FRIDAY: Kitchen Science - Solar Cookers and Ice Cream

Adapted from Discovery Education and
https://www.pcc.edu/about/events/sustainability-training/documents/solar-cooker.pdf

Part A: BUILD: Building a Basic Solar Cooker

Here's what each camper will need:
Tall Pringles can
Wooden Skewer

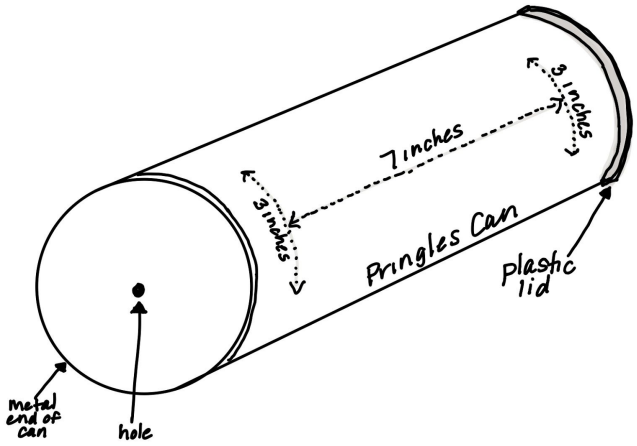
Here's what the campers can share:
Thermometer
Scissors (utility knife-ADULTS only)
Marshmallows
Nail

What

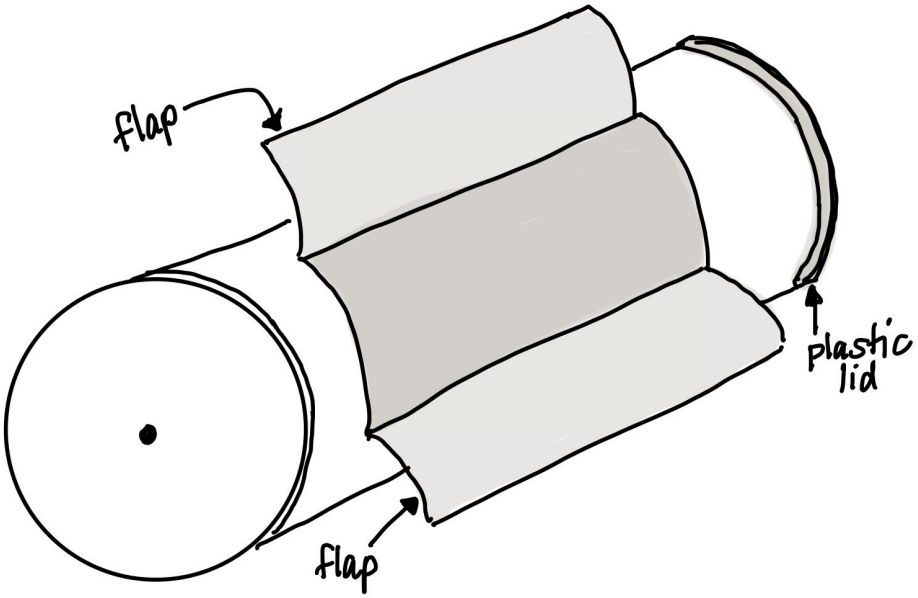
Radiant energy from the sun can be reflected and concentrated on an object. A portion of the radiant energy absorbed by an object is in the form of thermal energy (heat). This is an energy conversion: radiant energy to thermal energy. Radiant energy can pass through clear materials much easier than thermal energy can.
The flaps on the Pringles can will be used to reflect radiant energy onto the marshmallow, thus concentrating the amount of energy that will be converted into heat.
When positioning the flaps on the can to reflect the maximum amount of radiant energy onto the marshmallow.

Basic Procedure:

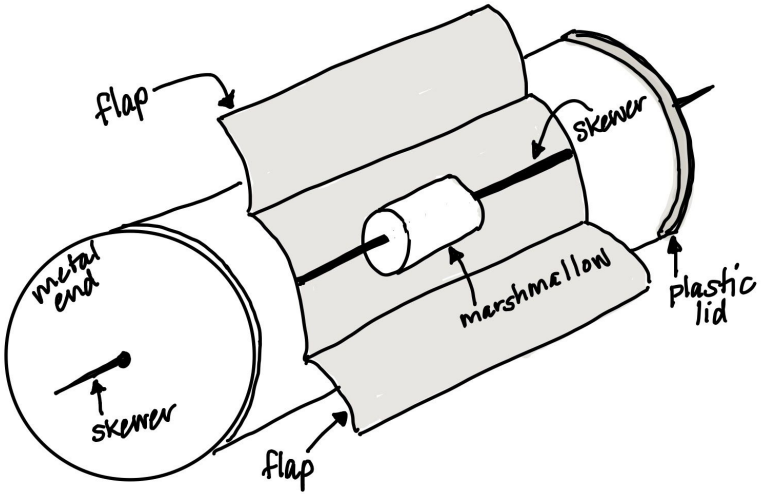
1. Open the Pringles can and remove the chips.
2. If you have a hammer, have an adult help you to use a hammer and nail to punch a hole in the center of the bottom of the can as shown in the diagram.
   OR
   If you do not have a hammer, have an adult help you to use the nail to dent the center of the can. Carefully push and twist the nail until you have created a hole in the can. You may need to move the nail around to make the hole big enough so that the wooden skewer is able to fit through it.
3. Measure and mark the can as shown in the diagram below. Have an adult help you to cut your marks on the Pringles can. They will need to use the utility knife to carefully cut the can.



