motivated? | ❑ Yes | ❑ No |
| 9. Was the energy knowledge content age appropriate? | ❑ Yes | ❑ No |
| 10. Would you use the unit again? | ❑ Yes | ❑ No |

| | | | | |
|---|---|---|---|---|
| How would you rate the unit overall? | ❑ excellent | ❑ good | ❑ fair | ❑ poor |
| How would your students rate the unit overall? | ❑ excellent | ❑ good | ❑ fair | ❑ poor |

**What would make the unit more useful to you?**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

**Other Comments:**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

**Please fax or mail to:** **The NEED Project**
8408 Kao Circle
Manassas, VA 20110
FAX: 1-800-847-1820

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