Some Like It Hot.....Or Cold

Design and Construct a Solar Cooker or Cooler

Developed by:

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Discipline / Subject: STEM

Topics: thermal energy, heat transfer, insulation, conduction, convection and radiation

Grade Level: 5-8

Resources / References / Materials Teacher Needs:

- A visualizer or projector
- Access to the internet
- Freeze pops
- Ingredients to make s'mores
- "Teaching Sheet" (*see below*)
- "Grading Rubric For The Solar Cooker / Cooler Design" (*see below*)
- Informational / instructional letter for teachers who will help supervise (*see below*)
- Students should bring in recycled materials to build their cooker/coolers: cardboard, foam packaging, aluminum foil, etc.

Lesson Summary: In this activity, students will utilize the Engineering Design Process to design and construct a prototype of either a solar cooker or cooler. Students must select materials that will insulate and/or conduct heat in order to solve a problem. Students will use their knowledge of thermal energy, heat transfer, insulation, conduction, convection and radiation.

Standards Addressed:

Physical Science and Technological Systems

5.3-5-ETS3-1(MA) - Use informational text to provide examples of improvements to existing technologies (innovations) and the development of new technologies (inventions). Recognize that technology is any modification of the natural or designed world done to fulfill human needs or wants

5.3-5-ETS3-2(MA) - Use sketches or drawings to show how each part of a product or device relates to other parts in the product or device.

6.MS-ETS1-1(MA) - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.

6.MS-ETS1-5(MA) - Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.

6.MS-ETS1-6(MA) - Communicate a design solution to an intended user, including design features and limitations of the solution.

6.MS-ETS2-1(MA) - Analyze and compare properties of metals, plastics, wood, and ceramics, including flexibility, ductility, hardness, thermal conductivity, electrical conductivity, and melting point.

6.MS-ETS2-2(MA) - Given a design task, select appropriate materials based on specific properties needed in the construction of a solution.

6.MS-ETS2-3(MA) -Choose and safely use appropriate measuring tools, hand tools, fasteners, and common hand-held power tools used to construct a prototype.

7.MS-PS3-3(MA) - Apply scientific principles of energy and heat transfer to design, construct, and test a device to minimize or maximize thermal energy transfer.

7.MS-PS3-4(MA) - Conduct an investigation to determine the relationships among the energy transferred, how well the type of matter retains or radiates heat, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

7.MS-PS3-6(MA) - Use a model to explain how thermal energy is transferred out of hotter regions or objects and into colder ones by convection, conduction, and radiation.

7.MS-ETS1-7(MA) - Construct a prototype of a solution to a given design problem.

Learning Objectives:	**Method of assessment for learning:**
1. Students will demonstrate their understanding of the Engineering Design Process by using all of the steps of the process in order to design and test a solar cooker or cooler. 2. Students will collaborate with their peers in order analyze a problem and develop a solution. 3. Students will be able to demonstrate their understanding of thermal energy, heat transfer, insulation, conduction, convection and radiation. 4. Students will effectively use close reading strategies in order to increase their comprehension and understanding of a text. 5. Students will develop an understanding that the significant idea is <u>*process* **OVER** *product*.</u>	1. Students complete all of the steps of the Engineering Design Process. 2. Students record all of their answers and observations in their student packet. 3. Students develop a solar cooker or cooler that is designed based on research and knowledge of important concepts (*see topics above*). Successfully designed solar cookers must melt a s'more in a given time. Successfully designed coolers must keep a freezepop from melting during a given amount of time. 4. Students respond to the questions based on the five informational articles. 5. Students are engaged and participate in classroom discussions and activities.

Procedural Activities:

1. Ensure that students understand the concepts of thermal energy, heat transfer, insulation, conduction, convection and radiation.

2. Introduce the "problem" to your students and let them know that they will be challenged to design a solar cooker or cooler. In order to do this, let them know that they must conduct research and learn about solar cookers and coolers, as well as the various designs and materials that are used to construct them.

3. Have the students closely read and annotate the five articles:
   - "How do solar cookers work?"
   - "The solar cooker that seeks its own place in the sun"
   - "5 Ways to Keep Food Cool Without a Refrigerator"
   - "What is solar cooling and how can developing countries nations benefit?"
   - "This New 'Refrigerator Backpack' Could Help Transport Vaccines to Remote Areas: This could change countless lives

   You might consider using the jigsaw activity/technique for these readings

4. Have a classroom discussion about each of the articles.

5. Have students answer the five questions that follow the articles.

6. Show students the following videos and make connections between the videos and the articles:

   - Solar Cooker Info
   - Solar Cooker Design
   - Biocooler
   - Solar Cooler

7. Explain the activity to your students. Emphasize that they will be using the Engineering Design Process in order to complete this task. Give each student a packet that outlines the assignment. This is also where students will record many of their answers and observations.

