UNIT PLAN

Keeping It Cool With Solar

An NGSS Solar Energy Unit for Grades K-2

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DESCRIPTION

Keeping It Cool With Solar unit asks the question: "How might we design a structure that will keep us cool on a hot day?" As an anchoring phenomenon, students will be shown a time-lapse video of an ice cube melting, and a second phenomenon of a solar panel parking structure being built. Students will plan, design, and build a structure that cools the ground. After exploring what materials will create the coolest structure and measuring temperature, students will be allowed to redesign, rebuild, and retest their structure. Students will be given a solar panel and fan motor to see if they can use these new materials to lower the temperature in their structure. Content areas include learning what materials block light, how blocking sunlight will decrease surface temperature on a hot day, and comparing and testing designs to create an optimal solution. ***This unit is best done during a sunny and warm weather.**

GRADE LEVEL(S)

This unit is designed for grades K-2. The following standards are addressed:

- **2-PS1-2** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- **1-PS4-3** Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.
- **K-PS3-1 Energy** Make observations to determine the effect of sunlight on Earth's surface.
- **K-2-ETS1-3**. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
- **CCSS.ELA-Literacy.W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).

SUBJECT AREA(S)

Subject areas include the following:

solar energy, structure, design, temperature, counting numbers, Kindergarten

LEARNING GOAL(S)

1. Students will make observations to determine the effect of sunlight on Earth's surface.
2. Students will plan and conduct investigations to determine whether structures made with various materials will keep objects cool when placed in a beam of light.
3. Students will analyze data from tests of two objects designed to solve the same problem in order to compare the strengths and weaknesses of how each performs.
4. Students will analyze data obtained from testing different materials to determine which materials have the properties that are best suited for keeping an object cool.
5. Students will test if solar panels and solar energy can help cool down their structure.

UNIT EXPERIENCES

Suggested Teaching Times:

Lesson/Experience	**Time**
Engage/Explore	
L1: Hot Spot/Cool Spot L2: Making Shade L3 Design Time L4 Build Time	30-45 min. each lesson
Explain	
L5: How Cool Are We? - Structure Test	30 minutes
Elaborate/Evaluate	
L6: Add solar panel Redesign, Rebuild, Retest L7: Reflect	L6 - 60 min. L7 - 20 minutes
Total	3hr 50 min or approx. 2 weeks

NEXT GENERATION SCIENCE STANDARDS

Guiding Phenomena	Ice melting video - https://www.youtube.com/watch?v=WgjksZoznuA Time Lapse of solar panel parking structures - https://www.youtube.com/watch?v=WgjksZoznuA

Supplementary Phenomena	L1.1: Playground Shade Structure - https://drive.google.com/open?id=1eOr4MGVFLr-RXMIg6c14S0hTwwPPLKW6 L1.2: How is the sunlight being blocked? - https://drive.google.com/open?id=1-BmFDp76LGUSJhe2fFFp-ot3YLxhIFX4

Table 2. Next Generation Science Standards Assessed in This Unit

Performance Expectation	**How is this Assessed?**
2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.	*L5 - Students will discuss the colors of the liquid crystal sheet and numbers from infrared thermometer to determine which materials worked best to cool the earth's surface.*
1-PS4-3 *Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.*	*L2 - Students will experiment with different types of paper and color paper to explore the material that best creates shade for their structure.*
K-PS3-1 *Make observations to determine the effect of sunlight on Earth's surface.*	*L1 - Students will explore their playground structure to determine the effect of sunlight in shade and sunny areas.*
K-PS3-2 *Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*	*L3-7 – Students will plan, design, build, and iterate a shade structure designed to reduce the impact of warming on an area.*
K-2-ETS1-2 *Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.*	*L3 – Students will generate a design of their structure, indicating how the shape of the structure will block light (and reduce temperatures beneath the structure).*
K-2-ETS1-3 *Analyze data from tests of two objects designed to solve the same problem to compare the*	*L5 - Students will share structures and results before redesigning and rebuilding structures with solar panels.*

strengths and weaknesses of how each performs.	

THREE DIMENSIONAL LINKAGES

NGSS focuses not only on content, but also on process and building bridges between concepts within and across disciplines. The following tables outline the way in which this unit addresses this three-dimensionality as is essential to NGSS.

