Environmental Science Institute
UNIVERSITY OF TEXAS AT AUSTIN

Cooking with the Sun

Subject: Science

Grade Level: Middle school (6-8)

Rational or Purpose:
Students will gain the understanding that solar cookers come in different designs and are simple to build.

Materials:

- Copies of “Cooking With the Sun” reading passage
- Copies of the student data sheet
- Copies of the assessment questions
- Sunglasses for each student
- For each solar cooker that is built:
  - 1 250 ml beaker with 200 ml of water
  - 1 small thermometer
- Materials for solar cooker #1 (box panel cooker):
  - 1 cardbox 30 cm per side
  - Xacto knife
  - Rubber cement
  - Aluminum foil
  - 8 inch dowel at c. ¼ diameter or chop stick
  - timer
- Materials for solar cooker #2 (simple cone cooker):
  - 1 90 by 90 cm poster board
  - Rubber cement
  - Aluminum foil
  - 3 brass brads
  - 1 box 30 cm by 30 cm by 30 cm
  - timer
- Materials for solar cooker #3 (modified box panel cooker):
  - 1 cardbox 30 cm per side
  - Xacto knife
  - Black paint
  - Paint brush
  - timer

Lesson Duration: Two 60 minute periods

TEKS Objectives:

§112.22. Science, Grade 6 -8

(1) (A); (2) (B-E); (4) (A)

Background Information:

Solar energy provides an alternative way to cook food, by converting sunlight into heat energy. It is the most convenient way to cook food without using our natural resources. There are 3 common designs of solar cookers that are used: heat-trap boxes, curved concentrators (parabolics), and panel cookers. In addition, solar cooking offers many advantages relating to health and nutrition (i.e. preserving nutrients at a moderate temperature), economics (i.e. saving money on cooking fuel by utilizing the sun's free energy), and many household uses (i.e. sanitizing dishes and utensils).

Activity:

This lesson will allow students to build 3 different types of solar cookers to test, record, and compare heating capabilities of each cooker.

Procedure:

Day one:

1. To spark your students' curiosity, offer each student a cookie. Ask them to look at the cookie. The students will report nothing unordinary. After they have discovered nothing unusual with the cookie, allow them to eat the cookie.

2. Introduce the lesson by informing students that the cookies were made in a solar oven. Initiate a classroom discussion about what the already know about solar cookers. Create a K-W-L chart on the board to organize this information visually.

3. After this discussion, pass out the reading passage handouts. This will help students to understand how the sun can be used to cook food, expose them to the several designs of solar cookers that currently exist, and aid them in understanding the vocabulary used in the lab activity instructions.

4. Collect and grade students' work. Return next class period.

5. Handout the lab activity handouts and ask the students to read it over for the next class period.

Day Two:

6. Ask students to summarize what they will be doing with solar cookers based on the lab activity handout and ask questions about the procedure to be sure students read the instructions.

7. Go over lab safety: inform students to wear sunglasses. In addition, demonstrate proper use and care of equipment used in this activity (i.e. Xacto knife)

8. Divide students into groups and determine if each group will build all 3 models of solar cookers or each group will construct a different model of solar cooker for comparison.

9. Instruct students to obtain materials for the solar cookers and follow directions in the lab activity handout to build each cooker.

10. After the construction of solar cookers has been completed, ask students to gather their solar cookers, timers, and sunglasses to go outside. In addition, be sure to bring beakers and thermometers to distribute outside to each solar cooker built.

11. Instruct students to place their solar cookers in an area to get the maximum expose to the sun.

12. Once this is completed, ask students to carefully place the beaker in the solar cooker and obtain an initial temperature reading.

13. Students will now start the timer and continue taking readings as indicated in the lab activity handout.

14. After all groups have completed taking temperature measurements, gather all the materials to go back inside. Instruct students to create a graph of their readings and answer the lab questions.

15. As a class, discuss the results and answers to the lab questions. Add this information to the chart (K-W-L) made on the board previously.

16. Pass out the assessment questions and collect once completed.

Resources:

- "The Infinite Power of Texas." Renewable Energy: The Infinite Power of Texas. Texas State Conservation Office. http://www.infinitepower.org/index.htm.

- "The Solar Cooking Archive." Solar Cookers International. http://solarcooking.org.

