Interdisciplinary Connections

See pages 31-34 for complete wording of the Texas Essential Knowledge & Skills for each content area addressed in this learning experience.

Language Arts TEKS

- Listing & speaking
- Vocabulary development
- Grammar and usage
- Connecting reading, writing, and inquiry
- Research

Mathematics TEKS

- Measurement:
  - Temperature
  - Length
  - Time
- Recording data
- Interpreting data
- Problem solving

Properties, Patterns, & Systems

Social Studies TEKS

- Problem-solving and decision-making skills
- Oral and visual communication
- Use of scale to determine distances

Art TEKS

- Express ideas in original artwork
- Use a variety of art materials
- Creation of artworks

Overview of Learning Experiences

TEKS	**3.11** The student knows that the natural world includes earth materials and objects in the sky. The student is expected to (D) describe the characteristics of the Sun.
Engage	✦ Students observe changes in UV beads and sun print paper when they are placed in sunlight and infer that sunlight is an energy source capable of causing changes in matter.
Explore	✦ Students discover that light energy makes a radiometer spin by designing tests to answer student-generated questions.
Explain	✦ Students analyze the parts of a radiometer and determine how the parts operate form a system. ✦ Students relate the silver or black color of the vanes in the radiometer to their function – to reflect or absorb light like radiation cans. ✦ Students conclude that light is energy because it can cause movement in radiometers and changes in matter, such as UV beads and sun print paper.
Elaborate	✦ Students describe the characteristics of the Sun, after reading *Sun Up, Sun Down* by Gail Gibbons. ✦ Students create scale models to analyze the size of the Sun and its distance from Earth. ✦ Students study a model of the Sun's surface characteristics. ✦ Students describe the importance of the Sun to the survival of plants. ✦ Students measure and record changes in temperature of water caused by the addition of solar energy.
Evaluate	**SUMMATIVE ASSESSMENT** ✦ Students research and create a product to demonstrate understanding of the characteristics and importance of the Sun.

ENGAGE

1. Distribute to each student a pipe cleaner bracelet and a piece of sun print paper. Do not mention that there is anything special about the beads or the paper. Ask students to make careful observations, including a color drawing of each item, in their journal.

SAFETY FIRST ALERT

Prior to taking students outside, preview the schoolyard area locating safety concerns that must be addressed with students.

2. Announce to students that the class is going on a short field trip outdoors to find two natural objects in the playground area. Ask students to write their name neatly at the top of the paper before going outside, and fasten the pipe cleaner bracelet around their wrist. Once outside, students should find a leaf, insect, rock or other natural object, place it on the paper, and place the paper in the sunshine while they look for the second natural object. The second object should also be placed on their paper in the sunshine. The objects must stay on the paper for at least two minutes.

3. Most students will notice that the beads on their bracelet have changed from white to a bright color. Allow students to compare bracelets to make sure everyone has a color change. Go into a shaded area, and observe for changes. Go back into the sunshine, and observe again. After observing several changes, students will begin to conclude that sunlight is causing the beads to change color.

4. Take the bracelets and the sun print paper back into the classroom. After observing the beads and the sun print paper, students should report the changes observed in their science journals using words and pictures.

Materials (details p. 26)

For each student:
- 5 UV beads
- pipe cleaner
- sun print paper
- 2 natural objects

ENGAGE

<u>*Grades 3-5*</u>

Students should be required to keep written records in bound notebooks of what they did, what data they collected, and what they think the data mean.

Benchmarks for Science Literacy, p. 286

ENGAGE

Questioning Strategies

- What color were the beads indoors? *(white)*
- What happened to the beads outside? (*turned different colors)*
- What happened when the beads were in the shade for a few minutes? *(beads turned back to white again)*
- What seemed to be causing the changes in the beads? (*sunlight)*
- What happened to the paper outdoors? (*It had prints of leaves, rocks, or other natural objects that were placed on it)*
- Energy can cause changes in matter. Is sunlight a kind of energy? How do you know? (*Sunlight is energy because it caused changes in beads and paper.)*
- Can light energy cause movement? How can we test to find out?

By experimenting with light, heat, electricity, magnetism, and sound, students begin to understand that phenomena can be observed, measured, and controlled in various ways. The children cannot understand a complex concept such as energy. Nonetheless, they have intuitive notions of energy- for example, energy is needed to get things done: humans get energy from food. Teachers can build on the intuitive notions of students without requiring them to memorize technical definitions.

National Science Education Standards, p. 126

EXPLORE

SAFETY FIRST ALERT

1. Show radiometers to students and discuss the importance of handling them very carefully, because they are made of glass. For safety reasons, the radiometers must stay in the middle of the tables unless the teacher moves them.

Materials (details p. 26)

- radiometers
- sources of light (flashlight, lamp, sunlight)
- hair dryer
- straw
- mirror
- student journals
- student data sheets

EXPLORE

2. Ask students to observe the radiometer when it is placed in sunlight, and think of two questions about the reaction of the radiometer to sunlight. The questions must be phrased so that they can be answered with a "Yes" or "No," without any additional information. Students should be given two or three quiet minutes to record questions on the data sheet.

Yes	No
?	

3. As the students ask the yes or no questions about the radiometer, record them on a "Yes" or "No" T-chart. If students ask a question that would require research, an investigation, or a test, record it at the bottom of the chart in the "?" section.

4. Students should listen carefully to the questions of other students and write down the ones that they are curious about on their data chart.