Table 3. Three-Dimensionality: Disciplinary Core Ideas (DCIs) -

Disciplinary Core Ideas	**Linkage in Unit**
PS1.A: Structure and Properties of Matter *Different properties are suited to different purposes.*	*Students are given a variety of materials to create a structure suited to cool down the earth's surface.*
PS3.B: Conservation of Energy and Energy Transfer *Sunlight warms Earth's surface.*	*Students experience the difference in temperature in sunlight and shade.*
PS4.B: Electromagnetic Radiation *Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach.*	*Students use a variety of materials to experience the gradients of shade that each different type of material allows sunlight to reach earth's surface.*
ETS1.B Developing Possible Solutions *Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.*	*Students will design and redesign shade structures, using drawings and other means of representation to communicate their design.*
ETS1.C: Optimizing the Design Solution *Because there is always more than one possible solution to a problem, it is useful to compare and test designs.*	*Students will use liquid crystal sheets and a infrared sensor to determine what criteria created the optimal structure with the coolest earth surface.*

Table 4. Three-Dimensionality: Science and Engineering Practices (SEPs)-

Science and Engineering Practices	**Linkage in Unit**

Planning and Carrying Out Investigations	*L3 & L4: Students will collaboratively design and build with given materials to create a structure that will reduce the earth's surface temperature.* *L5: Students will use liquid crystal sheets and a thermo infrared sensor to collect data and compare the effectiveness of their structures cooling the earth's temperature.*
Analyzing and Interpreting Data	*L6: Using the data collected, students will add solar panel and fan to see if they can further decrease the earth's surface temperature.*

Table 5. Three-Dimensionality: Crosscutting Concepts (CCCs) -

Crosscutting Concepts	Linkage in Unit
Cause and effect: mechanism and evaluation	*L1: Students will use cause and effect as they problem solve through the building of models and analyze the effects of specific changes to a design.* *L2: Students will identify key components of the wave attenuator that relate to prior electromagnetism lessons, identifying the components needs based on cause and effect relationships in the structure.* *L3: Student will use cause and effect as they problem solve through the building of the wave attenuator.*

COMMON CORE STATE STANDARDS

- **CCSS.ELA-Literacy.W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
- **K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference.

CONTENT BACKGROUND

STUDENT BACKGROUND

- The sun is a source of energy
- There are cool and hot places at school, even on a hot day.

- Different materials can affect the amount of light getting through.
- Renewable energy is used to create solutions

EDUCATOR BACKGROUND

While this unit is geared toward primary students, teachers know that primary students come up with the best and hardest questions. Please make sure you review the following at CE's Teacher Learning Center:

https://www.cebrightfutures.org/learn/fundamentals-energy

- How can energy be defined?
- What are the different forms of energy (especially heat and light)?
- What is the difference between kinetic and potential energy?
- What are photovoltaic cells and how do they function at a basic level?

Also, practice designing a structure yourself, and consider that it will take your students 3-5 times longer to create their structure. Last, practice how to create a circuit between the solar panel and the fan to get the fan motor to spin.

Extra resources:

A Place in the Shade-An Engineering Challenge - https://betterlesson.com/lesson/644795/a-place-in-the-shade-an-engineering-challenge - https://betterlesson.com/lesson/644795/a-place-in-the-shade-an-engineering-challenge

Literature links:

Bear Shadow by Frank Ash (video read aloud) - https://www.youtube.com/watch?v=Q9Ur_L8PdWs

The North Wind and the Sun by Aesop (Video read aloud) - https://www.youtube.com/watch?v=TrFUYAJXWLU

Science video links:

Sci Show Kids - The Power of Sunlight (Science Project) - https://www.youtube.com/watch?v=0Qmgdz9E47s&t=106s

Bob the Builder: Wind and Shine - https://www.youtube.com/watch?v=EEiT4IWHQ18&disable_polymer=true

VOCABULARY

Design	*A drawing that shows what something looks like and how it works. A design is not something itself but is a picture that we draw in order to explain some part the thing. Designs can be used to create all kinds of things like buildings, cars, computers, and many other things.*
Engineering	*Creating something to solve a problem*
Test	*Something we do to see whether something is working the way we want it to or to get other information on the thing we are testing.*
Investigate	*Exploring something to learn more about it and answer questions we might have about it.*
Data	*The results of when we measure something in a test, like a number or whether something can do what we want it to or not. In this case, the data we want is the temperature.*

REQUIRED MATERIALS

HANDOUTS/PAPER MATERIALS

- Lesson 1: Playground Picture
- Lesson 2: Sunlight Through the Forest
- Lesson 3: Engineering Design Worksheet
- Lesson 5: Thermomter (Obervation Worksheet

CLASSROOM SUPPLIES

ACTIVITY SUPPLIES (PER GROUP OF 3-4 STUDENTS)