Cooking With The Sun

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

HIGHLIGHTS

- **Solar cookers can be used everyday or for solar picnics**
- **They come in many types**
- **They are easy to build, or can be bought ready-made**
- **Solar cooking works well, is easy, fun, and good for the environment**

SUMMARY

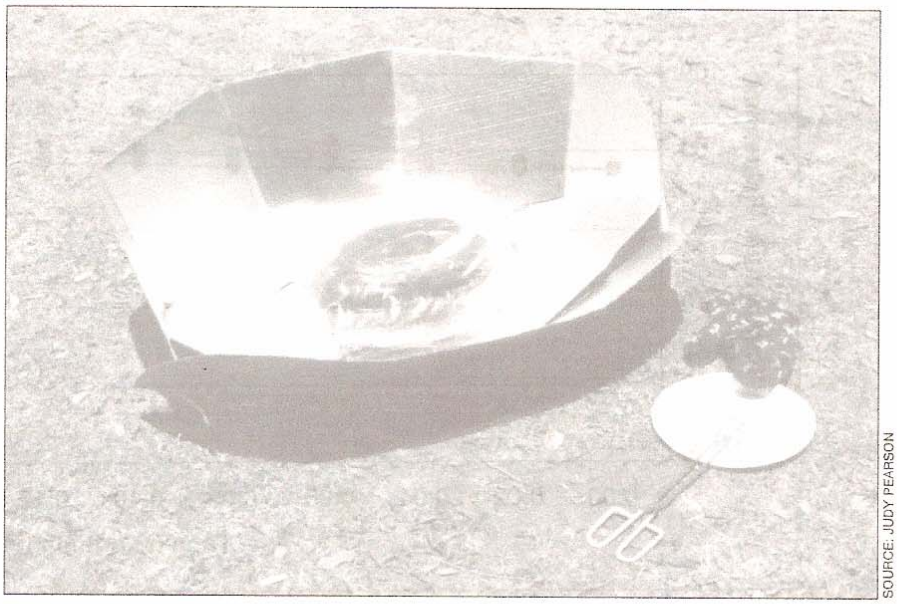
Most of you know how it can be hot enough to fry an egg on the pavement. But have you ever seriously considered actually cooking with the sun? In some parts of the world, solar cooking is very popular. In Texas it works just as well and can be used for everything from picnics to everyday cooking.

SOLAR COOKER BASICS

Solar cookers work because sunlight carries lots of power. For example, when sunlight hits a surface with an area of 1 square meter, there is about 1,000 watts of energy from the sun on that surface. Compare this to your toaster oven, which uses about 1,000 watts. In a solar cooker, sunlight is concentrated into a cooking area that gets hot enough to cook food. If more sunlight can be captured, more power can be generated. Solar cookers sometimes have an insulated cooking chamber to prevent heat from escaping.

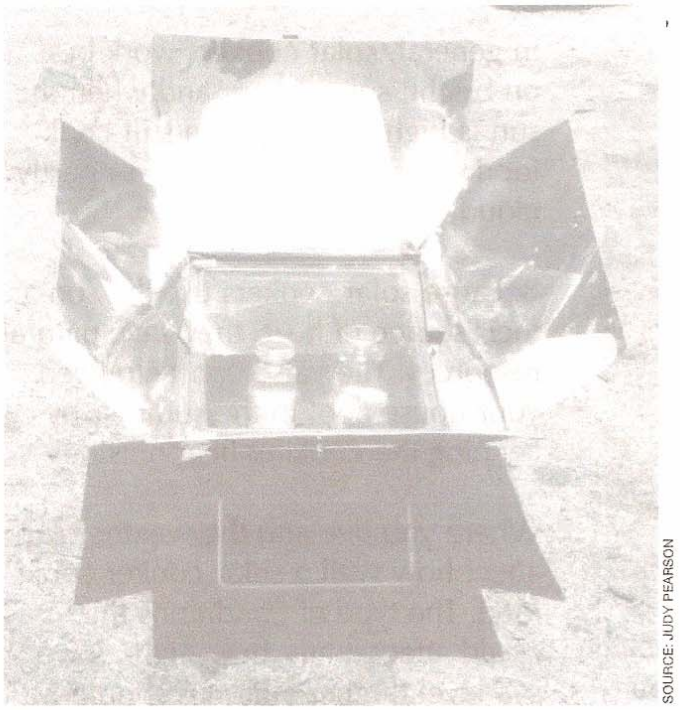
SOLAR COOKER DESIGNS

Just as there are many kinds of conventional cookers (ovens, stovetops, broilers, microwave ovens), there are many kinds of solar cookers. The simplest type of solar cooker is the "Cookit"



