# LETTER TO PARENTS

*Cut here and paste onto school letterhead before making copies.*

## SCIENCE NEWS

Dear Parents,

Every day something happens that most of us take for granted. The Sun comes up and the Sun goes down. Of course, we know that it's actually Earth rotating on its axis that makes the Sun appear to make this daily journey. Earth wouldn't be the same without the daily dose of sunshine supplied by our local star. Most life on Earth depends on the light and heat energy from the Sun.

In the FOSS **Solar Energy Module** we will focus our investigations on the Sun's energy. We'll start by tracking shadow patterns for a day and think about the information we can get from the constantly changing shadows. We will use thermometers to record temperature changes in earth materials as a result of solar heating, and conduct experiments to discover what materials hold the Sun's energy most effectively. We will go on to make solar water heaters, sorting out the variables that influence the temperature and heating rate of a water-heater system. In our last investigation we will investigate model solar homes and identify some of the variables, such as insulation and direct sunlight, that support energy-efficient solar space heating.

You can extend your child's experiences in the classroom in a number of ways. Spend some time identifying and talking about the various ways you use energy in your home and finding out where the energy you use originates. Find a place to "shadow watch" (e.g. a flagpole, tall tree, fence posts) for several weeks and months and begin to identify the pattern and make predictions about where shadows will appear. Consider what you should wear when you go out on cold days—should you wear a light-colored or dark-colored sweatshirt? You might look through the yellow pages for businesses that deal in solar water and space heaters for homes and equipment powered by solar cells, which make electricity directly from sunshine. We won't be studying solar cells in this unit, but if your child is interested in this important application of solar energy, he or she might choose to do a project to share with the rest of the class.

Watch for the home/school connections that I will be sending home from time to time. These suggest ways for family and friends to extend the solar investigations into your community. This is a chance to take a peek into a future when solar energy will assume a much more important role in meeting the energy demands of the world. If you have questions or expertise to share with the class, please stop by our classroom. We're looking forward to a couple of months of enlightening investigation into solar energy.

