U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

ENERGY EDUCATION AND WORKFORCE DEVELOPMENT

Energy From the Sun

Teacher Guide

(Seven Activities)

Grades: K-4

Topic: Solar

Owner: NEED

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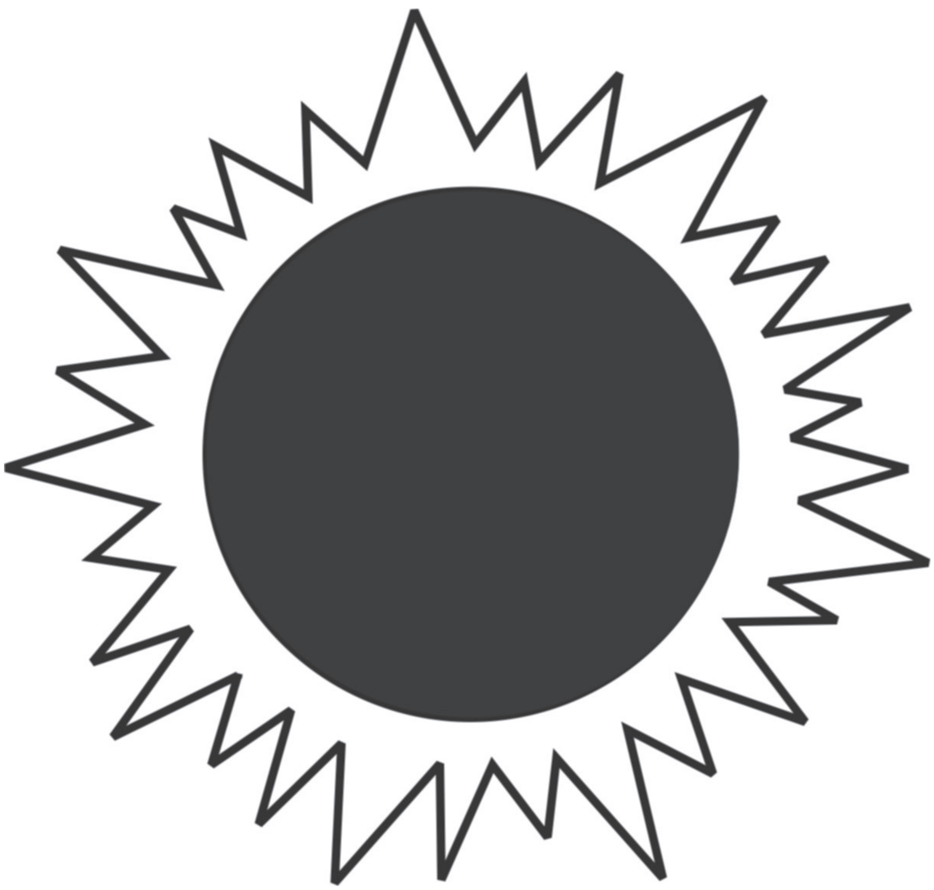
ENERGY FROM THE SUN

Teacher Guide

Hands-on explorations that introduce scientific concepts of solar energy to elementary students.

GRADE LEVEL
Elementary

SUBJECT AREAS
Science
Social Studies
Math
Language Arts



NEED
2006-2007
Putting Energy into Education

NEED Project PO Box 10101 Manassas, VA 20108 1-800-875-5029 www.NEED.org

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.

Teacher Advisory Board Vision Statement

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

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MATERIALS NEEDED

Shallow Pan with Water
Red, White, & Black Construction Paper
White Copy Paper
Tape
Scissors
Food to Cook in Solar Oven
Plastic Wrap
Cardboard Boxes (12” x 12” x 12”)

MATERIALS IN SOLAR KIT

Class Set of Student Guides
12 Student F/C Thermometers
4 Radiometers
2 Solar Balloons with String
2 Solar Ovens
4 Solar House Kits
4 Transparency Film
Clay
40-pack of NaturePrint® Paper

COST OF KIT: $350.00

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Putting Energy into Education

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Correlations to National Science Standards

UNIFYING CONCEPTS AND PROCESSES

1. Systems, Order, and Organization

a. The goal of this standard is to think and analyze in terms of systems, which will help students keep track of mass, energy, objects, organisms, and events referred to in the content standards.

b. Science assumes that the behavior of the universe is not capricious, that nature is the same everywhere, and that it is understandable and predictable. Students can develop an understanding of order–or regularities–in systems, and by extension, the universe; then they can develop understanding of basic laws, theories, and models that explain the world.

c. Prediction is the use of knowledge to identify and explain observations, or changes, in advance. The use of mathematics, especially probability, allows for greater or lesser certainty of prediction.

d. Order—the behavior of units of matter, objects, organisms, or events in the universe—can be described statistically.

e. Probability is the relative certainty (or uncertainty) that individuals can assign to selected events happening (or not happening) in a specified time or space.

f. Types and levels of organization provide useful ways of thinking about the world.

2. Evidence, Models, and Explanation

a. Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems.

b. Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have an explanatory power. Models help scientists and engineers understand how things work.

c. Scientific explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements. As students develop and as they understand more scientific concepts and processes, their explanations should become more sophisticated.

3. Change, Constancy, and Measurement

a. Although most things are in the process of change, some properties of objects and processes are characterized by constancy; for example, the speed of light, the charge of an electron, and the total mass plus energy of the universe.

b. Energy can be transferred and matter can be changed. Nevertheless, when measured, the sum of energy and matter in systems, and by extension in the universe, remains the same.

c. Changes can occur in the properties of materials, position of objects, motion, and form and function of systems. Interactions within and among systems result in change. Changes in systems can be quantified and measured. Mathematics is essential for accurately measuring change.

d. Different systems of measurement are used for different purposes. An important part of measurement is knowing when to use which system.

PRIMARY STANDARD A: SCIENCE AS INQUIRY

1. Abilities Necessary to do Scientific Inquiry

a. Ask a question about objects, organisms, and events in the environment.

b. Plan and conduct a simple investigation.

c. Employ simple equipment and tools to gather data and extend the senses.

d. Use data to construct a reasonable explanation.

e. Communicate investigations and explanations.

2. Understandings about Scientific Inquiry

c. Simple instruments such as magnifiers, thermometers, and rulers provide more information than using only senses.

PRIMARY STANDARD B: PHYSICAL SCIENCE

1. Properties of Objects and Materials

a. **Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools such as rulers, balances, and thermometers.**

b. Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

3. Light, Heat, Electricity, and Magnetism

a. **Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.**

b. Heat can be produced in many ways, such as burning, rubbing, or mixing one substance with another. Heat can move from one object to another by conduction.

PRIMARY STANDARD D: EARTH AND SPACE SCIENCE

2. Objects in the Sky

a. **The sun provides the light and heat necessary to maintain the temperature of the earth.**

PRIMARY STANDARD E: SCIENCE AND TECHNOLOGY

2. Understandings about Science and Technology

a. People have always had questions about their world. Science is one way of answering questions and explaining the natural world.

b. People have always had problems and invented tools and techniques to solve problems. Trying to determine the effects of solutions helps people avoid some new problems.

e. **Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.**

INTERMEDIATE STANDARD–B: PHYSICAL SCIENCE

3. Transfer of Energy

a. Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical.

b. Energy is transferred in many ways.

c. Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.

d. **Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).**

e. Electrical circuits provide a means of transferring electrical energy.

g. **The sun is the major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths.**

Teacher Guide

HANDS-ON EXPLORATIONS INTRODUCE ELEMENTARY STUDENTS TO THE BASIC CONCEPTS OF SOLAR ENERGY.

BACKGROUND

Students use a backgrounder and hands-on explorations to develop a basic understanding of solar energy.

CONCEPTS

- Nuclear reactions within the sun produce enormous amounts of energy, some in the form of radiant energy that travels through space to the earth.
- Most of the energy on Earth came 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.
- 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.