SOURCE: JUDY PEARSON

FIGURE 1. PANEL COOKER *The "Cookit" panel cooker is simple but effective.*



SOURCE: JUDY PEARSON

FIGURE 2. BOX COOKER *Box cookers are excellent for slow cooking.*

shown in Figure 1. It consists of a single piece of cardboard with aluminum that is folded into a panel that acts like a reflector. A dark pot placed in a plastic bag can be the cooking container. The dark color allows more heat energy to be absorbed by the cooking container.

Figure 2 shows a solar box cooker. A solar box cooker consists of an insulated box, black on the inside (to absorb sunlight) with a transparent cover (usually glass), and one or more reflective panels that allow more sunlight to enter the cooking chamber. Food is placed inside the chamber in a dark-colored pot. Box cookers can reach temperatures in the mid to high 200 degrees F.

Solar cookers that use parabolic designs, as shown in Figure 3, have a dish reflector with a parabolic shape. The dish reflects sunlight into the focal region of the parabolic curve. A dark colored pot is usually placed at this focal region to get the most sunlight. Depending on the size of the reflector, very high temperatures can be reached. Parabolic solar cookers may have a large area to collect sunlight and therefore can generate high power; but they typically do not have an insulated cooking chamber. Therefore, these solar cookers are used similarly to a conventional stovetop.

Some solar cookers use both a parabolic cooker, which can focus direct sunlight in a particular area resulting in high heat, and an insulated cooking chamber. These cookers are called solar concentrator ovens. These ovens operate like a conventional oven because they can reach high temperatures. Figure 4 shows one such unit that is sold commercially.

As you can see from these examples, there are many different types of solar cookers that can be made. There are even cookers that are built into a south wall, cookers that can fold into backpacks, cookers that are like stovetops and more.

COOKING WITH A SOLAR COOKER

Just as we cook differently with stovetops, ovens and microwaves, different types of solar cookers are used differently. A parabolic solar cooker might be used like a stovetop by

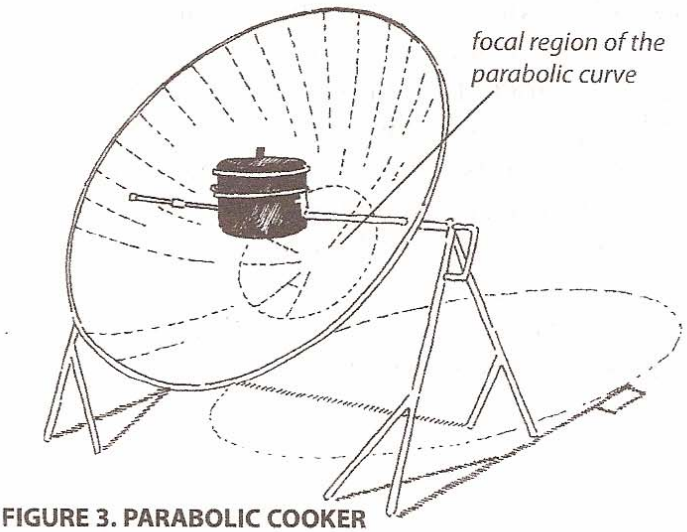
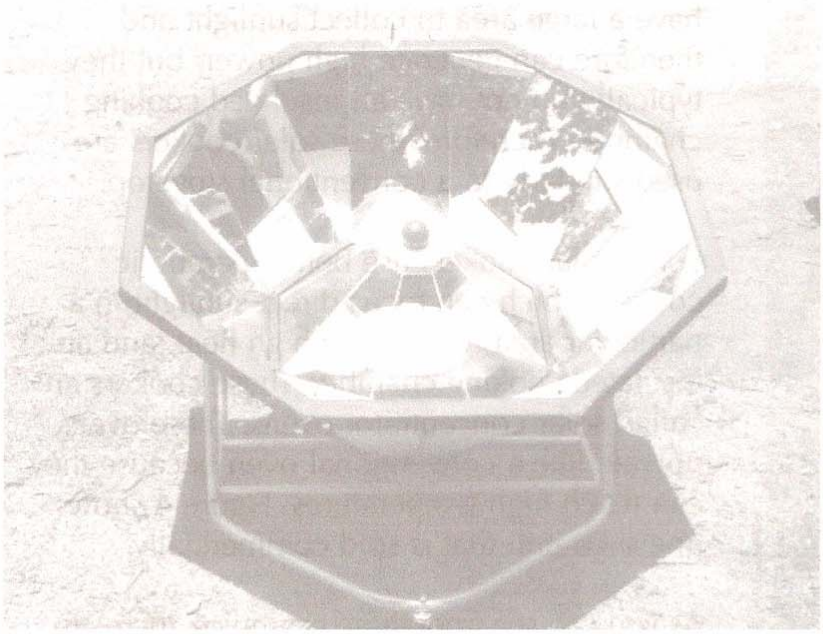