5. On a second piece of chart paper, group the student questions into two groups: "Questions that can be answered by research" and "Questions that can be answered by an investigation." Help students look for common phrases in the investigation questions. Have them write these common phrases in their journals on the next to the last page, and title it "Investigation Questions". More questions can be added throughout the year.

EXPLORE

6. Ask students to make a picture prediction on the student data sheet about how they think the radiometer works.

7. Assign each member of the group a cooperative learning role. Discuss the responsibilities of each role or job.

- Principal Investigator- in charge of leading the investigation
- Materials Manager-gathers and returns testing materials
- Safety Technician- makes sure safety rules are followed
- Reader/Recorder- reads directions and records group information

8. Have each group choose one question to answer, using the available materials listed, and write it on their data sheet.

9. Each group should decide the steps to follow during the investigation of their question. Visit each group to approve and initial their procedure steps **before** they begin testing.

10. After the tests are performed, allow time for results to be recorded on a chart paper visual that will be used during a discussion with the whole class.

EXPLORE

Racing Radiometers (See Masters A-B)
Student Data Sheet

Observe the vanes on the radiometer move when it is placed in sunlight. Think of two questions that can be answered with a Yes or No by the teacher. Write your questions on the lines below. (Example: Will it stop moving if you put it in the refrigerator? *Yes!)*

1.____
____

2.____
____

Listen carefully to other students' questions. Write down any questions you hear that might help solve the radiometer mystery.

____
____

Using your observations and the information from the "Yes" or "No" questions and answers, draw a **labeled** diagram in the box below that shows the parts of the radiometer. Write a brief explanation of how you think it **might** work. (The black and silver kite-like structures at the top of the instrument are called vanes.) Please remember that the radiometer must stay in the center of the table!

	I think the radiometer spins because

EXPLORE

Choose one question that your group wants to answer using these materials: radiometer, flashlight, mirror, hair dryer, straw, and lamp.

Our question:____
____

Discuss the steps needed to test your group's radiometer question, and write them below. Ask your teacher to approve and sign your test steps before you begin testing. Teacher's initials: ______

We will use these materials: ______________________________
____

We will follow these steps: (Remember you may not move the radiometer!)

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

Write the results of your group's experiment below. Be prepared to tell the class about your test and discuss the results.

____
____
____
____
____

We conclude that radiometers spin because:______________________
____

EXPLAIN

Materials (details p. 27)
- radiometer
- radiation cans
- water
- lamps with at least 75-watt bulbs
- thermometers
- student data sheets

1. Ask each group to report on the results of their experiment, using their chart paper visual. Have a radiometer and the materials used in the exploration activity available to clarify steps, if needed.

2. Post the visuals on the wall, and compare the groups' investigations and steps. Relate the results of the radiometer experience to the results of the first activity using UV beads and sun print paper.

Questioning Strategies

- What is the reaction of a radiometer when sunlight energy hits it? (*it spins fast)*
- What was your group's question about radiometers?
- What steps did you take to investigate your question?
- Compare your group's steps with another group. Are they similar?
- Describe the results of your group's experiment, and compare it to other groups.
- How is the reaction of the radiometer to sunlight connected or related to the first activity with UV beads and sun print paper? (*They all show evidence that light can cause* ***changes*** *in matter. This is evidence that light is energy.)*

Grades 3-5:

Investigations should often be followed up with presentations to the entire class to emphasize the importance of clear communication in science. Class discussion of the procedures and findings can provide the beginnings of scientific argument and debate.

Benchmarks for Science Literacy, p. 10

3. Show students the radiation can system, which includes a light source, one black can, one silver can, and thermometers. Ask students to draw and label the radiation can system in their journals.

4. After noting the color similarities to the radiometer vanes, fill the cans with water, and ask students to think of energy questions that could be answered using these

EXPLAIN

materials. Ask students to turn to the Investigation Questions page of their journal for reminders about previous questions.

5. Test the cans, and allow each student group to verify and record the temperature readings in their journals.

Questioning Strategies

- How are the **properties** of the radiation cans similar to the radiometers? (*There is a black can and silver can, which is similar to the black and silver sides of the vanes on the radiometer.)*
- How are the **properties** of the radiation cans different from the radiometers? (*The cans are filled with water, have a thermometer sticking out of the top, and they have no glass around them.)*
- How could we use the water-filled cans to show that light can cause changes in matter? (*Shine the light on them, and see if light can cause changes in the temperature of the water inside the cans.)*
- Did the light cause a change in the water temperature? (*The water in the black can became warmer than the water in the silver can.)*
- Which color of can absorbed the most light energy? (*The black can because the water in it got warmer.*)
- Which side of the radiometer vane might absorb the most light energy? (*The black side)*
- How could you test this? (*Shine a flashlight on the black side of the vane, and see how fast the radiometer spins. Then shine a flashlight on the silver side of the vane, and see how fast it spins.)**

EXPLAIN

Questioning Strategies

- Brainstorm with students about other light sources that might affect radiometers. *(candles, fires, matches, gas lanterns)*
- Why do some objects produce light? (*They are very hot and glow.)*
- Why does the Sun produce so much light? *(It is much hotter than any of the other light sources and is so much larger.)*
- How can we show how large the Sun is? *(We can make a scale model of the Sun.)*