8. Have students work in pairs. Determine whether or not you would like to make the pairings or let the students choose.

9. After the students are put into pairings, look at **Step 1- State the Problem**. Ensure that students understand what the solar cooker and cooler must be able to do. Have students discuss with their partner and determine which design challenge they would like to pursue.

10. Have students complete **Step 2 - Research the Need or Problem**. Students will conduct research and answer the questions that are provided for them. Model how to conduct research and locate credible, informative and relevant resources.

11. Have students complete **Step 3 - Develop Possible Solutions**. Pairings will draw, describe and label four different sketches of prototypes that they could possibly construct. Show students a model of a detailed sketch. ***Inform students that THEY will be responsible for locating and acquiring the materials to construct their design***

12. Have students complete **Step 4 - Select the Best Possible Solution**. Students will choose one of their prototype designs. Review the list of materials that students should consider using. Tell them that they are allowed to use materials that are not listed. Provide students with a timeline or date in which they must have their materials acquired by.

13. Have students complete **Step 5 - Construct Your Prototype**. Emphasize that while students are constructing their prototype, if they have any discussions or problems that they encounter, they should document how they worked together to come up with a solution. They should also describe the solution(s) they agreed upon.

14. Have the pairings share and present their final design to the class. Presentations should address the following questions:

    I. Did you create a cooler or cooker?
        A. Do you think it is more important that your design insulates or conducts heat or both?
        B. How will your design either prevent or promote heat transfer?

    II. What materials did you choose?
        A. Are these materials conductors or insulators?

    III. How do you think your group design will work?

    IV. Explain a few of your prototype choices and why you did not choose them.

    V. Why did you decide on your final design and how do you predict it will work?

    ➢ While each group presents, have the students, who are listening, complete a peer review form (*see form below*).
    ➢ Collect all of the peer review forms after the presentations have ended.

15. On a designated day, complete **Step 6 - Test and Evaluate Your Design**. Make sure you choose a day that expected to be sunny. If you live in a cold climate, you will have to have students test and evaluate the coolers in an indoor/warmer environment.

   - ➢ Give each student a “Student Observation Sheet.” Review the sheet with students and answer any questions. Tell students that they must complete this while they are testing their design.

   - ➢ Prior to this day, prepare your materials that you will give each group: s’mores ingredients or a freezepop. Give each group the necessary materials that correlate with their chosen project. Each team will also need a cellphone or another device that will help them time the testing and obtain weather data.

   - ➢ After the students test their design, have them describe the things that worked and/or did not work. They will record their answers in their student packet.

   - ➢ This activity/test will most likely take longer than your usual class period. Consequently, you may need to coordinate with teachers from other classes in order to solicit their help and support. Consider using the letter template that outlines the instructions. Also, the letter includes questions that supervising teachers can ask students while testing occurs (*see letter below*).

16. After students have tested their design and recorded their observations, have them complete **Step 7 - Communicate Your Solutions**. Have groups pair and share. Those who designed cookers should only pair with others who designed cookers. Similarly, those who designed coolers should only pair with others who designed coolers. Instruct groups to engage in a conversation and share the results with one another. Then, have the students compare and contrast each other’s designs. They should record their findings in the Venn diagram.

17. Have students complete **Step 8 - Redesign**. Students will evaluate the things that did and didn’t work well for their design. They must determine the things that they could do differently in order to create a better design. Instruct students to record their observations and answers in their packet. You also must instruct them to draw and describe their new design.

18. Have students complete and submit a “partner evaluation” (*see below*). Collect these after students have finished them.

19. Collect the student Engineering Design Process packets. Use the rubric (*see below*) to guide your grading.

Materials Students Need:

- Each student needs an Engineering Design Packet. This includes steps 1-8.
- Access to the internet
- The five informational articles (*see below*)
- Students will be responsible for acquiring the materials that they choose in order to design their prototype
- Each team will need a cellphone or another device that will help them time the testing and obtain weather data.