ITEM	AMOUNT	LESSON	EXAMPLES
1.5 x 500 mAmp Solar PV panel with alligator clips	1	6	https://sunwindsolar.com/solar-photovoltaic-panels/
DC motor (ensure the peg/attachment is 2mm)	1	6	http://www.nbleisonmotor.com/RE-280-Dc-Micro-Motor-pd6250584.html
Propellors (ensure the hole for attaching to motors is 2mm)	1	6	https://www.amazon.com/EUDAX-Propeller-Airplane-Science-Education/dp/B073XL73F6/ref=pd_bxgy_21_img_3/136-5581566-5388033?_encoding=UTF8&pd_rd_i=B073XL73F6&pd_rd_r=e8bec84b-f914-4da5-a569-b1fa851a89ee&pd_rd_w=qz5OM&pd_rd_wg=UuULA&pf_rd_p=a2006322-0bc0-4db9-a08e-d168c18ce6f0&pf_rd_r=8T0JE6VVKYSC7CQ5CKSD&psc=1&refRID=8T0JE6VVKYSC7CQ5CKSD
Optional: Liquid Crystal Sheet	1	5,6	https://www.sciplus.com/liquid-crystal-temperature-sheet-3676-p?gclid=EAIaIQobChMIp42cys-r5AIVFL3sCh3XagqcEAQYASABEgISSPD_BwE
Thermo Infrared Thermometer	1	5, 6	https://www.amazon.com/Infrared-Thermometer-Helect-Non-Contact-Temperature/dp/B071NBJJ2Q/ref=asc_df_B071NBJJ2Q/?tag=hyprod-20&linkCode=df0&hvadid=216635790640&hvpos=1o3&hvnetw=g&hvrand=4402885636343828 77&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9032936&hvtargid=pla-349733104962&psc=1

UNIT PROGRESSION

LESSON SUMMARIES

LESSON 1: HOT SPOT/COOL SPOT

This lesson is designed for 1 30-minute session. Using large chart paper, students will brainstorm ideas of how we stay cool on a hot day (umbrella, house, trees, clothes, structure, etc.). Students will then be asked, "On a hot day, where might we stay cool on the playground?" After looking at a photo of a playground, students discuss what parts of the playground would be hotter and cooler on a hot day. Students will go outside to their playground on a hot day to explore the hot and cool areas, correlating these areas to places with shade and no shade. Students return to the classroom and the playground photo and circle the areas they think are cooler in blue and hotter in red.

LESSON 2: MAKING SHADE

This lesson is designed for one 30-minute session. After reviewing the hot/cool playground spots from lesson 1, Students will be asked, "On a hot day, which materials might keep the ground the coolest?". Students will be given tissue paper, photocopy paper, and construction paper. Students will go outside in the sun and explore which type of paper will allow the least light through. Students will graph the results on a worksheet.

LESSON 3: DESIGN TIME

This lesson is designed for one 30-minute session. Students are shown materials. Students are asked "How might we design a structure that will keep the ground the coolest?" Students design their structures by discussing, collaborating, and drawing. Students share their designs with their peers and the teacher.

LESSON 4: BUILD TIME

This lesson is designed for one 30-minute session. Students build their structures based on their designs. Have materials ready for students. Students share how they built their structures.

LESSON 5: HOW COOL ARE WE? - Structure Test

This lesson is designed for one 30-minute session. Students are shown how infrared thermometers work. Teacher uses infrared thermometer and has students record the ground temperature outside and inside their structure. Students record observations.

LESSON 6: HOW COOL CAN WE ENGINEER?

This lesson is designed for one 60-minute session. Students will share and discuss results. Students are shown solar panel and fan and are asked, "Using solar technology, how might we make the ground in our structures even cooler?". Using the solar panel and fan, students are allowed to rebuild and measure the ground in their structure. They record the temperature of the ground in their structure.

LESSON 7: REFLECTION

This lesson is designed for one 30-minute session. Students analyze their data with a partner and reflect how solar technology and their structures kept the ground (earth's surface) cooler.

ASSESSMENT AND EXTENSIONS

FORMATIVE ASSESSMENTS

Formative assessments for this unit will take place after each session of design, build, test, rebuild, and reflection. The first formal formative assessment will take place after Lesson 3.The students will be assessed on if the constraints of the materials were adhered to, and if the plan is relevant to building a shade structure. The second formative assessment will take place after Lesson 4. Students will be assessed on whether their structure is free standing and blocks light. The third formative assessment will take place after Lesson 5. The students will use an infrared thermometer to measure the temperature difference between the shaded and non-shaded areas. The fourth and last formative assessment will take place after lesson 6: The redesign. Students will redesign their structure adding a solar panel that will charge a fan.

SUMMATIVE ASSESSMENT

The summative assessment is a performance task that shows the shade structures do the following: are freestanding, create shade that cools the temperature, and creates wind that may further cool the temperature. The measurement of success will be the decrease in temperature of the earth's surface.

UNIT EXTENSIONS

- Lesson 1: Have students think about how animals might keep cool on a hot day. Have the student draw an animal and where it might go in its habitat on a hot day. (K-ESS3-1)
- Lesson 2: Use a radiometer in direct sun. Have students place different materials between the sun and the radiometer. Have the students chart which materials creates the radiometer to be the slowest to fastest.
- Lesson 5: Have students design a use for infrared temperature tools or liquid crystals in their house or playground.
- Lesson 6: What else can students add to the fan to make their structure colder (e.g. add an ice cube). Have the students identify how their classroom and house is kept cool. Is a fan motor involved?

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