FIGURE 3. PARABOLIC COOKER
Parabolic solar cookers reflect sunlight into a fixed point.



SOURCE: JUDY PEARSON

FIGURE 4. CONCENTRATOR OVEN *Solar concentrator ovens combine a parabolic cooker and an insulated chamber to reach high temperatures.*

heating a pan or pot to a high temperature. A box cooker is most effective when it is used like a crock-pot (slow cooking or low heat over a long time). And a solar concentrator oven can be used like a conventional oven.

Let's consider the simple box cooker. On a sunny day in Texas, May through September, it will reach temperatures around 250 degrees, which will cook or bake most foods. The slow cooking brings out the flavor in many foods. Expect to cook food in this type of solar cooker about twice as long as with a conventional oven. But since it is almost impossible to burn food in this type of cooker, it does not matter how long food is left to cook. People who use solar box cookers usually prepare their dish, put it in the cooker, and go away until it is ready to eat. They can also move the oven a couple of times as the sun moves across the sky to better capture sunlight.

In general, solar cookers work best on bright, sunny days, and when the sun is high. But they can still cook food even if the sky is hazy or partly cloudy.

Because solar cookers use the sun as their source of heat, they save natural resources. They also can help keep your house cool in the summer by keeping the cooking heat outside!

Where you live and the weather can affect how well a solar cooker cooks food. The type of conditions that could affect it are: how high above sea level (higher altitudes should be better), latitude, seasonal rainfall and air pollution.

HOW TO GET A SOLAR COOKER

A good way to get a solar cooker is to build one yourself. The "Cookit" design shown in Figure 1 has the simplest design and can be very effective. A simple box cooker can be made in a couple of hours at home from scrap cardboard, aluminum foil, a piece of glass and some black paint. After building one from plans, some people decide to design their own. Many of the most successful designs started in just this way.

If you are more serious about cooking than building, then ready-made solar cookers are available, many of which can match conventional ovens in performance.

Understanding the Reading Passage

1. In your own words, describe the basic idea of how a solar cooker works.

_____

_____

_____

2. If you wanted to bake a pot of beans that needed to be cooked at a low heat for a long time, what is the best type of solar cooker to use? Why? _____

_____

3. What kinds of food or dishes would you bake in each of the solar cookers described in the Reading Passage? Explain why you think the cooker would cook your selected dish well.

Box cooker: _____

_____

Parabolic cooker: _____

_____

Concentrator cooker: _____

_____

Vocabulary

Based on the Reading Passage, write down your understanding of these words or word pairs and verify your definitions in a dictionary, on the Internet if available or with your teacher:

absorb _____

altitude _____

conventional _____

insulated _____

latitude _____

parabolic _____

reflector _____

square meter _____

transparent _____

Lab Activity: Constructing and Testing Solar Cookers

Introduction

The purpose of this activity is to gain an understanding that solar cookers come in different designs and are simple to build. You will build 3 simple solar cookers and test their heating abilities.

Before You Start

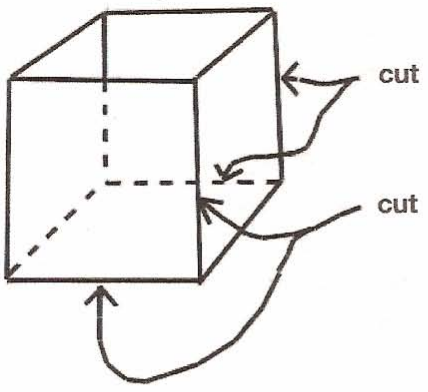
Review the vocabulary words from the Reading Passage. Ask your teacher if you are unsure of any of the meanings. Divide up all the steps in the Lab Activity first, so that everyone has a clear job to do.