Technology Utilized to Enhance Learning:

- Visualizer or Projector
- Stopwatches/timers
- Thermostat
- Cellphone

Other Information:

- Step 6 - Test and Design will take longer than your typical classroom time. Plan accordingly.
- If you live in a cold environment, you will need to have students who designed coolers test their projects indoors
- While testing outside, students might need sunscreen, a hat and/or a water bottle to stay hydrated

Modifications for Special Learners/ Enrichment Opportunities:

- Have students develop an ad campaign for their design -- what is the name of your device? Do you have a slogan? How much will it cost? Who is your target customer?
- Scaffold the notes
- Increase pairings to groups of 3-4 students
- Challenge pairings to create both a solar cooker and cooler

Some Like it Hot.....or Cold

In this activity, you will utilize the Engineering Design Process to design and construct a prototype of either a solar cooker or cooler. You must select materials that will insulate and/or conduct heat in order to solve a problem. You will use your knowledge of thermal energy, heat transfer, insulation, conduction, convection and radiation.

STEP 1 - State the Problem:
Solar Cooker - Can you make a smore with the sun's energy?
Cooler - Can you keep a freezepop from melting?

My partner and I were selected to create a ________________________.

STEP 2 - Research the Need or Problem: Do some research at home and use the readings from last week to answer the following questions: What materials will be the best conductors and insulators? What possible designs have other's constructed? How does the sun radiate heat? How do objects get this heat? How can the sun's energy be transferred to objects? How can we prevent heat transfer? How can you keep the heat or cold in your container?

STEP 3 - Develop Possible Solutions: Draw, describe and label 4 different sketches of prototypes your team could possibly construct. You can recreate another person's design or invent your own design. Your sketches should be very detailed and include the materials you will use.

Your team will need to bring in <u>all</u> of the supplies you plan to use to construct your design.

Prototype A	Prototype B
Prototype C	Prototype D

STEP 4 - Select the Best possible Solution: Choose one of your designs. Describe in detail how you plan to create your prototype. See the list of materials for some ideas.

My team chose Prototype _______

Material Ideas:

construction paper	newspaper	bubble wrap	aluminum foil
plastic/paper cups	styrofoam	tape	empty food boxes
ruler	saran wrap	scissors	cardboard

Materials you will use: ____

Why do you think this design is the best choice?

____

____

Plan of action: List materials and tools you plan to use and how you plan to assemble.

STEP 5 - Construct Your Prototype: At this step, you will build your prototype. During the building process, list any discussions or problems that occurred and how the team came together to decide on a solution and why it was chosen. This information will be valuable to your team when you test and evaluate your design.

Day One:

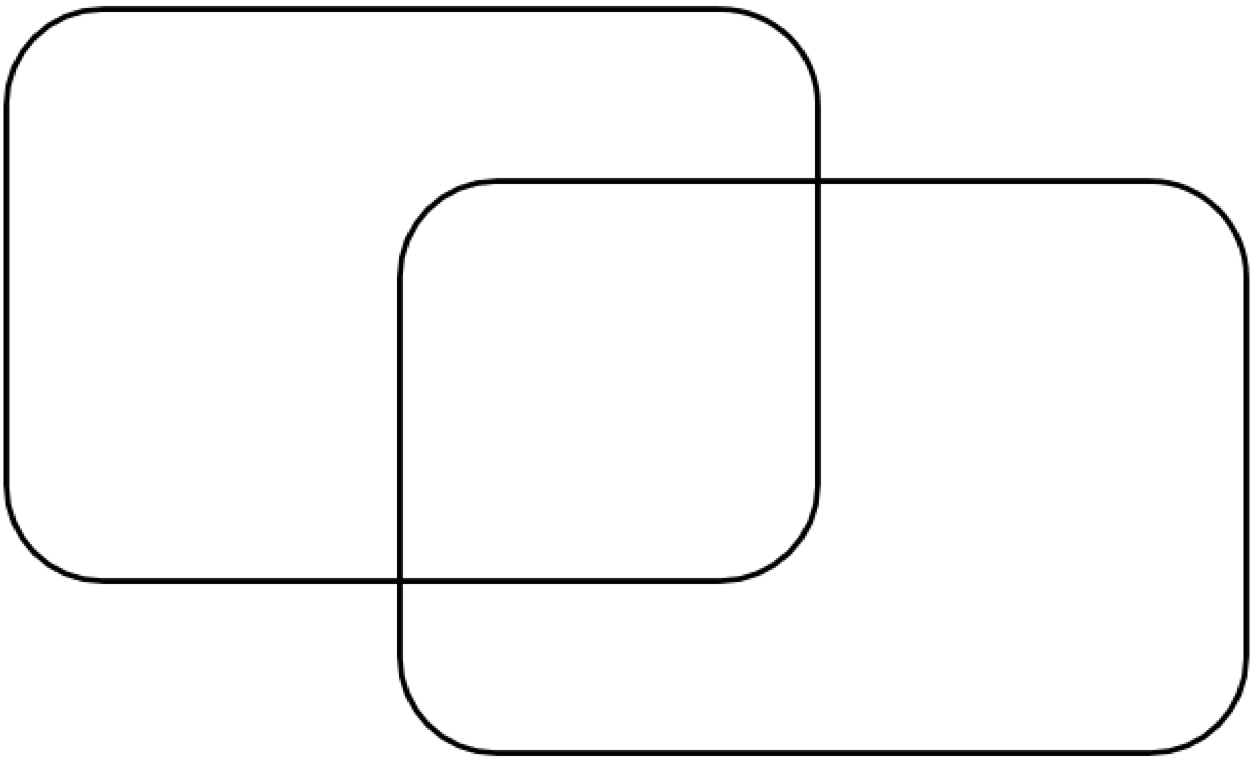
Day Two:

Day Three:

STEP 6 - Test and Evaluate Your Design: On a designated day we will test our designs.
Solar Cooker: A successful design must melt the s'more in a given amount of time.
Cooler: A successful design must keep a freezepop from melting in a given amount of time.
Was your team's design a success? Describe in detail. What worked? What didn't work?

STEP 7 - Communicate Your Solutions: Pair and Share your results with another team. If you made a cooker, team up with a team that also designed a cooker, etc. In your discussion, be sure to discuss your evaluation of your own design and field any questions/compliments/recommendations the other team may have for you. Compare and contrast your design with the other team's design in the Venn diagram below.

Your Design

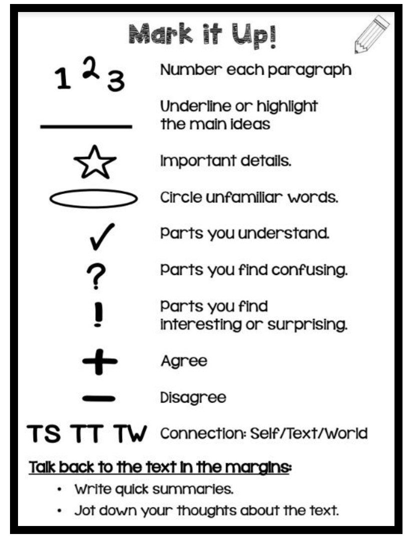


Their Design

STEP 8 - Redesign: If you were able to recreate this design, what would you do differently? Would you use different materials? Would you construct the prototype in a similar way? Would you create a new design? Draw and describe your redesign below.

Name ________________________________ Date _____________ Block ____

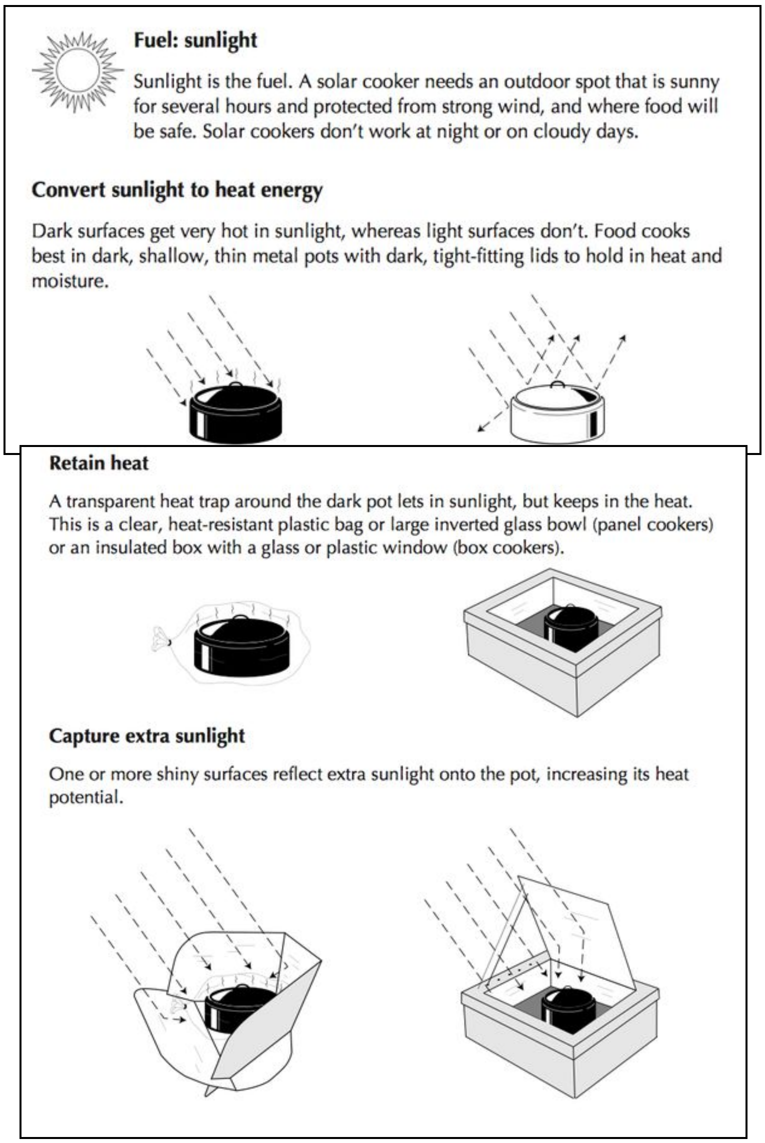
Read the following articles about the importance of solar cookers and coolers. Use the "Mark it Up! techniques in the box at the right of the page while you read the articles. Answer the questions that follow.