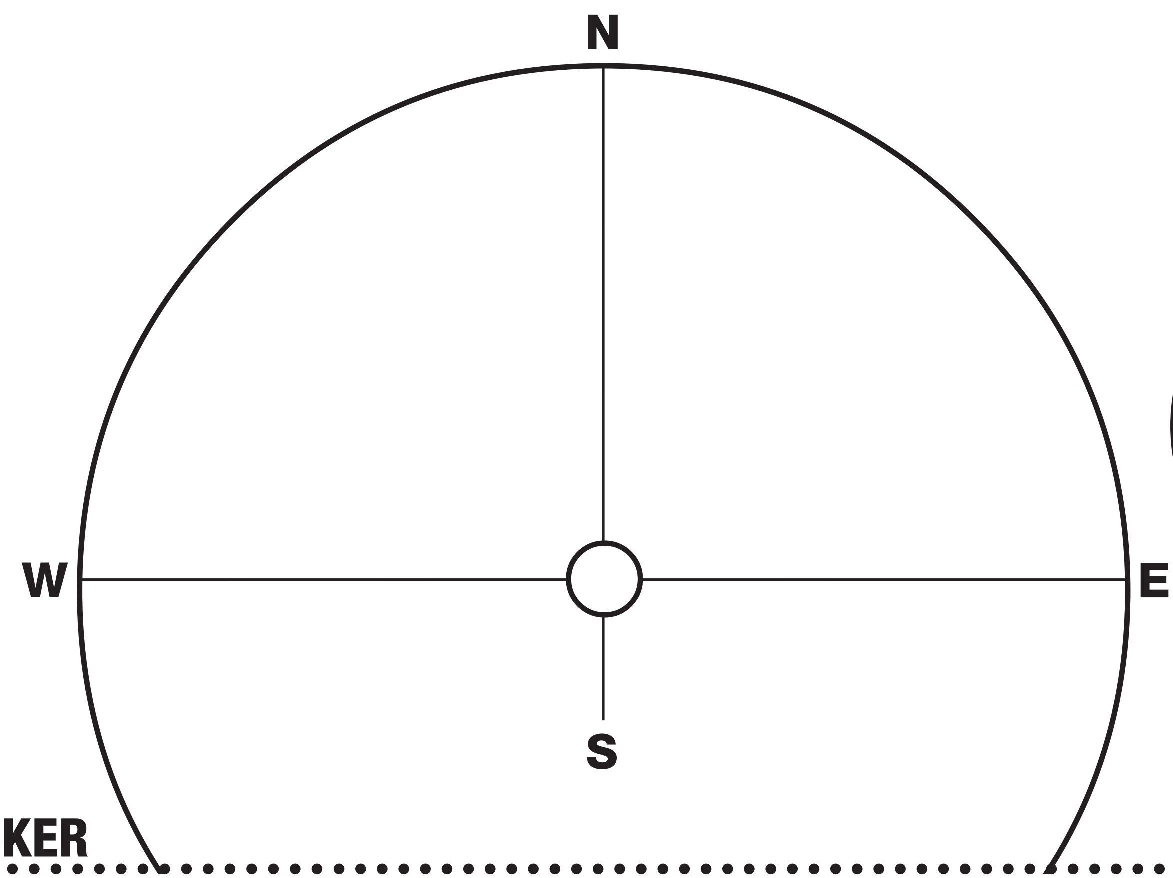
Comments

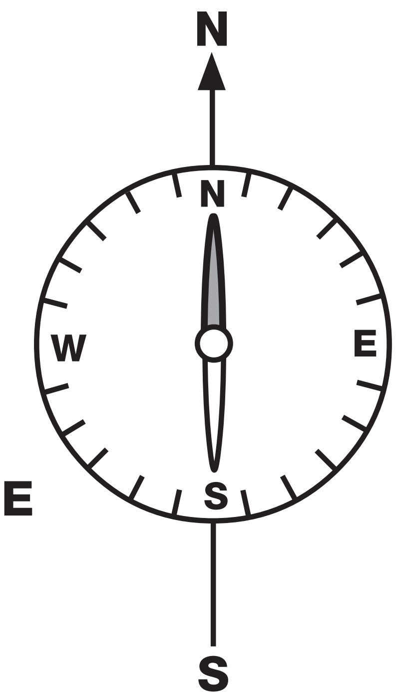
# *SOLAR ENERGY JOURNAL*

Name ______________________________

Names ______________________________

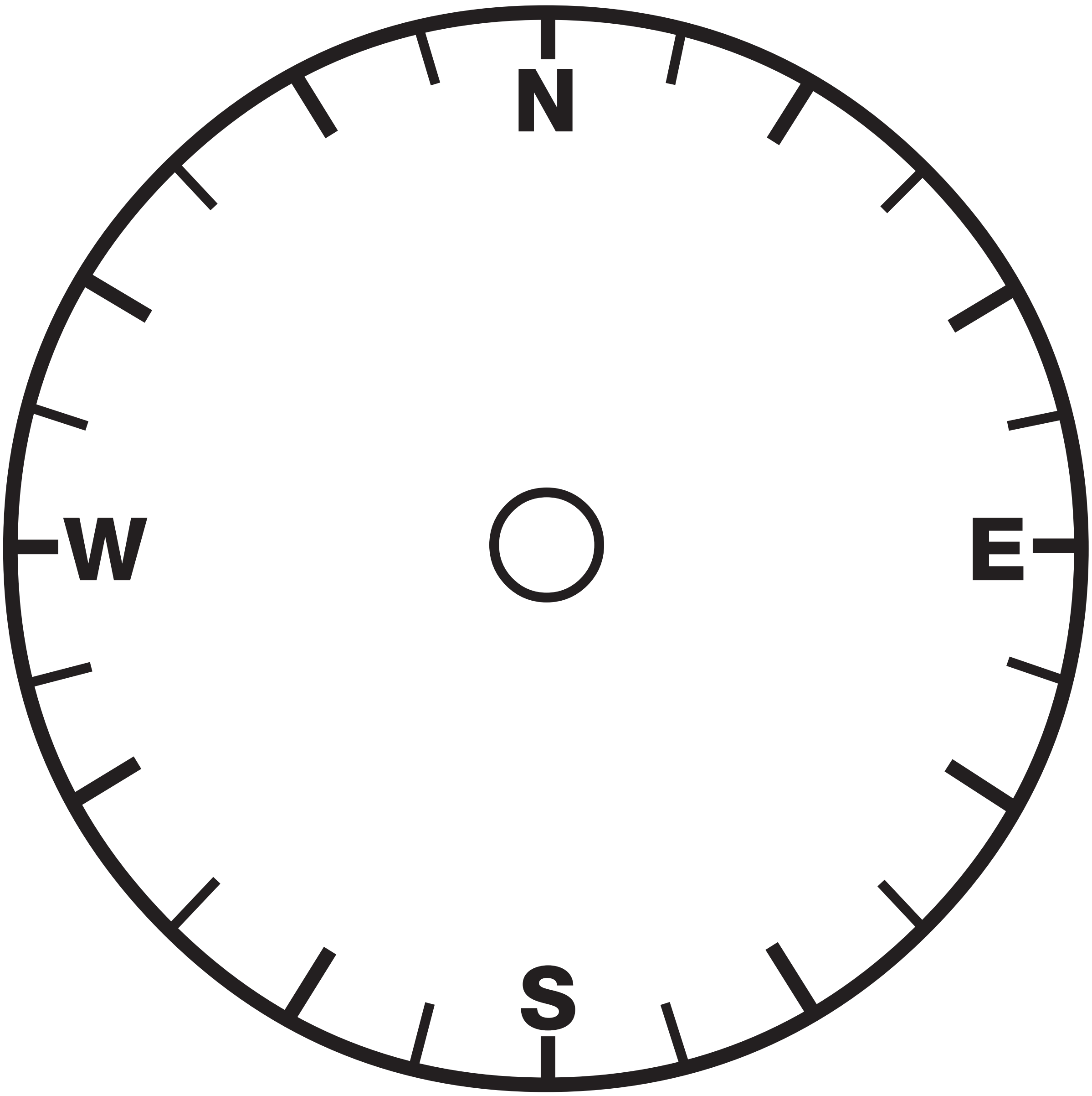
Date ______________________________

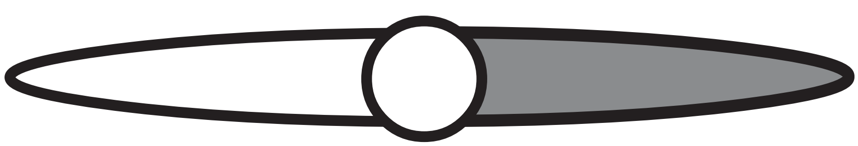



## SHADOW TRACKER

# DEMONSTRATION COMPASS

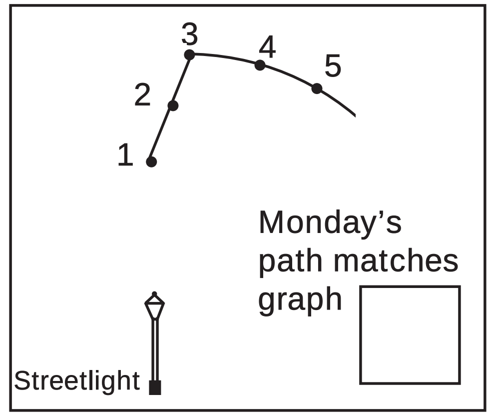


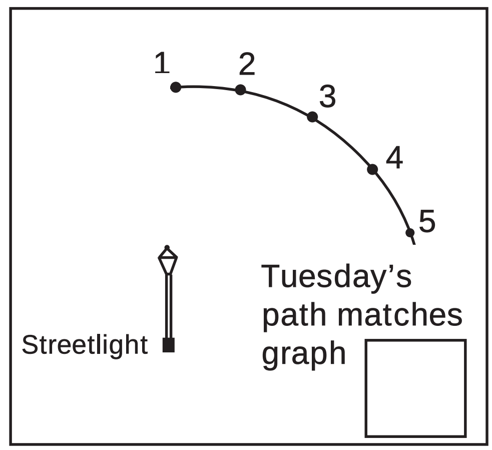
# RESPONSE SHEET—SUN TRACKING

**Directions:** Read the three stories below and look at the pictures. Figure out which graph (X, Y, Z) goes with each story. Write the letter of the graph in the box in the picture.