TIME

Eight 30 minute class periods.

PROCEDURE

Step One—Preparation

- Familiarize yourself with the Teacher and Student Guides, and with the materials in the kit.
- Make transparencies of the masters you want to use on pages 12-19. The kit includes transparencies.
- Collect the materials that are not included in the kit. See the Materials List on page 3 for materials that are not in the kit.
- Review the Lab Safety Rules on page 22.

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 up', 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 the following ways:

Energy is light—energy produces light—the movement of energy in transverse waves or rays—radiant energy.

Energy is heat—energy produces heat—the movement of atoms and molecules within substances—thermal energy.

Energy is sound—energy produces sound—the back-and-forth vibration of substances in longitudinal waves.

Energy is motion—energy produces motion—kinetic energy.

Energy is growth—energy is required for cells to reproduce—chemical energy stored in the bonds of nutrients.

Energy is electricity to run technology—the movement of electrons from atom to atom.

Forms of Energy: Energy is recognized in many forms, all of which are potential or kinetic:

Thermal Energy (Heat)

Mechanical Energy (Motion)

Chemical Energy (Energy in Wood, Fossil Fuels)

Electrical Energy (Electricity, Lightning)

Nuclear Energy (Fission, Fusion)

Radiant Energy (Light, X-rays)

Sound (Motion)

TEACHER INFORMATION: 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 two hydrogen atoms to fuse, producing one helium atom 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.

ACTIVITY 1: INTRODUCTION TO SOLAR ENERGY (60 MINUTES OVER TWO DAYS)

Objective: To learn about solar energy by reading and completing worksheets.

- Introduce solar energy as the topic of exploration and make a list of the things the students know about solar energy. Write their ideas on the board.
- Distribute the **Student Guides** to the students and have them write their names on the cover.
- Have the students read the backgrounder (pp. 3-10 in the **Student Guide**) or read the backgrounder with/to them, depending upon grade level. Use the transparencies to help explain the greenhouse effect, the water cycle, how wind is made, photosynthesis, and fossil fuel formation, as you choose. The graphics in the **Student Guide** are designed so that younger students can color them.
- Have the students complete the **Solar Energy** and **Wind & Water** worksheets (pp. 11-12 in the **Student Guide**) to reinforce new concepts and vocabulary.

ACTIVITY 2: SOLAR ENERGY TO HEAT AND MOTION (30 MINUTES)

MATERIALS IN KIT: ***12 thermometers and four radiometers***

MATERIALS NEEDED: ***White and black construction paper cut in 2”x2” squares***

Objectives: **To learn how to read a thermometer with Fahrenheit and Celsius scales.**

To learn that radiant energy can be reflected and absorbed by objects. When it is absorbed by objects, some radiant energy is converted into heat.

- **Go to PAGE 13 of the Student Guide**. Use the Thermometer Transparency 6 to explain how to read a thermometer with Fahrenheit and Celsius scales. Have the students fill in the tube of the thermometers on the worksheet to the level of the Fahrenheit reading, then write the corresponding Celsius reading in the circle of each thermometer. Review with the students.
- **Go to PAGE 14 of the Student Guide**. Set up four centers in sunny areas, each with three thermometers and pieces of black and white construction paper.
- Explain the procedure and have the students complete the exploration. Review the worksheet with the students to make sure they understand that:

  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.
- **Go to PAGE 15 of the Student Guide**. Have one radiometer at each center.
- Explain the procedure, emphasizing that the radiometer is made of glass and can break very easily. Have the students complete the exploration.
- Review the worksheet, using the Radiometer Transparency 7, to make sure the students understand that:

  the black vanes absorb more energy than the white vanes.

  the radiometer is a partial vacuum with few air molecules.

  the air molecules in the radiometer move around and bounce off the black vanes with more force because the black vanes have more energy.

  the force of the air molecules bouncing off the black vanes pushes the black vanes and makes the radiometer spin in a clockwise direction.

ACTIVITY 3: SOLAR ENERGY CAN CAUSE CHEMICAL REACTIONS (30 MINUTES)

MATERIALS IN KIT: ***One piece of NaturePrint® paper for each student***

MATERIALS NEEDED: ***White paper, red construction paper, shallow pan of water, scissors for each student***

Objective: **To learn that solar energy can cause chemical changes when it is absorbed by objects.**

- **Go to PAGE 16 of the Student Guide**.
- Explain the procedure and have the students complete the exploration. Review the worksheet with the students to make sure they understand that:

  solar energy can cause a chemical reaction when it is absorbed by objects.

  chemical reactions can produce a change in color.

ACTIVITY 4: SOLAR ENERGY TO HEAT AND MOTION (30 MINUTES)

MATERIALS IN KIT: Two solar balloons with string

Objectives: **To learn that air expands when it gets hotter—the molecules gain energy and bounce against each other with more force, pushing away from each other.**

To learn that warm air rises because it is less dense—there are fewer molecules per given volume than the surrounding air.

- **Go to PAGE 17 of the Student Guide.** Explain the procedure to the students, go outside and have fun! 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.
- Review the activity with the students, correlating it with the way wind is produced, to make sure they understand that:

  black objects tend to absorb solar energy.

  when solar energy is absorbed, some of it turns into heat.

  warm air is less dense and rises.

ACTIVITY 5: COOKING WITH SOLAR ENERGY (30 MINUTES)

MATERIALS IN KIT: Two solar ovens

MATERIALS NEEDED: Food to cook in solar oven–chocolate chip cookies are good

Objectives: **To learn that shiny materials reflect solar energy.**

To learn to cook with a solar oven.

- **Go to PAGE 18 of the Student Guide**. Explain the procedure to the students, go outside and cook a snack! The ovens will work even in really cold weather if you cover the ovens with clear plastic wrap.
- Review the activity with the students to make sure they understand that:

  the shiny sides of the oven reflect the solar energy onto the food.

  the food absorbs the solar energy and turns it into heat that cooks the food.

TEACHER INFORMATION: Photovoltaic {PV} Cells

Photovoltaic (PV) comes from the words *photo* meaning *light* and *volt*, a measurement of electricity. PV cells are made of two thin pieces of **silicon**, the substance that makes up sand and the second most common substance on earth. One piece of silicon has a small amount of boron added to it, which gives it a tendency to attract electrons. It is called the **p-layer** because it has a positive tendency. The other piece of silicon has a small amount of phosphorous added to it, giving it an excess of free electrons. This is called the **n-layer** because it has a tendency to give up electrons. When the two pieces of silicon are placed together, some electrons from the n-layer flow to the p-layer and an electric field forms between the layers. The p-layer now has a negative charge and the n-layer has a positive charge.

When the PV cell is placed in the sun, the radiant energy energizes the free electrons. If a circuit is made connecting the layers, electrons flow from the n-layer through the wire to the p-layer. The PV cell is producing electricity—the flow of electrons. If a load such as a lightbulb 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. *(See the diagram on the next page for a graphic explanation of how a PV cell works.)*

ACTIVITY 6: TURNING SOLAR ENERGY INTO ELECTRICITY (30 MINUTES)

MATERIALS IN KIT: ***Four Solar House kits, transparency film, clay***

MATERIALS NEEDED: ***Four cardboard boxes , black paper, tape, scissors***

Objectives: **To learn that photovoltaic (PV) cells turn solar energy into electricity.**
To learn that electricity can produce light and motion.

- **Go to PAGE 19 of the Student Guide**. Set up four centers, each with one Solar House Kit, a piece of transparency film, a small piece of clay, scissors, and tape. You can also have crayons and markers on hand if you would like the students to decorate the boxes to look like houses. Divide the class into four groups.
- Explain the procedure to the students, 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. For younger students, it is recommended that adult helpers at each center assist students with this activity.
- Review the activity with the students to make sure they understand that:

  a solar collector turns solar energy into heat.

  a PV cell changes solar energy into electricity.

  electricity can produce light and motion.