Article 1:

How do solar cookers work?

Most solar cookers work on the basic principle: Sunlight is converted to heat energy, that is retained for cooking. Below is the basic science for solar panel cookers and solar box cookers. Another style of solar cooker is a parabolic solar cooker. They typically require more frequent reorientation to the sun, but will cook more quickly at higher temperatures, and can fry foods.



A solar cooker needs an outdoor location that is sunny for several hours and protected from strong wind, and where food will be safe. Solar cookers don't work at night or on cloudy days, though during the best months for cooking, many foods can be cooked under intermittent clouds or a light haze, as long as food is put out early and there is definitely more sun than not overall.

Parabolic solar cookers use a bowl-shaped reflector to focus the light more directly onto the cookpot, usually from below, and typically do not require a greenhouse enclosure to retain the heat. They can also fry and broil foods.

Converting sunlight to heat energy

At its simplest, the sunlight-to-heat conversion occurs when photons (particles of light) moving around within light waves interact with molecules moving around in a substance. The rays emitted by the sun have a lot of energy in them. When they strike matter, whether solid or liquid, all of this energy causes the molecules in that matter to vibrate. They get excited and start jumping around. This activity generates heat. Dark surfaces get very hot in sunlight, whereas light surfaces don't. While food cooks best in dark, shallow, thin metal pots with dark, tight-fitting lids, there are many other containers that can also be used in a solar cooker.

Retaining heat

A transparent heat trap around the dark pot lets in the sunlight, and keeps the heat that is produced from escaping. This is a clear, heat-resistant plastic bag or large inverted glass bowl (in panel cookers) or an insulated box with a glass or plastic window (in box cookers).

Light passes through the plastic bag or glass cover as a relatively short wavelength. Heat is reflected back as a longer wavelength, and does not easily pass back through the clear enclosure. This explains why cars left in the sun, especially those with black interiors, will slowly become hotter and hotter, even on days with low air temperatures.

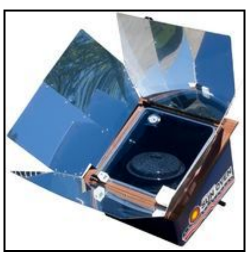
Parabolic solar cookers typically do not require a heat trap, as the light from the reflector is tightly focused on the cook pot. They cook at higher temperatures, but require more frequent reorientation with the sun than box or panel cookers.

Capturing extra sunlight energy

One or more shiny surfaces reflect extra sunlight onto the pot, increasing its heat potential. Mirrors, aluminum foil, Mylar, mirror-finish metals, chrome sign vinyl, and other shiny materials have all been used successfully for solar cooking, depending on the type of cooker and the environment in which it will be used.

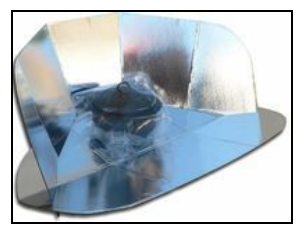
Solar cooker types

The three most common types of solar cookers are box cookers, curved concentrators (parabolics) and panel cookers. Hundreds — if not thousands — of variations on these basic types exist. Additionally, several large-scale solar cooking systems have been developed to meet the needs of institutions worldwide.

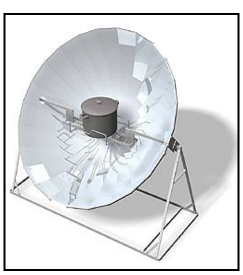


Box cookers

Box cookers cook food at moderate to high temperatures and often accommodate multiple pots, typically taking between one and three hours to cook various foods. Worldwide, they are the most widespread. There are several hundred thousand in India alone.



Panel cookers Panel cookers incorporate elements of box and parabolic concentrator cookers. They are simple and relatively inexpensive to buy or produce.