FYI on Radiometers

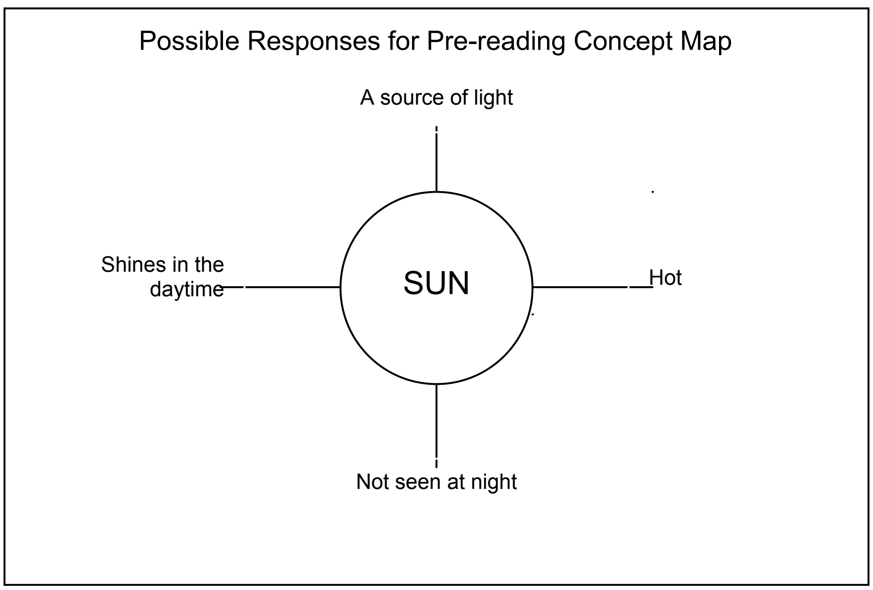
* Radiometers spin because the vanes are dark on one side, and light on the other side. The dark side absorbs heat energy, and causes a temperature difference between the vanes. The air molecules "bump" against the dark side of the vane harder and form convection currents in the very free moving air inside the glass cover. This causes the vanes to spin away from the side the air molecules "bumped" against, which is the dark side.

*It is NOT necessary for students to memorize how a radiometer works, but it is important for them to realize that the seal underneath the radiometer may not be tampered with or broken. A radiometer works because over 99% of the air has been removed from inside the glass, forming a partial vacuum. This allows the few air molecules left inside to move very freely and form convection currents with the slightest temperature difference in the vanes. If the seal underneath the plastic base is broken, excess air molecules will move into the glass container and the radiometer will not work.

ELABORATE

1. Draw a large circle in the middle of chart paper, and label it Sun. Create a simple pre-reading concept map to activate prior knowledge about the sun by adding information contributed by students.

*Note – Honor all responses to encourage active participation, which may include helping students to rephrase misconceptions after reading *Sun Up, Sun Down*.



2. Read the book *Sun up, Sun down* by Gail Gibbons to students. Discuss the story as a formative assessment, using the following questions. Refer back to the story to verify information when needed.

3. After the discussion and activities on characteristics and uses of the Sun, ask students for more details from the story to add to the concept map. Encourage students to give examples to clarify and extend new terms.

Materials (details p. 27)

- ❑ book, *Sun Up, Sun Down*
- ❑ yellow beach ball
- ❑ dried split peas
- ❑ demo paper models
- ❑ unlined chart paper
- ❑ metric ruler
- ❑ meter sticks
- ❑ pencils
- ❑ string
- ❑ crayons
- ❑ large candle with more than 1 wick
- ❑ matches
- ❑ journals
- ❑ Sentence strips
- ❑ 4 % milk
- ❑ dish soap (not Dawn)
- ❑ soda bottle caps
- ❑ red and yellow food coloring
- ❑ pepper packets
- ❑ small plastic plates
- ❑ toothpicks
- ❑ plants with large leaves
- ❑ tag board circles
- ❑ paper clips
- ❑ journals
- ❑ plastic baggies
- ❑ black squares
- ❑ white squares
- ❑ water
- ❑ thermometers

ELABORATE

Questioning Strategies

- What are some characteristics of the Sun? *(huge round ball of hot, glowing gases that produces enormous amounts of light and heat)*
- Why should we avoid looking directly at the Sun? *(It can damage our eyes.)*
- What does the Sun provide for us? *(light and heat energy)*
- What is the Sun's energy used for? (*It warms our planet, helps make rain because it warms the water in lakes and oceans to form water vapor in the water cycle, and it helps plants to grow.)*
- Where is the Sun located? *(It is at the center of our solar system, over 93 million miles away from the earth)*

4. Use a concrete model to demonstrate the relative size of the Sun by showing students a large yellow beach ball and asking them what object this model might represent. *(Most will answer that it looks like the Sun.)* Show them a whole split pea that has two halves glued together and ask them what object it might represent. They may not think of it as a model for the Earth! Discuss the use of models for objects that cannot be brought into the classroom easily, and their limitations. The beach ball / pea model is a visual estimation of the size difference between the Sun and the Earth.

5. Scientists can also make mathematical scale models. Using the pea size of 0.5 cm as the base measurement, and the knowledge that the diameter of the Sun is about 108 times the diameter of the Earth, we can make a somewhat accurate scale model of the Sun. If a paper circle that has a diameter of 0.5 cm represents the size of the Earth, then a paper circle with a diameter of 54 cm can represent the Sun. (108 x .5 cm = 54 cm).