ACTIVITY 7: PV CELLS ON THE SCHOOL (30 MINUTES)

Objective: **To learn about the PV cells in use on the school.**

- Have the school energy/facility manager or administrator show the students the PV system on the school and explain how the system helps the school 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 **Monitoring & Mentoring** activity for more information.

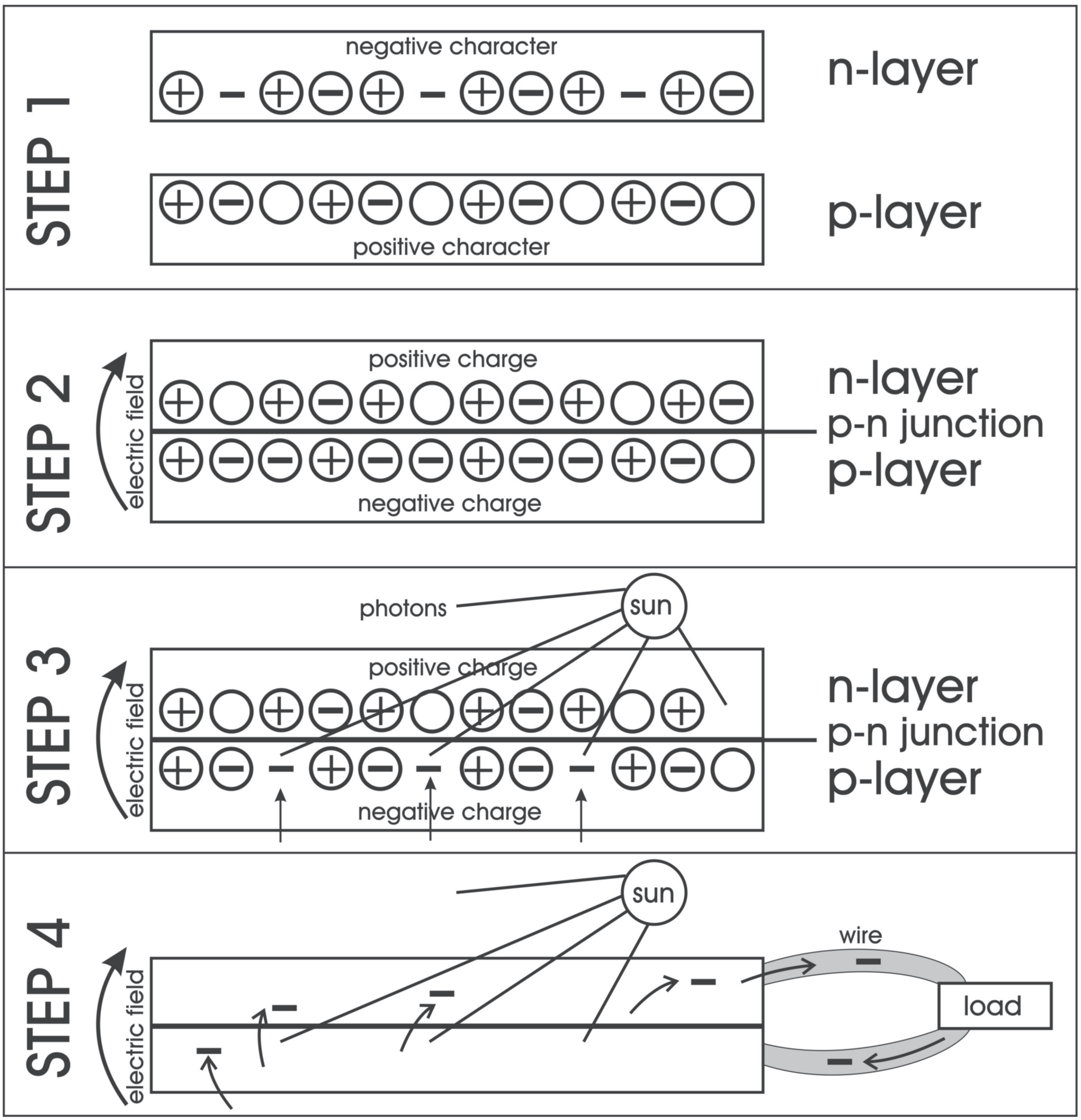
PHOTOVOLTAIC CELL

⊕ proton

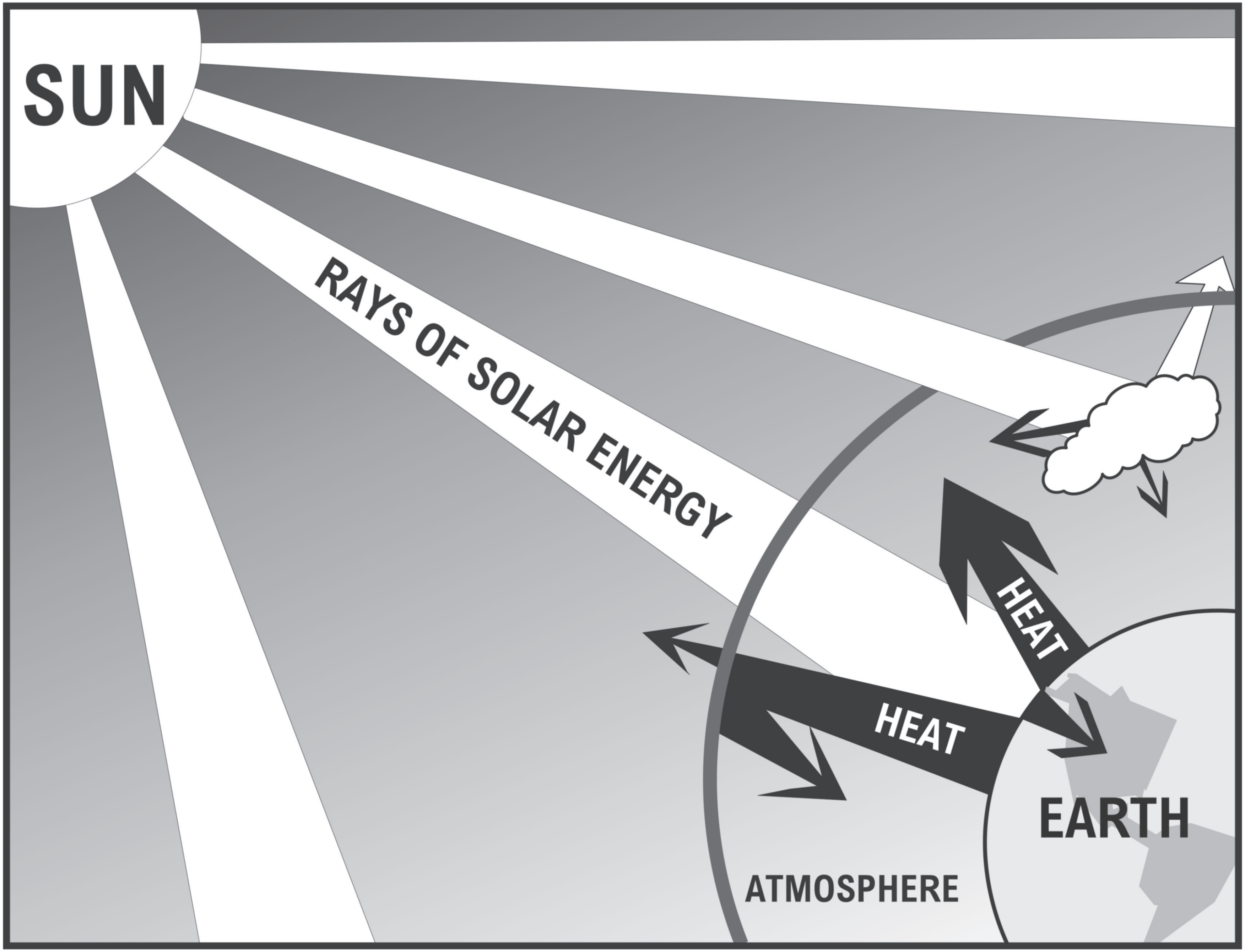
⊖ tightly-held electron

– free electron

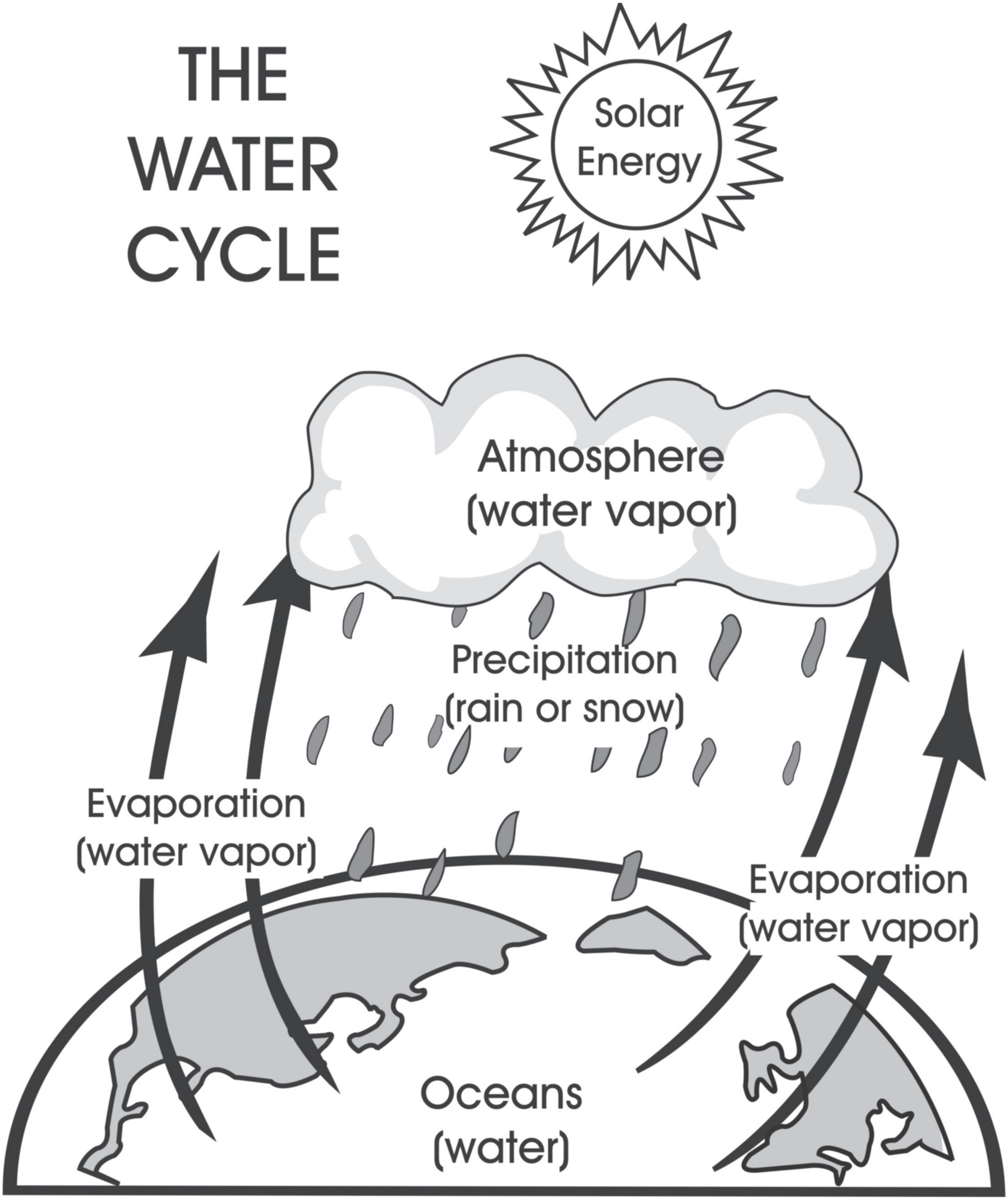
○ location that can accept an electron

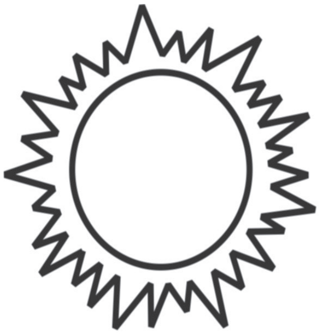


GREENHOUSE EFFECT



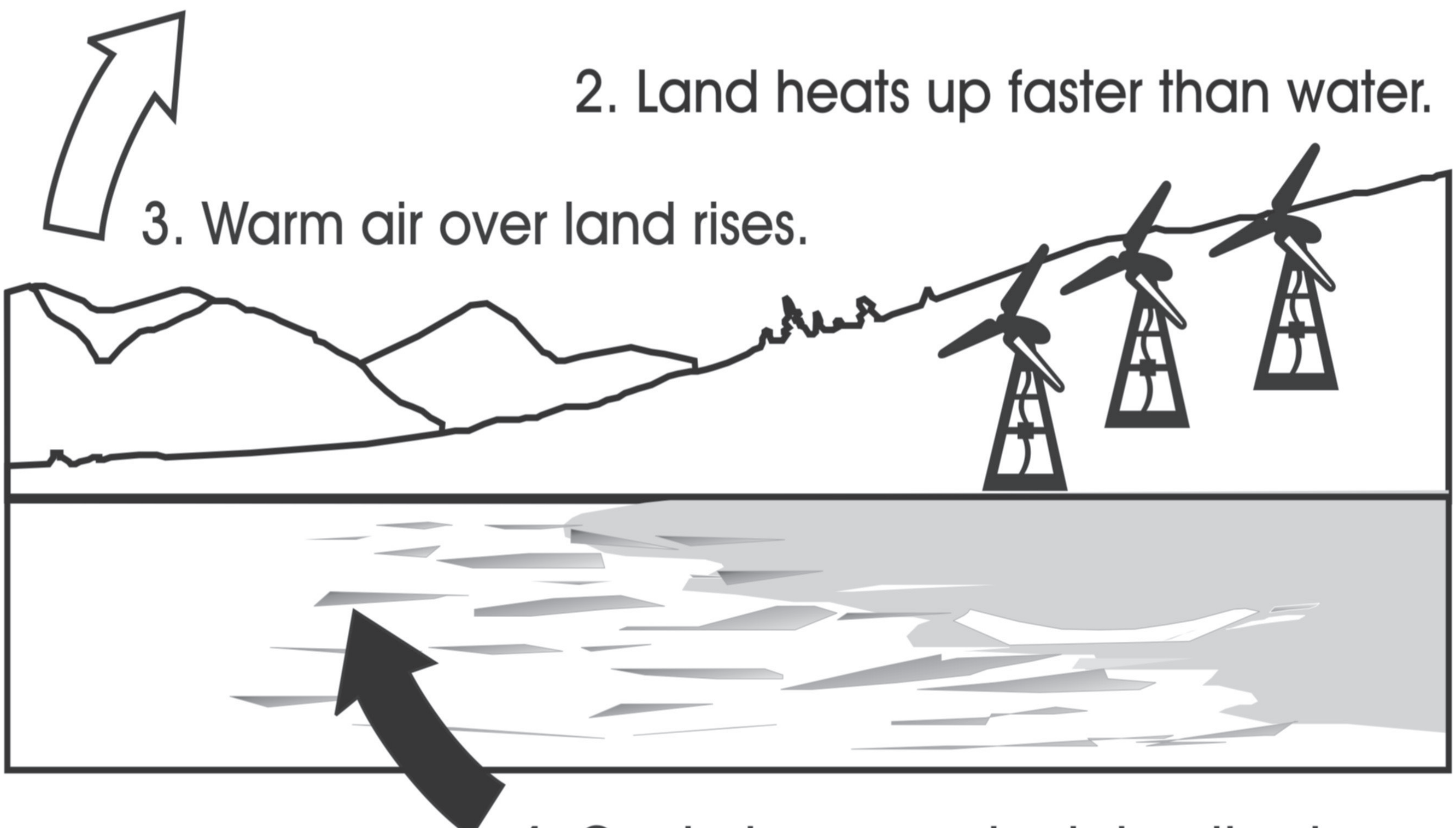
THE WATER CYCLE