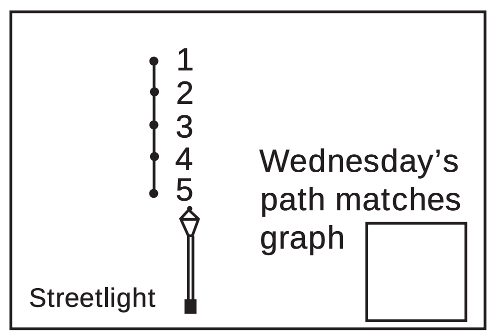
**Story 1.** On Monday night you were standing near a streetlight at position 1. Your friend measured the length of your shadow. It was 2 m long. You then walked to positions 2, 3, 4, and 5. At each position your friend measured the length of your shadow.



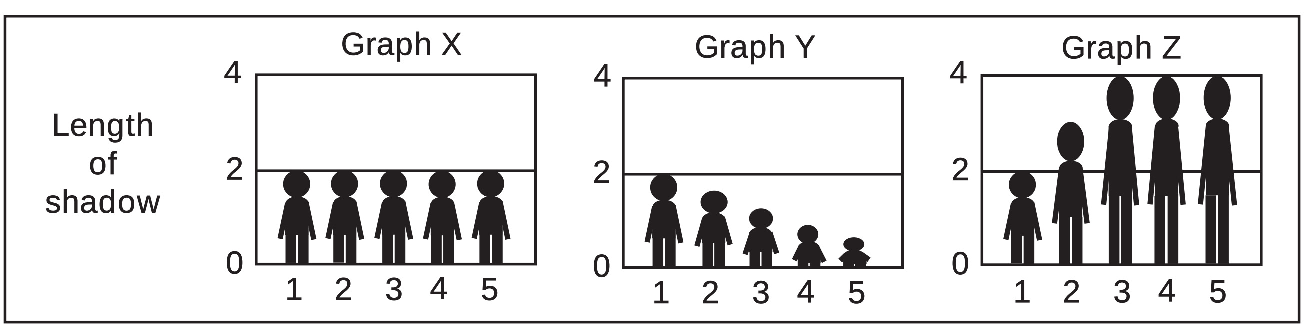

**Story 2.** On Tuesday night you began from the same place near the streetlight and walked a different path. Your friend measured the length of your shadow at each of the five stops.