ELABORATE

Procedures for scale model of Sun's size:

→ Show students completed paper scale models of the Sun and Earth to demonstrate what theirs will resemble.
→ Ask students to measure the diameter of the split pea, using the metric ruler. It is exactly half of a centimeter, which is written as 0.5 cm.
→ Hand out large chart or butcher paper and string. Demonstrate how to place the flat side of the split pea in the upper corner of the paper to trace it. Reserve the middle of the chart paper for the Sun drawing.
→ Demonstrate how to fold the chart paper in the middle. Use the fold to measure a 54 cm line right in the middle of the paper.
→ Ask students to make a pencil dot in the center of the 54 cm line. What is the center of the line? *(27 cm)*
→ Make a loop in the end of the string that fits on your pencil. Place your pencil on the end of the 54 cm line, and have a partner help you hold the end of the string tightly at the 27 cm mark. The string represents the radius of the circle that will be drawn.
→ Demonstrate how to move the pencil (still attached to the string) around the center point to draw a circle with a 54 cm diameter.
→ Ask students to color the paper model of the Sun yellow and the paper model of the Earth blue before cutting them out.

6. Make a scale model of distance on the playground to show that the Sun is 100 "sun diameters" from the Earth. We can use our paper Sun models to measure this distance. (54 cm x 100 = 5,400 cm or 54 meters).

ELABORATE

Procedures for scale model of Sun's distance from Earth:

→ Each student should take their paper Sun model out to the playground so the class can measure the scale distance together.

→ Have one person hold the split pea to represent the position of the Earth. Ask students for input about the best way to measure the distance accurately in "sun diameters". Some students may suggest the class lining up, putting the Sun models on the ground, and repeating this process until they have measured 100 "sun diameters." Other students may use math to make by multiplying the paper Sun's diameter times 100. (54 cm x 100 = 54 meters) This would allow them to measure with meter sticks. Make a class decision about the best way to measure.

→ Students should draw a picture in their journal showing that it is 100 "sun diameters" from the Earth to the Sun.

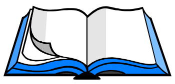
Questioning Strategies

- If the Sun is so large and so hot, why doesn't it make the Earth burning hot? *(It is very far away from Earth)*
- If the Sun is so much larger than the Earth, why does it look about the size of our moon, which is much smaller than the Earth? *(The Sun is millions of miles further away from Earth than the moon, which makes it seem smaller than it really is.)*
- If the Sun is a star, why does it look so different from the other stars that we see in the sky at night? *(The other stars are much further away from Earth than the Sun. The Sun is the closest star to Earth.)*

Grades 3-5:

Students should know that stars are like the sun, some being smaller and some larger, but so far away that they look like points of light.

Benchmarks for Science Literacy, p. 63



7. Light a candle, and ask students to make observations in their journals. *(has a flame, hot, gives off light)*

8. Show a large picture of the surface of the Sun, like the one on page 15 of *The Sun* by Michael George. Ask students how the Sun is like a candle. *(Hot, glows, has red, yellow and orange colors, produces light and heat)* List these characteristics on chart paper so students can list them in their journals.

9. Ask students to think of another object that reminds them of the Sun. Have students write a sentence in their journal that can be completed with an object of their choice and a reason **why** it reminds them of the Sun. Challenge students to make the sentence as vivid and descriptive as possible, so that the person reading the sentence can "see" a picture of the object in their minds.

"A ______________ is like the Sun because it ________________________."

10. Allow students time to write their Sun analogy sentences and then ask them to read the sentence to the person next to them. After both students have read, allow a few moments for them to offer suggestions about descriptive words that could be added to the sentence to make it even more vivid. Ask each table group to choose their most descriptive Sun analogy sentence so it can be shared with the class.

11. Have each group write their sentence on a sentence strip and post it on the wall. What are some descriptive words that were used to describe the Sun? Why is it important to use descriptive words when writing? (*So readers can get a clear picture of what you are writing about)*

ELABORATE

Grades 3-5:

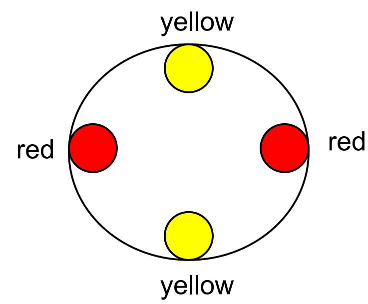
Students should know that one way to make sense of something is to think how it is like something more familiar.

Benchmarks for Science Literacy, p. 232

ELABORATE

12. Show students pictures of the surface of the Sun such as the one on page 16 of *The Sun* by Michael George that shows swirling granules and gases and dark patches called sunspots. Announce to students that they are going to make a model of the Sun's surface using milk, which may surprise some students. Have students label a new page in their journal with the title Twirly Whirly Sunspots.

→ Place a small plastic plate on each group's table and in pour $\frac{1}{2}$ cup of milk.
→ Ask students to pretend the plate is like a clock and to carefully place a drop of yellow food coloring at 12:00, a drop of red food coloring at 3:00, a yellow drop at 6:00, and a final red drop at 9:00. An optional student data sheet is provided that can be used as an overhead transparency demonstration.
→ Demonstrate how to place a small shake of pepper in the middle of the plate without disturbing the food color dots.
→ Ask students to draw a color picture of the plate in their journal.
→ While students are working on their pictures, place on each group's table a small cup or soda bottle cap that contains dish soap and four toothpicks.
→ When everyone is ready, students should carefully dip their toothpicks into the dish soap, and wait for the teacher's signal to dip the toothpicks into the center of the plate. Swirling of colors will occur.
→ Have students draw and label a picture of the plate in their journal to show how things looked after the soap was added.



Questioning Strategies

- What happened when soap was added to the milk? *(Rapid swirling and churning occurred)*
- What happened to the dots of food color? *(They swirled together)*
- What happened to the pepper? *(It moved around the dish)*
- How is the model like the surface of the Sun? *(The Sun has gases swirling all over its surface, with some dark spots called sunspots that move around.)*
- Models have limitations because they are not exactly like the object they represent. How is the model not like the Sun's surface? *(The Sun's surface is not made of milk, it is very hot, and sunspots are not made of pepper)*

13. Ask students to begin a new page in their journal titled "Spotted Plants." Allow students time to make careful observations of the leaves growing on a green plant using words and color pictures in their journal. Make sure students date the observation entry.