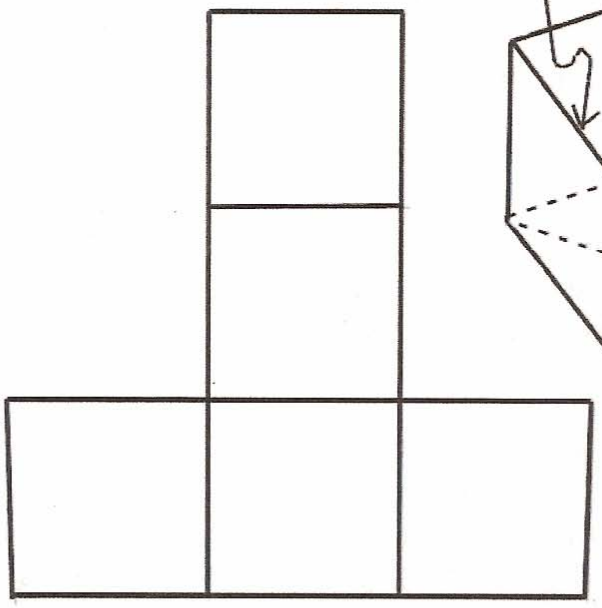
Materials

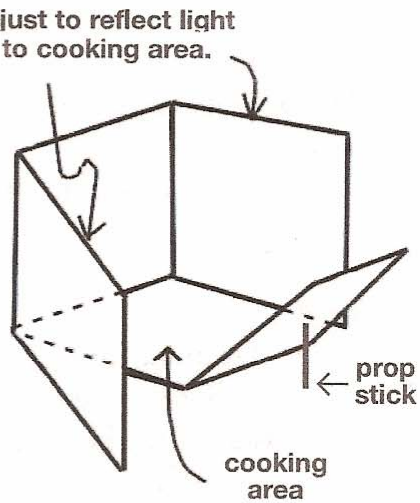
Obtain an equipment kit from your teacher. Check that it contains the following materials:

- 1 timer
- sunglasses per student
- Materials for Solar Cooker #1 (box panel cooker)
  - 1 cardboard box approximately 30 cm per side
  - cutting tool
  - rubber cement
  - aluminum foil
  - prop stick
- Materials for Solar Cooker #2 (simple cone cooker)
  - 1 90 x 90 cm poster board
  - aluminum foil
  - rubber cement
  - hole punch tool
  - 3 brass brads
  - 1 box 30 cm x 30 cm x 30 cm (i.e. copier paper box without lid)
- Materials for Solar Cooker #3 (modified box panel cooker)
  - 1 cardboard box approximately 30 cm per side
  - cutting tool
  - black paint
  - paint brush

Cookers #1 and #3



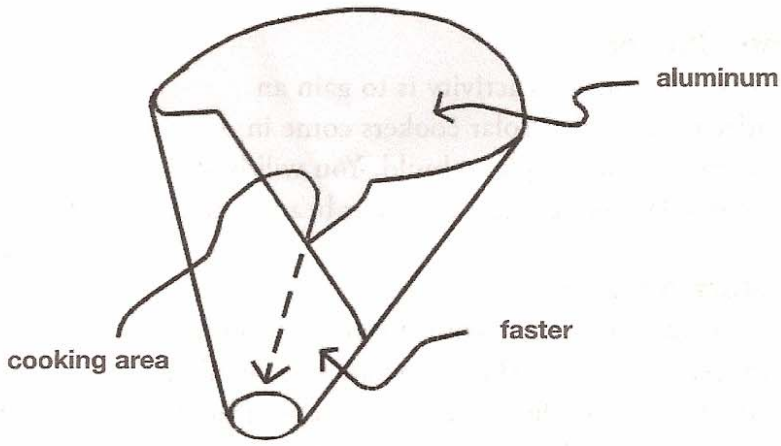




Constructing the Solar Cookers

Cooker #1: Box Panel Cooker

1. Cut off the top flaps of the box so the box is now cover-less.
2. Cut along 2 consecutive corners of the box on each opposite side.
3. Open up the box to lay flat on the floor or a table.
4. Measure a piece of aluminum foil to cover the inside surface of the box and glue it down.
5. Adjust the side sections of the box to reflect light on the cooking area.
6. Prop up the front flap with the stick to direct light on the cooking area.