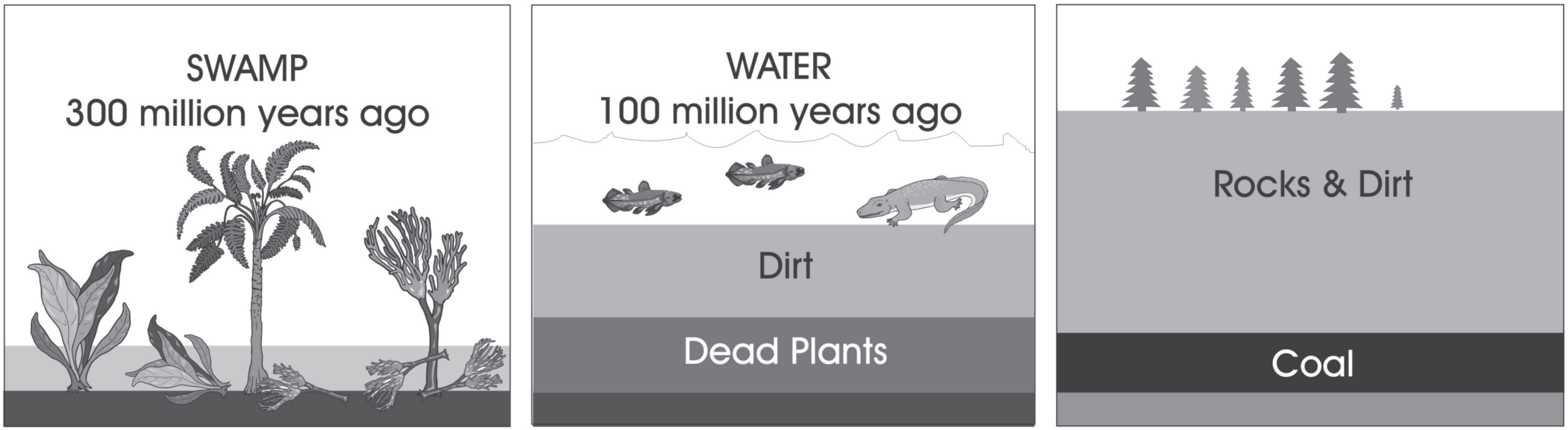
HOW WIND IS MADE

1. The sun shines on the Earth.



4. Cool air over water takes its place.

HOW COAL WAS FORMED

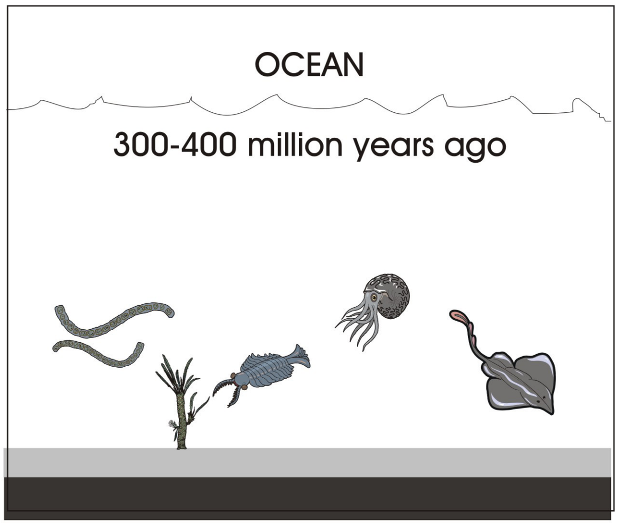


Before the dinosaurs, many giant plants died in swamps.

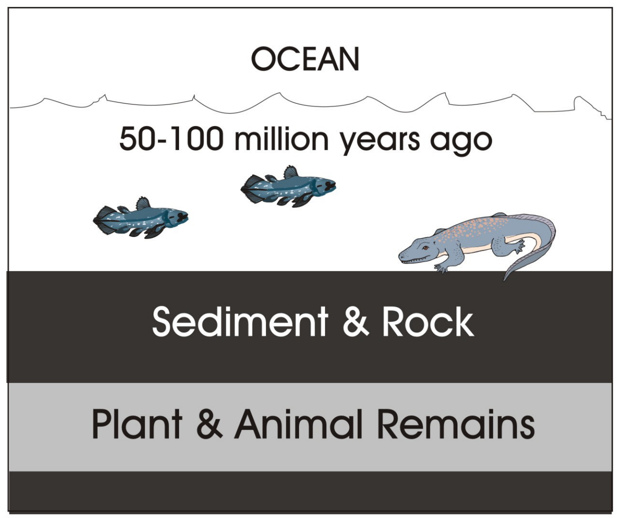
Over millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