14. Hand out one circle cut from tag board to each student and have them write their name and date on it. Allow students to choose a leaf on a plant and attach their cardboard circle to the top of the leaf using a paper clip. The leaves will look very "spotty" if you use a plant with large leaves so that several cardboard spots are placed per leaf. Ask students to make careful observations of the "spotty" leaves in words and color pictures in their journals. **Make sure students realize they are not to remove the leaves from the plant!**

Return the plants to their normal setting with light and water. After four days, place each group's plant on the table for observations. Allow students to carefully

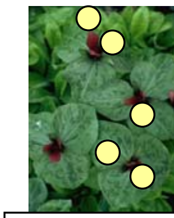
ELABORATE

ELABORATE

remove their circles and make detailed observations of the leaves in words and color pictures.


Before


Paper spots


After

Questioning Strategies

- How did the leaf appear before the circles were attached? (d*eep green)*
- What did the paper circles keep the leaf areas from getting? *(sunlight)*
- How did the leaves look after the paper spots were removed? (*The green was not as dark where the leaf had not received sunlight.*)
- What might happen if we left the paper circles on for several weeks? (*The leaves might not get enough Sun to grow, or they might get brown and die.)*
- What happens to grass if an object like a small swimming pool or a sandbox covers it up for several weeks? (*It gets no sunlight, and turns very light green.)*
- What do you predict would happen if you tested two plants by placing one in a dark closet, and one on a sunny windowsill?

ELABORATE

15. Show students a Celsius thermometer, and review its use:

- Scientists use a Celsius thermometer to measure the temperature of materials.
- Thermometers have a thin glass tube that contains a red liquid called alcohol and a temperature scale on the side of the tube. Some thermometers show the Celsius and Fahrenheit scales. The side that says ° C is the Celsius side.
- To measure the temperature of a liquid, place the bulb of the thermometer into the liquid for a minute. Do not hold the thermometer by the bulb because it will measure the temperature of your hand.
- When the thermometer is placed in a warm substance, the red alcohol in the tube gets warmer, expands or gets bigger, and moves up the tube.
- When the thermometer is placed in a cold substance, the red alcohol in the tube gets cooler, contracts or gets smaller, and moves down the tube.
- To read a thermometer, read the number that is next to the line that is closest to the top of the liquid in the tube.
- Make a transparency of a large thermometer, and use a water-based red transparency pen to color in the tube to model several temperature readings. Ask students to read and verify the temperatures.

SAFETY FIRST ALERT

Remind students to be careful when handling thermometers. The glass tube can shatter if the thermometer is dropped or hits a hard surface. If a thermometer breaks, students must notify the teacher immediately.

Only non-mercury thermometers should be used in the classroom for safety.

ELABORATE

16. Advance Preparation:
*Pre-cut plastic squares of heavy-duty black and white trash bags so that they will just fit into the plastic bags. Prepare a black and a white bag filled with 100 ml of water for each group.
*Typically, elementary thermometers may not all read the same temperature because they are not attached to the scale at exactly the same point. Pair up thermometers that have similar readings after they have been sitting at room temperature for 10 minutes. Write the same number on thermometers with matching temperatures to avoid having to pair them up each time. Give group 1 the pair of thermometers marked with 1's, and so on. This will avoid discrepancies in results caused by inconsistent scales.

→ Based on their previous experiences with radiometers and radiation cans, ask students to predict which color of plastic bag is more likely to absorb, or take in, more of the Sun's energy and heat up the water.
→ Assign cooperative roles for each group. The Materials Managers should get the plastic bags and thermometers. The Recorder will record observations and temperature readings during the outdoor test and share data with the group when students return to the classroom from outdoors. (A clipboard for each group is handy for outdoor observations to prevent flyaway papers.) The Safety Technician will make sure group members handles the thermometers safely. The PI will make sure temperature readings are taken at the right time and that each group member stays on task.
→ While in the classroom, demonstrate how to place the thermometer in the plastic bag and squeeze out most of the air without spilling the water. Ask students to take a temperature reading of the water at room temperature. Use a transparency of the data sheet

ELABORATE

to demonstrate how to record data. Visit all groups to be sure everyone is able to accurately read the thermometer.

→ Go outdoors to a sunny area where students can safely sit with their solar water heaters and record temperature readings on their data table. When students return to the classroom they will share data with other groups. This allows students to examine trends in data.

→ Students should also note how warm each baggie feels when they pick it up.

Questioning Strategies

- Which bag of water felt the warmest? *(black)*
- Which bag had the highest temperature? *(black)*
- Why do you think the black bag got hotter? *(The dark color absorbs more of the Sun's energy, like in the dark sides of the vanes of the radiometer.)*
- How did the white bag feel? *(Fairly cool, the temperature was nearly the same)*
- Why did the white bag stay fairly cool? *(It reflected or bounced off the Sun's energy, and didn't absorb much)*
- How did the results compare with your prediction?
- What is the best color for a water heater powered by the Sun's energy? *(Black)*
- What would be the best color of clothing to wear when outdoors on a hot Texas summer day? Why? *(Light or white colored clothing, because it doesn't absorb as much energy, and would keep you cooler.)*

ELABORATE

Solar Water Heater (See Master D)
Class Data Sheet

I predict that the water in the _________ bag is more likely to become warmer when placed in the Sun for six minutes.