Parabolic cookers Parabolic solar cookers use a bowl shaped reflector to focus the light more directly onto the cook pot, usually from below, and typically do not require a greenhouse enclosure to retain the heat. The parabolic name refers to the shape of the curve of the reflector cross-section. They will require more frequent reorientation to the sun, possibly every 10 minutes, but they cook food more quickly at higher temperatures compared to other solar cookers, often reaching over 200°C (400°F). They also have the ability to fry foods. Generally parabolic solar cookers will need to be attended to more than box or panel cookers to avoid possibly burning the food at the bottom of the cook pot. They are especially useful for large-scale institutional cooking.

Article 2: from the Guardian - Jan 2017

The solar cooker that seeks its own place in the sun

Solar cookers need to be moved during the day, an inconvenience that leads to some being discarded. But what if a clever unit did its own sun tracking?

Solar cookers have been promoted as a safe alternative to boil water, cook food, or even sterilize medical equipment, but many require the user to move the unit so that its focal point is in direct line with the sun. It is a seemingly simple move, but critics claim it has tended to deter users from cooking with them.

Roughly 3 billion people worldwide still cook on open fires or solid fuel stoves, according to the World Health Organization, which estimates more than 4 million people die every year because of household pollution associated with such cooking measures.

To address the inconvenience of using a standard solar cooker, South African electrical engineer Wilfred Leslie Owen Fritz has spent the past year developing a version that tracks the sun's rays automatically, allowing the user to leave it in the same place.

"Imagine all the times in a day when you would have to move the unit – it's annoying," says Fritz. "If you don't adjust the unit, then it doesn't heat the pot or pan. So even if communities get 1,000 of these cookers donated to them, they end up using them to cover holes in their roofs or as dishes for the animals to eat from. Then they go back to their other methods for fuel: wood or even electricity, if a grid is nearby."

Working alongside colleagues and students at the University of Stuttgart in Germany, and Cape Peninsula University of Technology in South Africa, Fritz has designed a solar cooker with automatic sun tracking, and temperature and timing controls. While working on the cooker, he realized it would be more efficient if it could also purify water and sterilize medical equipment – then it would have both commercial and household uses.

Water&Solar100, as they named it, is lightweight, foldable and portable, and can generate electricity, charge batteries and sterilize water and medical instruments in rural areas where alternative equipment is unavailable.

"You can place our unit anywhere in the world – from the inner city to Alaska – and when the sun comes up, it will automatically track where the sun's rays are most concentrated and then follow that path. You do not need to move it, you just place it. You can also leave your food on [the cooker], and as soon as the temperature gets too high, it moves the focal point away [for you] so that your food remains at the temperature you have set for it."

The oven's combination of timer and temperature controls enables users to set a required heat (low, medium or high) for their dish along with the time required. "If you know your meal will take 30 minutes to cook, you put your pot on to our solar stove and then you can go off and do something else," says Fritz.

The cooker is being piloted in various locations, including a Cape Town orphanage, a rural South African farming community, a low-income housing scheme and a German research lab.

Although each unit costs €200 ($245) to produce, much of that cost is due to production being in China, says Fritz, who estimates that unit costs would decrease by 50% if production were moved to South Africa.

While the oven is created to focalize the sun's rays, Fritz has also developed a wider version that would allow for larger, more effective use. "That doesn't create a focal point but a focal line, which means you can place pots and pans side by side," he says. "If you let water flow through a pipe on that line, then it automatically gets purified at

100℃. This is useful for rural areas where water is not potable, or for hospital systems." The Cape Town orphanage is using the cooker to heat its water system.

For Fritz and fellow oven innovator Deon Kallis, both of whom grew up in rural communities with little access to running water, electricity or proper medical services, their solar cooker is just one way to improve living conditions for millions of people across South Africa.

Ultimately, Fritz hopes to develop a system that can be used by clinics and hospitals across South Africa and the continent. "Our personal goals are to use sustainable practices, such as solar and others, to address life-threatening issues across the globe," he says.

Article 3:

5 Ways to Keep Food Cool Without a Refrigerator

Did the power go out, and you're panicking to keep your food from rotting without a refrigerator? Are you trying to cut back on costs, or go about cooling your food in a more natural approach? Or, are you moving and you need to keep your food from spoiling while you drive to your new home? Don't worry! Your food will be perfectly safe and cool with these five methods of keeping food cool without a refrigerator:

Coca Cola's Bio Cooler

Coca Cola has invented a way to keep it's cans of Coke cool as well as refrigerate food by simply harnessing the power of the sun's heat! This Bio Cooler doesn't use any electricity which means it can be used in rural places off the grid. Interestingly, the hotter the outside temperature, the cooler the items are inside the Bio Cooler. This invention was discovered by researching ancient refrigeration technologies which do not use electric power. Their final product combines evaporation refrigeration with a conventional refrigeration system activated just from the sun's energy captured by a mirror.