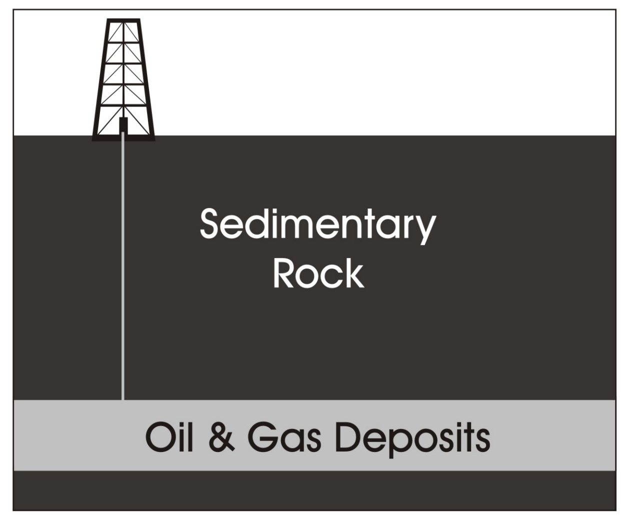
HOW OIL & NATURAL GAS WERE FORMED



Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

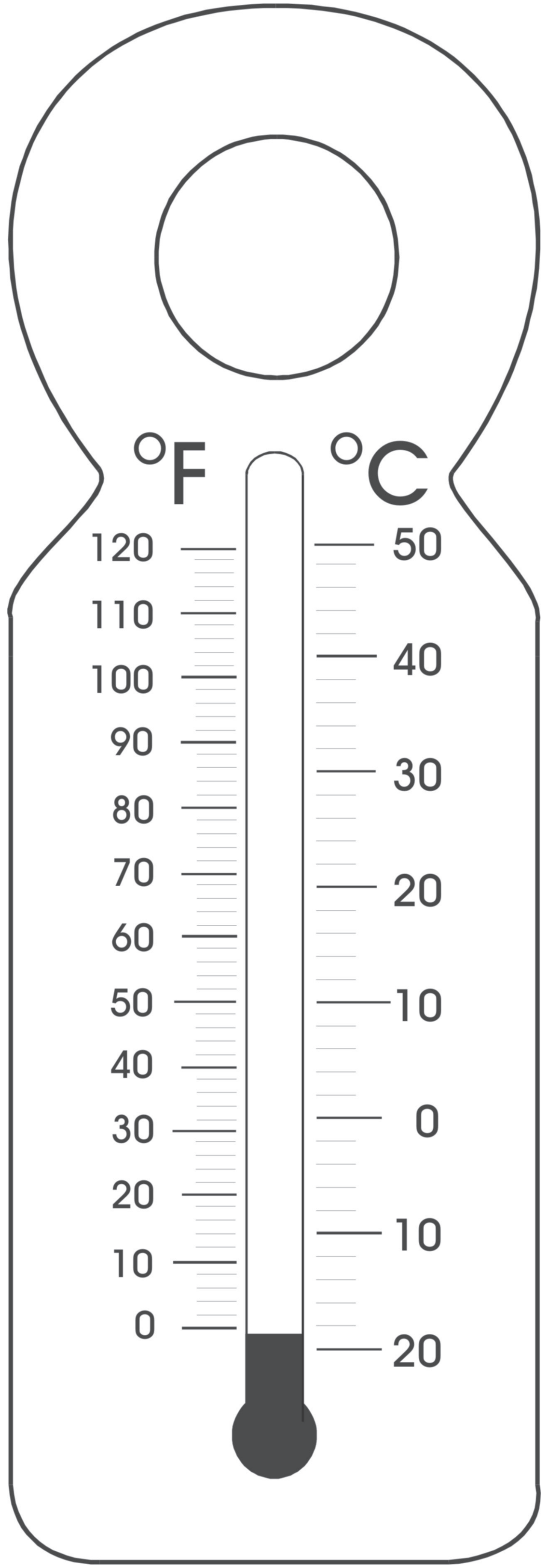


Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

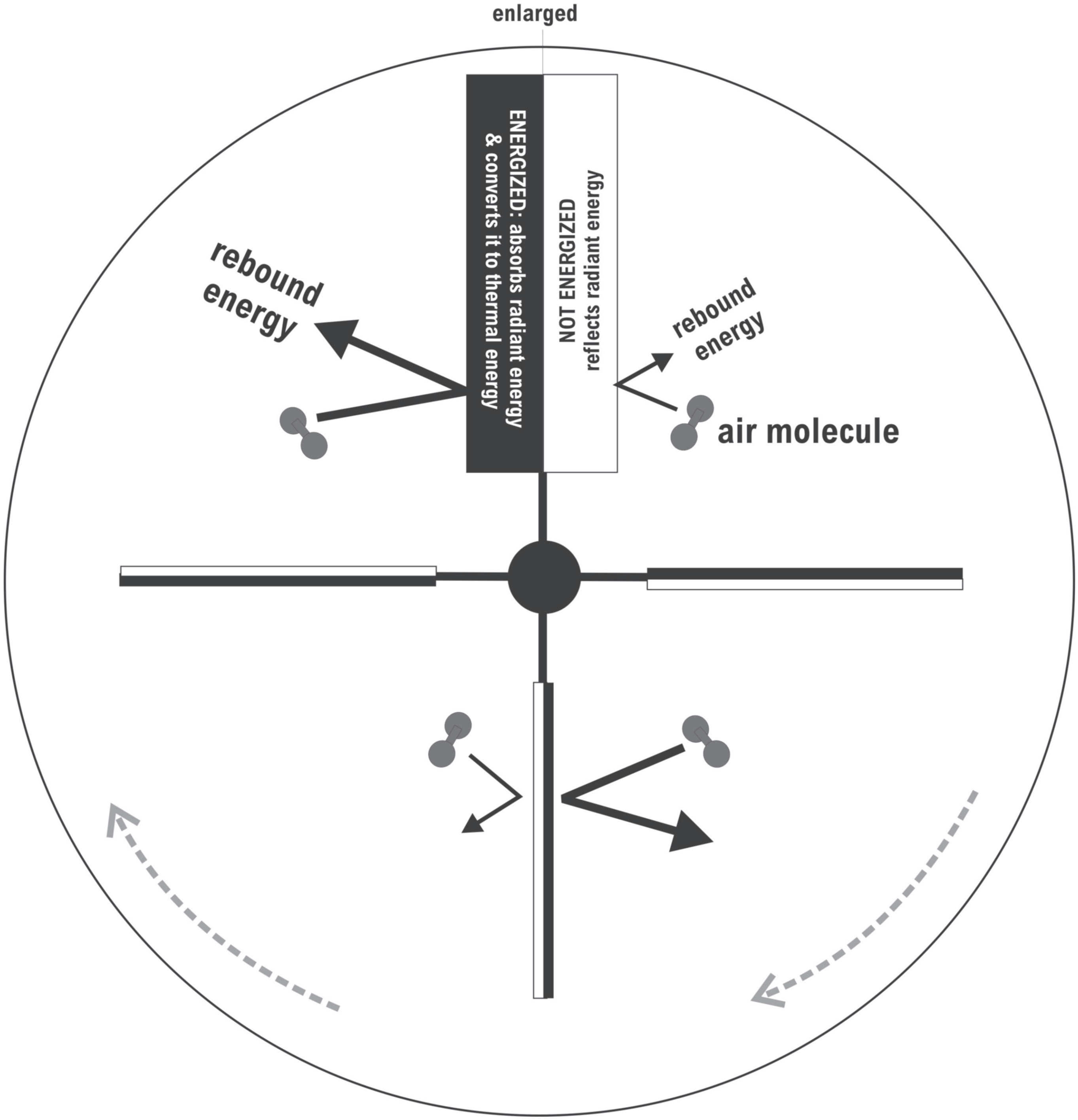


Today, we drill down through layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