Instructions: Look at the back of your group's thermometers for your group number. Record all of your group's temperature readings for the black bag and the white bag in the row next to your thermometer number. Data from the other groups will be shared in class to complete the rest of the chart.

Black Bag

Group #	Starting Temperature (° C)	After 2 minutes (° C)	After 3 minutes (° C)	After 6 minutes (° C)
1				
2				
3				
4				
5				
6				
7				

White Bag

Group #	Starting Temperature (° C)	After 2 minutes (° C)	After 3 minutes (° C)	After 6 minutes (° C)
1				
2				
3				
4				
5				
6				
7				

EVALUATE

Materials (details p. 28)

- book, *The Sun is My Favorite Star*
- Scoring Rubrics

EVALUATE

Student understanding of the characteristics and importance of the Sun is enhanced and assessed by further solar research and development of a student product about the characteristics and importance of our Sun. Choices for products include, but are not limited to:

1. An illustrated Big Book about the Sun*
2. A large, illustrated, expanded concept map on the Sun
3. A 3-D model of the Sun
4. Scientific investigation demonstrating that plants need sunlight energy to grow
5. Construction of a device to capture solar energy to cook food or heat water
6. Construction of a "Characteristics of the Sun" game

Student products will be assessed using a rubric that includes quality of the research and completed product and on an oral presentation to the class.

* Read the book, *The Sun is My Favorite Star*, by Frank Asch, as an example of a big book product. The big book could be read to younger students to teach them about the characteristics of the Sun.

EVALUATE

Star Power Product (See Master E)
Scoring Rubric

Research	Product Design	Application	Presentation
4 Research is accurate, clear, and very detailed.	4 . Creative design & use of materials.	4 A clear, unique application of concepts through explanation, construction, or illustrations	4 Explanations are accurate, clear, and very detailed. Entertaining and creative!
3 Research is accurate, clear, and fairly detailed.	3 Good choice of design and materials.	3 A clear application of concepts through explanation, construction, or illustrations	3 Explanations are accurate, clear, and fairly detailed. Creative!
2 Research is limited in scope. More preparation needed.	2 Design and use of materials are similar to previous activities.	2 A partial application of concepts through explanation, construction, or illustrations.	2 Explanations are limited but accurate, and are somewhat clear. More preparation needed.
1 Very little research is attempted.	1 The product is incomplete.	1 Product is not an application of concepts.	1 Explanations are limited, unclear, and inaccurate

Materials Detail Sheet

ENGAGE

For the class:

- ☐ "Here Comes the Sun" by the Beatles
- ☐ CD player
- ☐ Sunny outdoor area

For each student:

- ☐ UV beads; available from vendors of science teaching supplies $6.95 per 250
- ☐ pipe cleaners
- ☐ sun print paper; available from vendors of science teaching supplies $7.95 per pack of 30 sheets
- ☐ 2 natural objects

EXPLORE

For the class:

- ☐ "Yes" or "No" T-chart

For each group of students:

- ☐ radiometer; available from vendors of science teaching supplies $7.95 each
- ☐ sources of light (flashlight, lamp, sunlight)
- ☐ hair dryer
- ☐ straw
- ☐ mirror
- ☐ chart paper
- ☐ markers

For each student:

- ☐ journals
- ☐ data sheets

Materials Detail Sheet

EXPLAIN

For the class:
- ☐ radiometer
- ☐ radiation cans; available from vendors of science teaching supplies or use identical shiny cans with one of them spray-painted black
- ☐ water
- ☐ lamps with at least 75-watt bulbs
- ☐ thermometers

For each group of students:
- ☐ radiometer

For each student:
- ☐ data sheet

ELABORATE

For the class:
- ☐ *Sun Up, Sun Down* by Gail Gibbons $6
- ☐ Chart paper
- ☐ Demo paper models
- ☐ Yellow beach ball
- ☐ Dried split peas
- ☐ Large candle with more than 1 wick
- ☐ Matches
- ☐ Sentence strips

For each student:
- ☐ Dried split peas
- ☐ Unlined chart paper
- ☐ Metric ruler
- ☐ Meter sticks
- ☐ Pencils
- ☐ String

For each group of students:

- ☐ 4 % milk
- ☐ dish soap (not Dawn)
- ☐ medicine cups
- ☐ red and yellow food coloring
- ☐ pepper packets
- ☐ small plastic plates
- ☐ toothpicks
- ☐ Plants with large leaves
- ☐ Tag board circles
- ☐ Paper clips
- ☐ Plastic Bags
- ☐ Black squares
- ☐ White squares
- ☐ Water
- ☐ Thermometers

<u>EVALUATE</u>

For the class:

- ☐ *The Sun is My Favorite Star*, by Frank Asch ISBN 0-15-202127-2 $15
- ☐ Examples of Sun Products

For each student:

- ☐ Sun Products Rubric

Background Information for Teachers

Energy is the ability to do work or cause changes in matter. There are many types of energy, including energy of motion, position, heat, light, electrical, chemical, and nuclear energy. Energy can be transformed or changed from one form to another. For example, a radiometer is a scientific instrument that visibly changes sunlight energy into heat and mechanical energy. The *Benchmarks for Science Literacy* recommends that "students should have experience in using a variety of energy-transforming devices and considering what their inputs and outputs are" to develop a practical understanding of energy. (*Benchmarks*, p. 192)
It is also recommended that study of the Sun and energy transfer should begin at the earliest grade levels, with the understanding that "plants need light," and that "many materials can be recycled and used again, sometimes in different forms." (Benchmarks, p. 119) From the 3rd to the 5th grade, students should have many opportunities to observe and discuss uses of the Sun's light and heat to develop the understanding that the Sun is our planet's main source of energy. (*Benchmarks*, p. 193)