Zeer Pot: Make Your Own Fridge

This is a must have in rural Africa and the Middle East! It's very simple and preserves food, keeping it cool without the need for electricity. Simply take two different sized clay pots and fill the larger pot with wet sand or gravel. Place the smaller pot inside making sure it is surrounded by the sand or gravel. On the smaller, inside pot place a lid on top. Keep all of your vegetables, fruits, and other food cool with this pot set up!

Ice Chest

Yes, the classic ice chest cooler that was a stronghold in many houses in the West before the modern invention of the refrigerator. Simply grab an insulated chest and fill it with ice. You can use a variety of materials such as plastic, metal, etc. Secure the lid on it to keep the inside air cool and keep your foods at a safe temperature. All you need is some ice – cubed or liquid – and you're good to go! Great for camping trips, boats or to the beach, etc.

Sea Water Cooler

Keep a water and air tight container full of your favorite goodies and attach it to a rope. Tie it up to your dock and keep it in the sea. This will work if you live in a cooler climate. The temperature of the sea is always much more cold that the air outside.

Article 4:

What is solar cooling and how can developing countries nations benefit?

Vaccines can be life saving and life changing. However most of them need to be kept not too hot and not too cold. In a report, “Sustainable Energy for Developing Countries Report,” written for the Tear Fund, one of the primary needs identified for some of the world’s poorest communities (which do not have access to any electricity) is a device to keep medicines and vaccines at a safe temperature to ensure that they can be used. Such communities are often provided with medication free of charge by relief agencies but much is spoiled before use, as there is no means to maintain the items at the requisite temperature. Sometimes cooler packs like the ones you might take on a picnic are used during transport and they make the vaccine too cold and damage them. Other places just don’t have the electrical power to work a simple fridge to keep them from damage.

Solar cooling is able to provide an off grid solution. Solar cooling uses the sun’s thermal energy to heat fluid to a high temperature and is used to run a chiller system very similar to standard refrigeration models. These systems can be used in very rural areas without the use of electricity. These units can also provide fresh drinking water.

Water as a basic human right. Women in Africa and Asia have to walk five hours a day to collect 20kg water, wasting 40 billion working hours. 443 million school days are wasted because of sickness caused by unclean water. In conflict zones there is a terrible rate of attack during these trips. In areas of high humidity, the solar cooling units can be used to condense water from the atmosphere, making a source of clean safe water close to villages.

Article 5: JOSH HRALA 12 SEP 2016

This New 'Refrigerator Backpack' Could Help Transport Vaccines to Remote Areas
This could change countless lives.

A student in the UK has designed a miniature, mobile refrigerator that can fit inside a backpack to easily transport medical supplies and vaccines to people in remote areas.

The portable device has been shown to keep vaccines at an optimal temperature for up to 30 days, and if it lives up to its potential, health experts have predicted that it could help treat more than 1.5 million people around the world. "I make things every day for people who have everything," the inventor, Will Broadway, told Michael Baggs from the BBC. "I wanted to make something for people who have next to nothing. It should be a basic human right, in my opinion, to have a vaccination. I don't think that it should be patented to restrict use." Right now, getting vaccines to people in developing countries in Africa and parts of Asia relies on something called the 'cold chain transport' - a type of supply chain where goods are kept at very precise temperatures while in transit by making a series of stops along the way.

The problem with this system is that many developing countries and remote regions don't have proper cold chain supply lines in place, because their roads and electrical systems are unreliable. This means that many vaccines and other medical supplies run the risk of hitting unsafe temperatures in transit, rendering them useless by the time they reach their destination. "Blood donations, organ transplants - if they get stuck in traffic, you still use cold packs that really aren't adequate for long periods of time," Broadway, who is currently studying at Loughborough University in England, told the BBC.

After noticing these flaws during a trip to Cambodia in 2012, Broadway went about developing a device that would keep vaccines and other supplies at a proper temperature for the duration of the trip, skipping all the stops that a normal vaccine transport route would take.

He came up with a mini refrigerator - which he's named the Isobar Cooling Tank which has a self cooling process using chemicals but relies on effective insulation to reduce heat transfer.

Broadway says he envisions the device as a way to transport organs and blood in the future, though right now his focus is on vaccines. Going forward, he says he wants to be involved in the production of the device to ensure that it's working the way he intended. "I would be hands on, all the way through it, knowing that it works," he told the BBC. "It's amazing to just give it a go, even in my backyard, and see the potential of the technology."