Cooker #2

Cooker #2: Simple Cone Cooker

1. Glue aluminum foil to the 90 cm x 90 cm poster board.
2. Roll the poster board into a cone, as shown, without damaging the aluminum foil.
3. Punch holes through the poster board and fasten with brads. The holes should be punched so that the overlapping parts of the poster board can be secured together by the brads. This should prevent the poster board from opening, and keep it in a cone shape.
4. Place weights in the box so it will not move in the wind.
5. Place the solar cooker in the box, narrow side down.

Cooker #3

Follow the directions for Cooker #1, The Box Panel Cooker, but instead of using aluminum foil, paint the inside of the box black (the 4 side panels and the bottom of the box).

Testing the Solar Cookers

Note: Your teacher may instruct you to build one cooker or all 3 cookers. Follow the directions below based on the number of cookers you were instructed to build.

1. As the teacher directs, gather your cooker(s), sunglasses and timer and proceed to the outdoor cooking site.
2. Position your cooker(s) for maximum sunlight outdoors. Face the opening of the cooker directly at the sun.
3. Wait for your teacher to pour 200 ml of water into a 250 ml beaker and provide you with a thermometer for each beaker used.
4. Take an initial temperature reading of your water. Record the temperature on your Lab Report Form.
5. Carefully place the beaker with water in the cooking chamber of your solar cooker(s).
6. Start the timer and record the temperature of the water every 2 minutes for 14 minutes and record the readings on your Lab Report Form.
7. Collect the materials as the teacher directs and return to the classroom.
8. Complete the answers to the questions on your Lab Report Form.
9. Based on the temperature readings you measured, develop a graph showing the change in temperature over time for each cooker you built.
10. Share results with the class to determine which cookers generated the highest temperature.

Lab Report Form: Constructing and Testing Solar Cookers

Date _____

Purpose of this lab is to _____

_____

Instructions

Follow the instructions listed in the Lab Activity and record your measurements in the Data Table below. Once you have completed all the measurements and calculations, answer the questions at the end of this form.

DATA TABLE. Temperature Readings of Water Placed in Solar Cookers

Time (minutes)	Cooker #1 Temperature	Cooker #2 Temperature	Cooker #3 Temperature
00:00 (initial)			
00:02			
00:04			
00:06			
00:08			
00:10			
00:12			
00:14			
Total Temperature Change			

DATA SUMMARY

1. Which solar cooker achieved the highest water temperature? Why? _____

   _____

   _____

2. In which solar cooker did the water temperature start to change the fastest? Why? _____

   _____

   _____

3. Did one cooker maintain a constant temperature for a long time? Which one and why? _____

   _____

   _____

4. What did you learn about solar cookers after completing this activity? _____

   _____

   _____

   _____

Assessment Questions

1. In what circumstances would you use a solar cooker?

2. What local conditions might affect how well a solar cooker works?

Multiple Choice Questions

1. Solar cookers:
   a) are easy to build
   b) can be used on picnics
   c) are used in some parts of the world daily
   d) all answers a, b, and c

2. Types of solar cookers include:
   a) box cookers
   b) cone cookers
   c) parabolic cookers
   d) all answers a, b, and c

3. Solar cookers require:
   a) reflective material
   b) dark glass covers
   c) firewood
   d) constant monitoring

4. You would be:
   a) disinterested in trying solar cooking
   b) interested in seeing a variety of solar cookers
   c) willing to try solar cooking
   d) b and c

5. Foods you would like to try in a solar cooker include:
   a) cake
   b) rice
   c) spaghetti sauce
   d) all answers a, b, and c

6. One of the precautions to take with solar cooking is:
   a) shade the cooker
   b) wear sunglasses
   c) never cook vegetables
   d) not to burn food

7. Solar box cooker temperatures tend to reach:
   a) 50°F
   b) 50°C
   c) 200 – 250°F
   d) 72°F

8. Solar energy:
   a) is non polluting
   b) is free
   c) conserves other forms of energy
   d) all answers a, b, and c

9. Ten degrees Centigrade is about:
   a) 2°F
   b) 50°F
   c) 196°F
   d) 150°F