Our Sun is a star, which is a gigantic ball of very hot gases that releases its own light and heat energy. The gases at the center, or core, of the Sun are the hottest, and can have a temperature of over 15 million degrees Celsius. This intense heat and the constant nuclear fusion of millions of tiny atoms of hydrogen gas atoms into new atoms of helium create conditions similar to a continuous hydrogen bomb explosion in the Sun's core. Huge amounts of light and heat energy are released during this nuclear fusion causing the Sun to shine. The Sun's energy is released into space in the form of electromagnetic radiation of many wavelengths, including visible light, ultraviolet light, and infrared light or heat. This light and heat energy travels about 93 million miles or 150 million km to the Earth, which seems to be the ideal distance from the Sun to make conditions on Earth an optimum temperature for living things. Without the Sun's energy, the Earth would be a cold, dark, and lifeless planet.

Energy from the Sun is a form of electromagnetic radiation that travels in waves. Visible light is one type of radiant energy. Light travels in straight lines that scientists call rays. Rays of light travel in straight lines unless reflected, refracted, or blocked by an object. The properties of a material or an object determine how much light will be reflected or absorbed. A dark, dull material absorbs more light than it reflects. If a material absorbs light, it can raise the temperature of the material.

Radiometers spin because the vanes are dark on one side and light on the other side. The dark side absorbs heat energy, and causes a temperature difference between the vanes. The air molecules "bump" against the dark side of the vane harder, and form convection currents in the very free moving air inside the glass cover. This causes the vanes to spin away from the side the air molecules "bumped" against, which is the dark side.

A radiometer works because over 99% of the air has been removed from inside the glass, forming a partial vacuum. This allows the few air molecules left inside to move very freely and form convection currents with the slightest temperature difference in the vanes. If the seal underneath the plastic base is broken, excess air molecules will move into the glass container, and the radiometer will not work.

The Sun also produces invisible ultraviolet light waves that are just beyond the color of violet in the visible spectrum. Too much UV radiation can cause sunburn and eye damage so it is important to wear sunscreen and UV sunglasses when outdoors on sunny days. UV beads can be used to detect UV waves because they contain a special pigment that changes color when they are exposed to ultraviolet light.

Targeted Texas Essential Knowledge & Skills

Science TEKS

3.1 The student conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations

3.2 The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

(A) plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology;

(B) collect information by observing and measuring

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence;

(D) communicate valid conclusions;

(E) construct simple graphs, tables, maps, and charts to organize, examine and evaluate information.

3.3 The student knows that information, critical thinking, and scientific problem solving are used in making decisions. The student is expected to:

(C) represent the natural world using models and identify their limitations

3.4 The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

(A) collect and analyze information using tools including calculators, microscopes, cameras, safety goggles, sound recorders, clocks, computers, thermometers, hand lenses, meter sticks, rulers, balances, magnets, and compasses

3.8 The student knows that living organisms need food, water, light, air, a way to dispose of waste, and an environment in which to live. The student is expected to:

(C) describe environmental changes in which some organisms would thrive, become ill, or perish

3.11 The student knows that the natural world includes earth materials and objects in the sky. The student is expected to:

(D) describe the characteristics of the Sun

Language Arts TEKS

3.1 Listening/speaking/purposes. The student listens attentively and engages in a variety of oral language experiences. The student is expected to:

(A) determine the purposes for listening such as to get information, to solve problems, and to enjoy and appreciate.

(C) participate in rhymes, songs, conversations, and discussions

(D) listen critically to interpret and evaluate

3.3 Listening/speaking/audiences/oral grammar. The student speaks appropriately to different audiences for different purposes and occasions. The student is expected to:

(A) choose and adapt spoken language appropriate to the audience, purpose, and occasion, including use of appropriate volume and rate

(C) ask and answer relevant questions and make contributions in small or large group discussions

(E) give precise directions and instructions such as in games and tasks

(F) clarify and support spoken ideas with evidence, elaborations, and examples

3.4 Listening/speaking/communication. The student communicates clearly by putting thoughts and feelings into spoken words. The student is expected to:

(A) use vocabulary to describe clearly ideas, feelings, and experiences

(B) clarify and support spoken messages using appropriate props, including objects, pictures, and charts

3.7 Reading/variety of texts. The student reads widely for different purposes in varied sources. The student is expected to:

(B) read from a variety of genres for pleasure and to acquire information from both print and electronic sources

(C) read to accomplish various purposes, both assigned and self-selected

3.8 Reading/vocabulary development. The student develops an extensive vocabulary. The student is expected to:

(A) develop vocabulary by listening to and discussing both familiar and conceptually challenging selections read aloud
(B) develop vocabulary through reading

3.17 Writing/grammar/usage. The student composes meaningful texts applying knowledge of grammar and usage. The student is expected to:

(D) compose sentences with interesting, elaborated subjects

3. 18 Writing/writing processes. The student selects and uses writing processes for self-initiated and assigned writing. The student is expected to:

(A) generate ideas for writing by using prewriting techniques such as drawing and listing key thoughts
(B) develop drafts
(C) revise selected drafts for varied purposes, including to achieve a sense of audience, precise word choices, and vivid images

3.20 Writing/inquiry/research. The student uses writing as a tool for learning and research. The student is expected to:

(B) record his/her knowledge of a topic in a variety of ways such as by drawing pictures, making lists, and showing connections among ideas
(C) record his/her knowledge from relevant sources such as classroom guests, books, and media sources

Mathematics TEKS

3.11 Measurement. The student selects and uses appropriate units and procedures to measure length and area. The student is expected to:

(A) estimate and measure lengths using standard units such as inch, foot, yard, centimeter, decimeter, and meter

3.12 Measurement. The student measures time and temperature. The student is expected to:

(A) tell and write time shown on traditional and digital clocks
(B) use a thermometer to measure temperature

3.13 Measurement. The student applies measurement concepts. The student is expected to measure to solve problems involving length, area, temperature, and time.