4. Bend back the flaps, but do not remove them from the can.



5. Remove the plastic lid from the can. Place the skewer through the plastic lid. Put the plastic lid back onto the can, adjusting so the skewer reaches the hole in the metal end of the can. Push the skewer so that it is secured through the hole in the metal end of the can. The marshmallow should be suspended inside the can.
6. Take the temperature of the solar cooker before you start cooking. Record the starting temperature on your data chart.
7. Place the solar cooker in direct sunlight, positioning the flaps to reflect the maximum amount of radiant energy onto the marshmallow.
8. At the end of cooking, take the temperature again and record the temperature. Record the amount of time required to cook the marshmallow.



Part B: REDESIGN: Improving your Solar Cooker

Here's what the campers can share:
Thermometer
Scissors (utility knife-ADULTS only)
Marshmallows
Tape and/or glue
Acetate and sheet protector
Aluminum foil
Black construction paper
White construction paper

In order to cook using sunlight, we need to transform the radiant energy of sunlight into thermal energy. Thermal energy is heat. It is the internal energy of substances. It is caused by the vibration and movement of atoms and molecules within substances. The faster the molecules in a substance move or vibrate, the more thermal energy is in that substance.

Successful solar cookers must have a large area of reflecting surface to focus light waves. All cookers are most effective if:

- they directly face the sun (or are at least at a 45-degree angle to the sun to catch incoming energy)
- when their reflective material is as smooth as possible.
- when the user is able to change the angle of reflection so that it hits the food more directly.
- thermal heat is contained inside the cooker.
- when the cooking container is a dark color.
- when the cooker is only a bit larger than the food it holds.

USE YOUR MATERIALS TO PLAN SOME CHANGES:

1. Look at the basic solar cooker that you built. What types of improvements can you make to make it more effective? Use your additional materials to make changes to the basic design.
    a. How can you better direct the light to your marshmallow?
    b. How can you direct MORE light to your marshmallow?
    c. How can you allow light to enter but trap the heat inside the can?
    d. Is your can the appropriate size for the marshmallow? How can you adjust the size of the internal cooking area WITHOUT changing the size of the can?
    e. How can the rest of the can absorb heat, even if light cannot enter?

TEST YOUR REDESIGN:

2. Remove the plastic lid from the can. Place the skewer through the plastic lid. Put the plastic lid back onto the can, adjusting so the skewer reaches the hole in the metal end of the can. Push the skewer so that it is secured through the hole in the metal end of the can. The marshmallow should be suspended inside the can as in the diagram.
3. Take the temperature of the solar cooker before you start cooking. Record the starting temperature on your data chart.
4. Place the solar cooker in direct sunlight, positioning the flaps to reflect the maximum amount of radiant energy onto the marshmallow.
5. Take the temperature again at the end of cooking. Record the amount of time required to cook the marshmallow.
6. Did your cooking time and cooking temperature improve?

Part C: FOOD SCIENCE: Ice Cream After Phase Change

Materials:

Here's what each camper will need:

Gloves to protect your hands

Here's what the campers can share:

Thermometer
Gallon plastic bag
Quart plastic bag
4 cups ice
½ cup rock salt or ice cream salt
1 cup of half & half (or whole milk) per serving
Sugar (2 tbsp) per serving
Vanilla (1tsp) per serving

Ice cream is delicious, but it is also a really cool example of phase change. Technically, the temperature that the salt lowers is called the freezing point. When a freezing point is lowered, such as by adding salt to water, the process is called freezing-point depression. When the cream changes phases it will change from a liquid to a solid.

However, because we will use salt to make this more difficult, the ice cream will stop before it freezes into a solid. As we'll see in this activity, freezing-point depression is not unique to solutions made of water and salt; it also happens with other solutions. (A solution is made when a substance, such as salt, is dissolved and becomes a *solute*. The medium into which it is dissolved is a *solvent*—typically a liquid, like water.) . The secret to making ice cream is to lower the freezing point of ice so it can freeze the cream. How? The scientific secret is plain old salt!

If you are lactose intolerant - Coconut milk and lactose-free milk can be used to replace the half&half. Be patient though...it might take a little longer to freeze! Why do you think that might be?

Basic Procedure:

1. Pour half & half (or milk), vanilla and sugar into a quart-sized zip-top bag for each serving.
2. Squeeze out air and seal the bag tightly. Place inside the second quart-sized bag and seal.
3. Place the double-bagged ingredients inside the gallon-sized freezer bag. Fill the freezer bag with ice, pour in the rock salt, squeeze out the air and seal. Use the thermometer to take a temperature reading of the milk mixture. Record the temperature on the temperature graph.
4. Put on your gloves to protect your hands.
5. Gently shake the bag, making sure the ice is evenly spread out. Continue to shake and knead the bag in your hands. If you have secured the bags well, you can toss your ice-cream making package back and forth. Put on some music and enjoy the time.
6. After 3 minutes, carefully open the bags and take the temperature of the ice mixture. Record the temperature on the temperature graph.
7. Continue shaking and tossing the bag. Test the temperature every three minutes and record on the graph. Continue until the ice cream should be solid and ready to eat. This should take about 10-15 minutes. The ice cream will be in a solid phase.
8. Distribute the ice cream in small cups and ENJOY!

Optional Experimentation:

Part 3 was designed to use some kitchen chemistry for fun, but if you would like to be more experimental with your ice cream, design your own experiment! Some suggestions are below.

1. Test different concentrations of salt - Does it affect the freezing time of the ice cream? What does this tell us about the effect of salt on freezing point?
2. Test different types of milk (heavy cream, half & half, whole, 2% or skim)- Which freezes fastest? What is the texture of ice cream made by the different types of milk?