So far, there's no word when the Isobar Cooling Tank will start seeing actual use, but given the amount of attention it's garnered, and the possibilities it offers, hopefully it lives up to its promise and makes a real difference for those in need of better access to medications in the future.

Questions:

1. Discuss why the invention of solar cookers is important to developing nations?

2. Discuss why the invention of solar coolers are important to developing nations?

3. How can these inventions benefit you, living in the United States? Connect your ideas to our previous units of study.

4. What materials would you use to create a solar cooker? Label each material as an insulator or conductor.

5. What materials would you use to create a solar cooler? Label each material as an insulator or conductor.

TEACHING SHEET -- NOT FOR STUDENTS

Videos:
Solar Cooker Info
Solar Cooker Design

Biocooler
Solar Cooler

Solar Cooker / Cooler Presentation Questions

1. Did you create a cooler or cooker?
   a. Do you think it is more important that your design insulates or conducts heat or both?
   b. How will your design either prevent or promote heat transfer?

2. What materials did you choose?
   a. Are these materials conductors or insulators?

3. How do you think your design will work?

4. Explain a few of your prototype choices and why you did not choose them.

5. Why did you decide on your final design and how do you predict it will work?

For those who have *extra time*: Develop an ad campaign -- what is the name of your device? Do you have a slogan? How much will it cost? Who is your target customer? Show your colorful newspaper advertisement.

YOUR NAME______________________________ **Block** _____ **(Please do in order)**

PEER REVIEW

Team Names ____

How well did this team communicate their design to the class?

0 1 2 3 4 5 6 7 8 9 10

PEER REVIEW

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0 1 2 3 4 5 6 7 8 9 10

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PEER REVIEW

Team Names ____

How well did this team communicate their design to the class?

0 1 2 3 4 5 6 7 8 9 10

PARTNER EVALUATION

Your partner's name______________________________________

How well did your partner contribute to your design? (work ethic, effort, cooperation)

0 1 2 3 4 5 6 7 8 9 10

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PARTNER EVALUATION

Your partner's name______________________________________

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GRADING RUBRIC FOR THE
SOLAR COOKER/COOLER DESIGN

Name______________________________ **Block**________

Packet Steps 1-8: ______/ 40

Peer Grading: ______/ 20
Partner & Team Evaluation

Your Design: ______/ 40

TOTAL: ______/ 100

Teacher Comments:

Dear Teacher,

Thank you for helping out with today's solar cooker & cooler experimental testing. At ____________ (time), students will go to their science classroom to retrieve their project and file out to _____________________________ (location). Students should report to their designated science section. I/We would ask that you help supervise the students. We plan to be testing until approximately _____________.

Students will be instructed to sit in their partner groups and set up their designs. Once they receive their supplies (S'more or Freeze-pop), they will begin their timers and make careful observations.

While you are helping to supervise our students, we would like you to ask each group to communicate information on their designs. Use the following questions below. You will receive a sheet of award stickers that you are free to distribute to deserving teams. Once again thank you for your help and support!

Questions:

1.Did you create a cooler or cooker?

2. How does your cooker/cooler work?

2. What materials did you choose?
    a. Are these materials conductors or insulators?

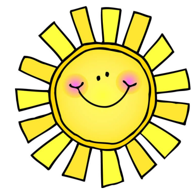
3. Do you think it is more important that your design insulates or conducts heat or both?
    a. How will your design either prevent or promote heat transfer?

4. What are some ideas you were going to create but did not?

5. Did you enjoy this project this? What do you like or not like about this activity?

Names ____ Teacher Name/Block ___________

Student Observation Sheet



What to bring:

-This Paper! -Your Project -Pencil

-Cell phone to time your testing and to obtain weather data

-Sunscreen / hat / water bottle - the forecast is hot and sunny!

Sit with your group/design at all times in your designated teacher area and answer teachers' questions politely. Your design will be evaluated by your teachers!

Date: ________________________

Starting Time: ________________ Ending Time:________________

Weather Conditions:

Temperature:__________ Cloud Cover:__________________________

Humidity:_____________ Wind Direction and Speed:_______________

Air Pressure:__________ UV Index:__________

Design Observations:

Sketch a drawing of the placement of your cooker/cooler. Include the sun in your drawing, if there is any shade, is your design place on grass, dirt, asphalt?

Throughout testing make observations by touching the outside of your design. Note any adjustments you needed to make to your design during the testing process. Does it appear to be working?

Bring this sheet to class tomorrow to help complete your packet (steps 6,7,8).

At the end of testing, you may take your project home or back to your science teacher's class.