3.14 Probability and statistics. The student solves problems by collecting, organizing, displaying, and interpreting sets of data. The student is expected to:

(C) use data to describe events as more likely, less likely, or equally likely.

3.15 Underlying processes and mathematical tools. The student applies Grade 3 mathematics to solve problems connected to everyday experiences and activities in and outside of school. The student is expected to:

(C) select or develop an appropriate problem solving strategy, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, or working backwards to solve a problem

3. 16 Underlying processes and mathematical tools. The student communicates about Grade 3 mathematics using informal language. The student is expected to:

(A) explain and record observations using objects, words, pictures, numbers, and technology

3.17 Underlying processes and mathematical tools. The student uses logical reasoning to make sense of his or her world.

(A) make generalizations from patterns or sets of examples and nonexamples

Social Studies TEKS

3.5 Geography. The student understands the concepts of location, distance, and direction on maps and globes. The student is expected to:

(B) use a scale to determine the distance between places on maps and globes

Art TEKS

3. 1 Perception. The student develops and organizes ideas from the environment. The student is expected to:

(A) identify sensory knowledge and life experiences as sources for ideas about visual symbols, self, and life events

3.2 Creative expression/performance. The student expresses ideas through original artworks, using a variety of media with appropriate skill. The student is expected to:

(A) develop artwork based on personal observations and experiences

(C) produce drawings, paintings, prints, constructions, ceramics, and fiber art, using a variety of art materials appropriately

Reading Connections

The following books are recommended as literary resources for teachers to share with grade 3 students. **Teachers are cautioned, however, to remember that "reading about science" is not "doing science."** These books can enhance students' study of the Sun but cannot replace the learning that occurs by active engagement in the learning experiences.

The Sun Is My Favorite Star. Asch, Frank. Gulliver books, Harcourt, Inc. San Diego, 2000. (ISBN 9780152021276)
Illustrated and written in a friendly and informative style to help young readers visualize and appreciate the Sun.

See for Yourself: Sun. Davies, Kay and Oldfield, Wendy. Raintree Steck-Vaughn Publishers, Austin, Texas, 1996. (ISBN 0-8172-4040-3) Explores the characteristics of the Sun using simple, informative scientific investigations and beautiful photos of the natural world.

Sun Up, Sun Down. Gail Gibbons. Voyager Books, Harcourt Inc., 1986. (ISBN 9780152827823) Basic information for young readers about the characteristics of the Sun, with beautiful illustrations.

The Planets in the Solar System. Franklyn M. Branley. Harper Collins Publishers, New York, 1998.(ISBN 0-06-027769-6) Describes the Sun, nine planets and other bodies in the solar system, as well as how to make a solar system model.

The Sun. George, Michael. Creative Education, Inc., Mankato, Minnesota, 1991. (ISBN 0-88682-402-8) Stunning solar photographs and descriptions of the Sun help students and adults to visualize the characteristics of the Sun and appreciate its brilliance.

The Sun. Walker, Niki. Crabtree Publishing Company, New York, 2001. (ISBN 0-86505-682-X) Explains the Sun's characteristics and its effects on the Earth.

The Sun's Family of Planets by Allan Fowler. Children's Press, Chicago, 1992. (ISBN 0-516-06004-X) Provides information about the Sun, and each of the nine planets in the solar system that orbit the Sun.

Student Internet Links

Beakman and Jax Science Stuff
http://www.beakman.com/

Bill Nye the Science Guy
http://nyelabs.kcts.org/

Energy Quest
http://www.energy.ea.gov/education/index.html

Optics for Kids
http://www.opticalres.com/kidoptx.html

References

Benchmarks for Science Literacy. Oxford University Press, New York, 1993.

George, Michael. *The Sun.* Creative Education, Inc. , Mankato, Minnesota, 1991.

Maton, Anthea. *Exploring the Universe.* Prentice Hall, Englewood Cliffs, New Jersey, 1994.

National Science Education Standards. National Academy Press, Washington, DC, 1996.

Project ASTRO Resource Notebook. Astronomical Society of the Pacific

Smith, P. Sean. *Project Earth Science: Astronomy.* National Science Teacher's Association, Arlington, Virginia, 1998.

Van Cleave, Janice. *Solar System.* John Wiley and Sons, Inc., New York, 2000.

Websites

Electromagnetic Spectrum
http://observe.ivv.nasa.gov/nasa/education/reference/main.html

Eyes on the Sky, Feet on the Ground
http://hea-www.harvard.edu//ECT/the-book/Chap1/Chapter1.html

Marshall Brain's How Stuff Works: How the Sun Works
http://www.howstuffworks.com/sun.htm

Solar Matters
http://www.fsec.ucf.edu/

Stanford Solar Center
http://solar-center.stanford.edu/activities.html

The Sun
http://lpl.arizona.edu

Today's Space Weather
http://www.noaa.gov/wx.html

Ultraviolet Radiation
http://www.msc-smc.ec.gc.ca/woudc/