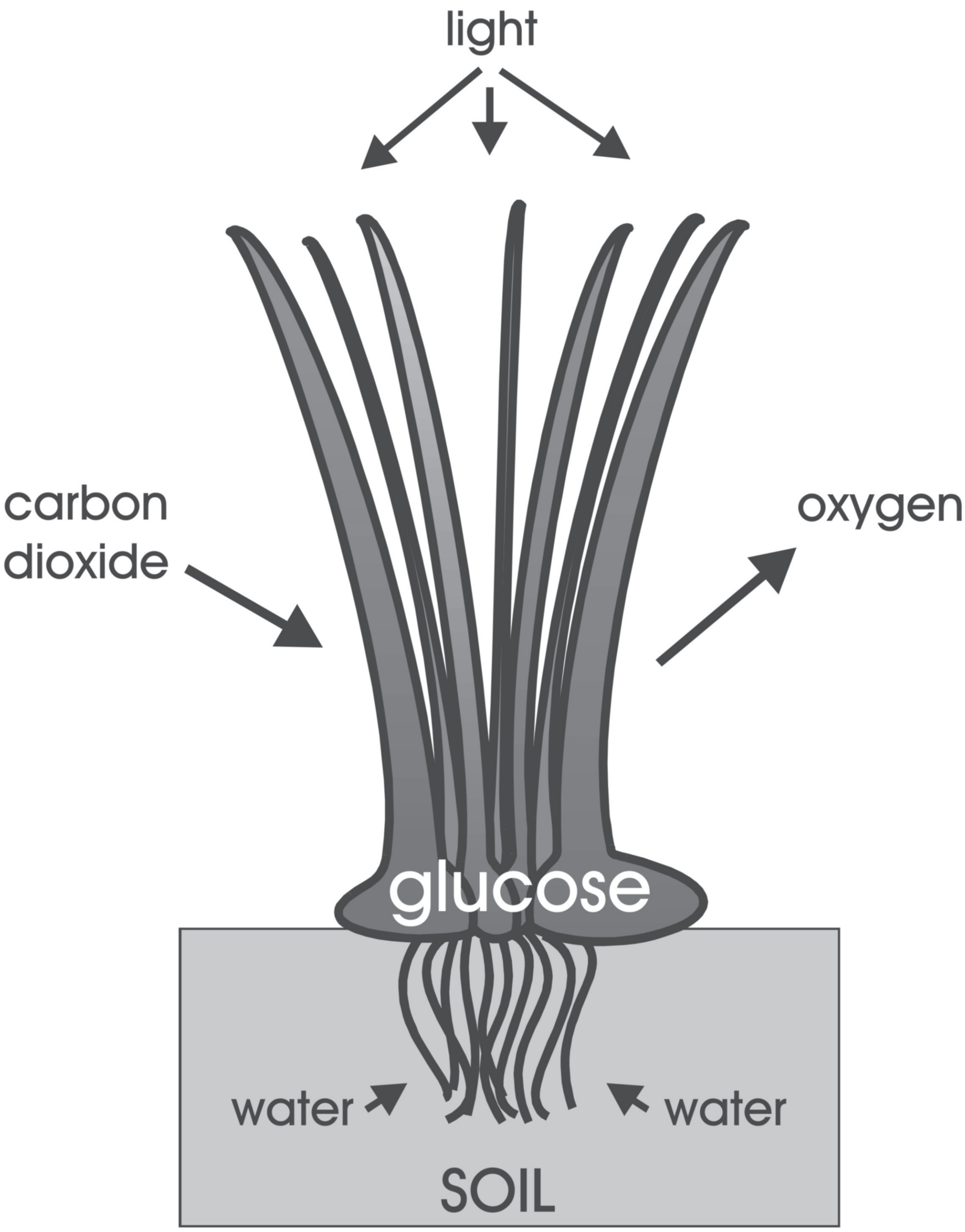
FAHRENHEIT AND CELSIUS THERMOMETER



TOP VIEW OF RADIOMETER

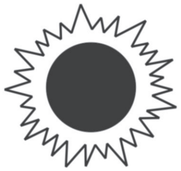


PHOTOSYNTHESIS

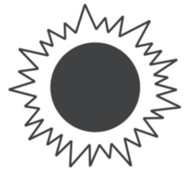


water + carbon dioxide + light → oxygen + glucose

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



SOLAR ENERGY



Fill in the blanks with the words in the box at the bottom of the page. Use each word 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 & WIND

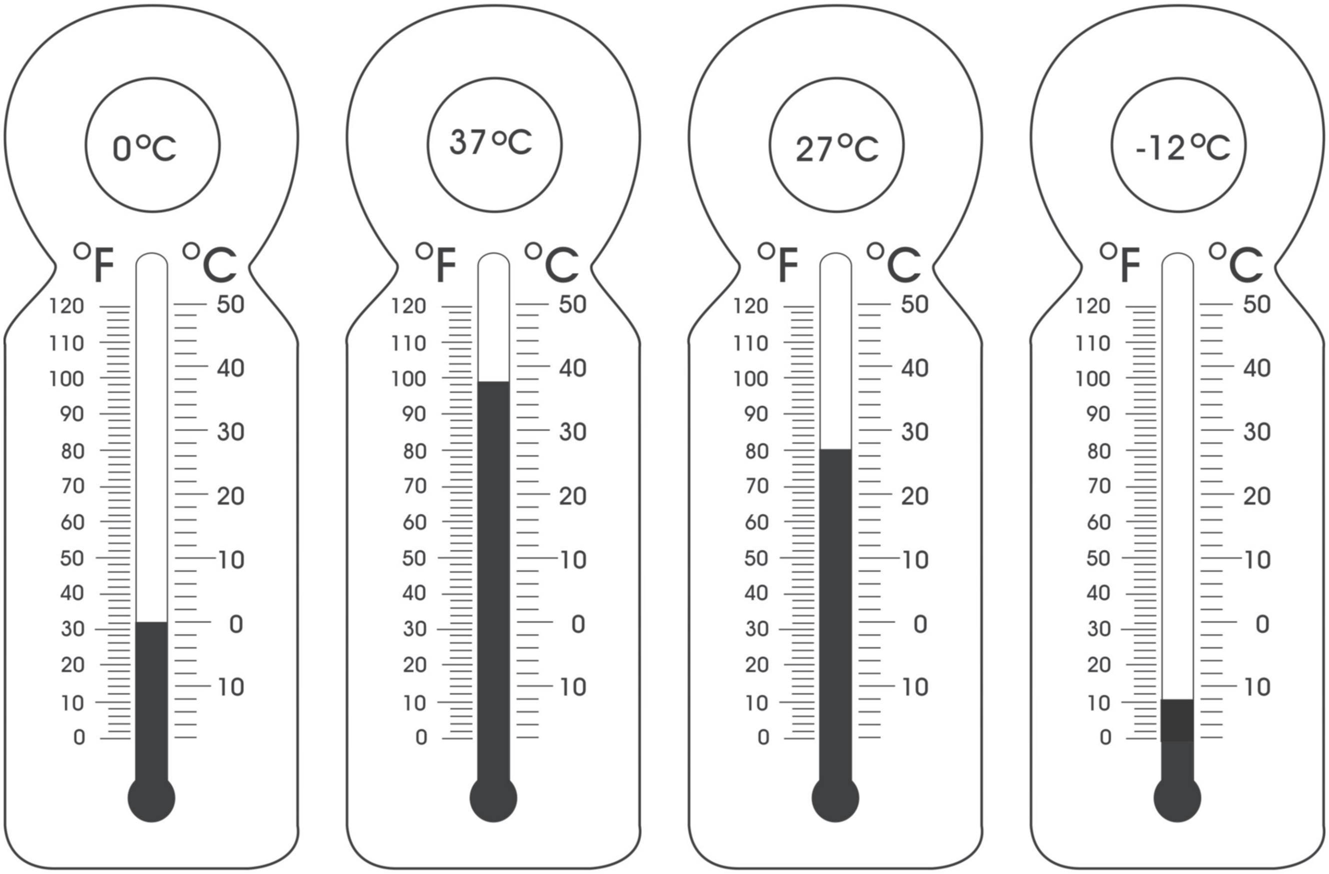
Fill in the blanks with the words in the box at the bottom of the page. Use each word only once.

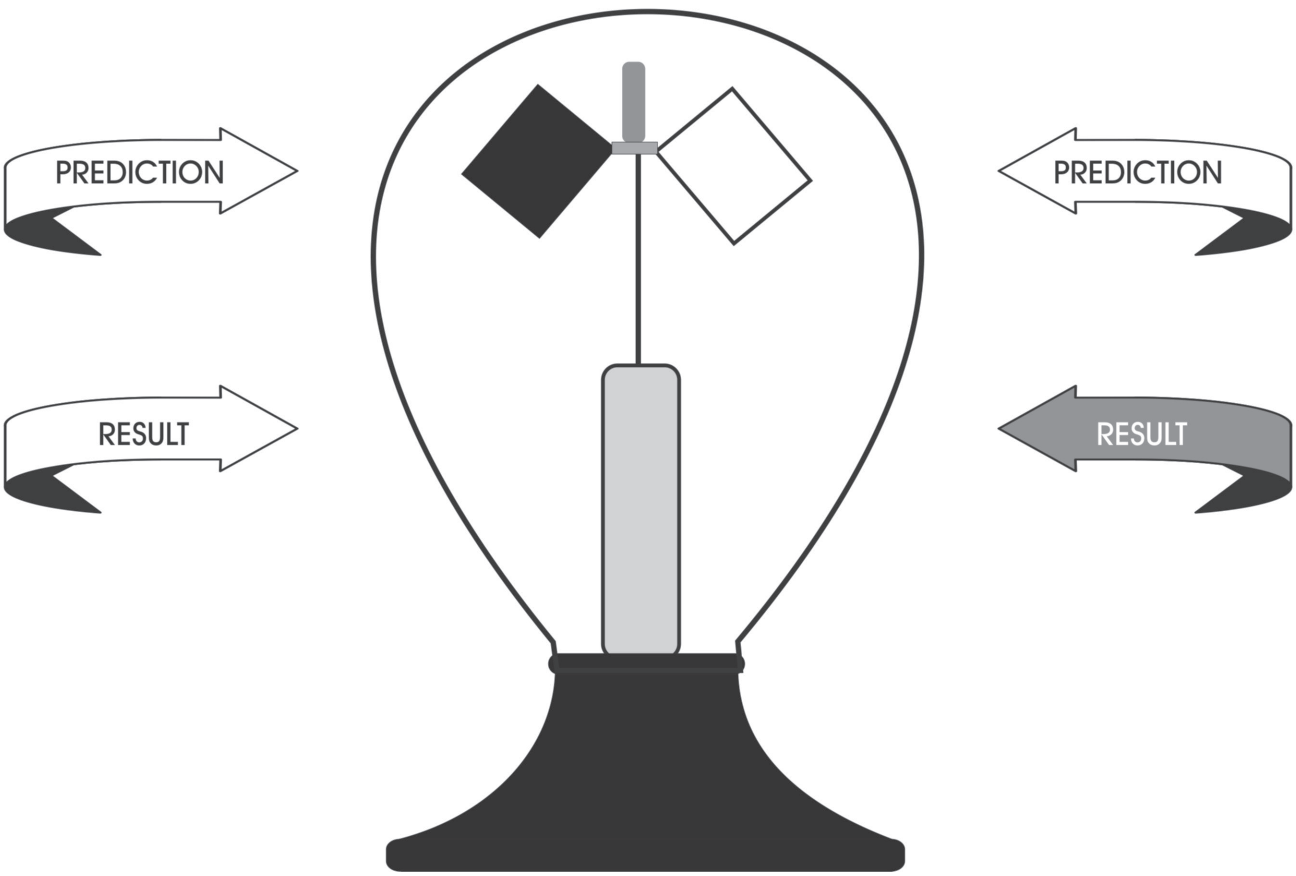
1. Water as a gas is called **water vapor**.
2. Rain and snow are called **precipitation**.
3. The air around the earth is the **atmosphere**.
4. When water turns into a gas, it **evaporates**.
5. The air over **land** heats up faster than air over water.
6. A **windmill** is a machine that captures 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. Windmills and dams turn the energy in moving air and moving water into **electricity**.

evaporates	rises	water vapor	precipitation	gravity
windmill	electricity	land	atmosphere	wind

Thermometer & Radiometer Answer Sheet

Freezing Water 32°F | Body Temperature 98-99°F | Warm Summer Day 80°F | Very Cold Winter Day 10°F





Lab Safety Rules

Eye Safety

Always wear safety glasses when performing experiments.

Fire Safety

Do not heat any substance or piece of equipment unless specifically instructed to do so.

Be careful of loose clothing. Do not reach across or over a flame.

Pull long hair back and keep secure.

Do not heat any substance in a closed container.

Always use the tongs or protective gloves when handling hot objects. Do not touch hot objects with your hands.

Keep all lab equipment, chemicals, papers, and personal effects away from the flame.

Extinguish the flame as soon as you are finished with the experiment and move it away from the immediate work area.

Heat Safety

Always use tongs or protective gloves when handling hot objects and substances.

Keep hot objects away from the edge of the lab table—in a place where no one will come into contact with them.

Do not use the steam generator without the assistance of your teacher.

Remember that many objects will remain hot for a long time after the heat source is removed or turned off.

Glass Safety

Never use a piece of glass equipment that appears cracked or broken.

Handle glass equipment carefully. If a piece of glassware breaks, do not attempt to clean it up yourself. Inform your teacher.

Glass equipment can become very hot. Use tongs if glass has been heated.

Clean glass equipment carefully before packing it away.

Chemical Safety

Do not smell, touch, or taste chemicals unless instructed to do so.

Keep chemical containers closed except when using them.

Do not mix chemicals without specific instructions.

Do not shake or heat chemicals without specific instructions.

Dispose of used chemicals as instructed. Do not pour chemicals back into container without specific instructions to do so.

If a chemical accidentally touches your skin, immediately wash the area with water and inform your teacher.

ENERGY FROM THE SUN
Evaluation Form

State: ___ _ Grade Level: ___ _ Number of Students: ___ _

1. Did you conduct the entire activity?	Yes	No
2. Were the instructions clear and easy to follow?	Yes	No
3. Did the activity meet your academic objectives?	Yes	No
4. Was the activity age appropriate?	Yes	No
5. Were the allotted times sufficient to conduct the activity?	Yes	No
6. Was the activity easy to use?	Yes	No
7. Was the preparation required acceptable for the activity?	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 activity again?	Yes	No

How would you rate the activity overall (excellent, good, fair, poor)?

How would your students rate the activity overall (excellent, good, fair, poor)?

What would make the activity more useful to you?

Other Comments:

Please fax or mail to:

NEED Project
PO Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

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Aramco Services Company
Association of Desk & Derrick Clubs
BJ Services Company
BP
BP Solar
Bureau of Land Management – U.S. Department of the Interior
Cape and Islands Self Reliance
Cape Cod Cooperative Extension
Cape Light Compact – Massachusetts
Chesapeake Public Schools – Virginia
Chevron
Chevron Energy Solutions
Cinergy Corporation
Citizens Gas
ConEd Solutions
Council of Great Lakes Governors – Regional Biomass Partnership
Cypress-Fairbanks Independent School District – Texas
D&R International – School Energy Efficiency Program
Dart Container Corporation Foundation
Desk and Derrick of Roswell, New Mexico
Devon Energy
Dominion
Duke Energy Indiana
Duke Energy Kentucky
East Kentucky Power
Energy Information Administration – U.S. Department of Energy
Equitable Resources
Escambia County School District – Florida
Florida Department of Environmental Protection
FMC Technologies
Fuel Cell Store
Gerald Harrington
GlobalSantaFe
Governors' Ethanol Coalition
Guam Energy Office
Halliburton Foundation
Hydril
Illinois Clean Energy Community Foundation
Illinois Department of Commerce and Economic Opportunity
Independent Petroleum Association of NM
Indiana Community Action Association
Indiana Office of Energy and Defense Development
Indianapolis Power and Light
Interstate Renewable Energy Council
Iowa Energy Center
Johnson Controls
Kentucky Clean Fuels Coalition
Kentucky Office of Energy Policy
Kentucky Oil and Gas Association
Kentucky Propane Education & Research Council
Kentucky River Properties LLC
Kentucky Soybean Board
Lee Matherne Family Foundation
Llano Land and Exploration
Maine Energy Education Project
Maine Public Service Company
Marathon Oil Company
Marianas Islands Energy Office
Massachusetts Division of Energy Resources
Michigan Energy Office
Michigan Oil and Gas Producers Education Foundation
Minerals Management Service – U.S. Department of the Interior
Mississippi Development Authority – Energy Division
Narragansett Electric – A National Grid Company
National Association of State Energy Officials
National Association of State Universities and Land Grant Colleges
National Biodiesel Board
National Fuel
National Hydrogen Association
National Ocean Industries Association
New Jersey Department of Environmental Protection
North Carolina Department of Administration State Energy Office
Nebraska Public Power District
New Mexico Oil Corp.
New Mexico Landman's Association
New York State Energy Research and Development Authority
Noble Energy
Offshore Energy Center/Ocean Star/OEC Society
Ohio Energy Project
Oil & Gas Rental Services
Pacific Gas and Electric Company
Permian Basin Petroleum Association
Petroleum Equipment Suppliers Association
Premiere
Puerto Rico Energy Affairs Administration
Renewable Fuels Association
Roanoke Gas
Robert Gorham
Rogers Training and Consulting
Roswell Desk and Derrick Club
Roswell Geological Society
Rhode Island State Energy Office
Saudi Aramco
Schlumberger
Sentech, Inc.
Shell Exploration and Production
Society of Petroleum Engineers
Southwest Gas
Spring Branch Independent School District – Texas
Strategic Energy Innovations
Tennessee Department of Economic and Community Development
Texas Education Service Center – Region III
Texas Independent Producers & Royalty Owners Association
TransOptions, Inc.
University of Nevada – Las Vegas
Urban Options
U.S. Environmental Protection Agency
U.S. Department of Agriculture – Biodiesel Education Program
U.S. Department of Energy
U.S. Fuel Cell Council
Vectren
Virgin Islands Energy Office
Wake County Public Schools – North Carolina
W. Plack Carr Company
Xcel Energy
Yates Petroleum