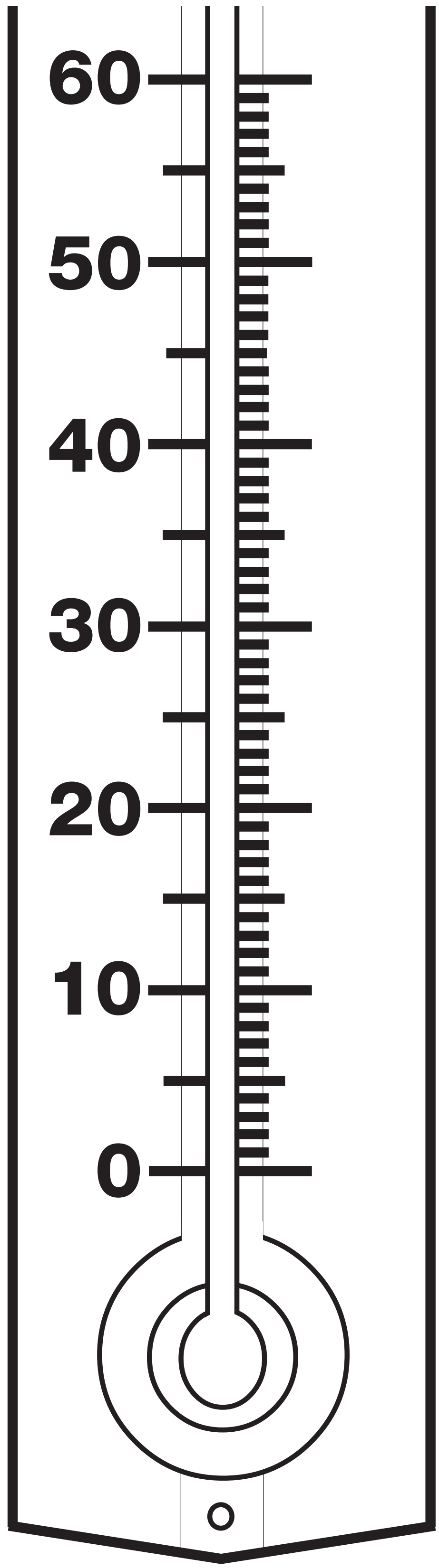

**Story 3.** On Wednesday night you started from the same spot but walked in another direction. Again, your friend recorded the length of your shadow five times.




Your friend made a bar graph of the shadow lengths for each night's walk. Below are the graphs your friend made. Match each graph with the path walked and explain your answers on the back of this sheet.



# THERMOMETER READING



Name ______________________

Date ______________________

# THERMOMETER IN SUN AND SHADE

Tape the thermometer in this space.

Time of day ______________________

| | Elapsed time | Temperature |
|---|---|---|
| | 0 min. | |
| In sun | 1 min. | |
| In sun | 2 min. | |
| In sun | 3 min. | |
| In sun | 4 min. | |
| In sun | 5 min. | |
| In shade | 6 min. | |
| In shade | 7 min. | |
| In shade | 8 min. | |
| In shade | 9 min. | |
| In shade | 10 min. | |

Temperature change after 5 minutes **in the sun**

5-min. temp. __________

Starting temp. – __________

Temp. change = __________

Temperature change after 5 minutes **in the shade**

5-min. temp. __________

10-min. temp. – __________

Temp. change = __________

Name ______________________________

Date ______________________________

# EARTH MATERIALS IN SUN AND SHADE

Time of day ______________________________ Air temperature ________________

Earth material investigated ______________________________

**Place container here**

| | Elapsed time | Temperature |
|---|---|---|
| | 0 min. | |
| In sun | 5 min. | |
| In sun | 10 min. | |
| In sun | 15 min. | |
| In sun | 20 min. | |
| In shade | 25 min. | |
| In shade | 30 min. | |
| In shade | 35 min. | |
| In shade | 40 min. | |

| Temperature change after 20 minutes **in the sun** | |
|---|---|
| 20-min. temp. | __________ |
| Starting temp. − | __________ |
| Temp. change = | __________ |

| Temperature change after 20 minutes **in the shade** | |
|---|---|
| 20-min. temp. | __________ |
| 40-min. temp. − | __________ |
| Temp. change = | __________ |

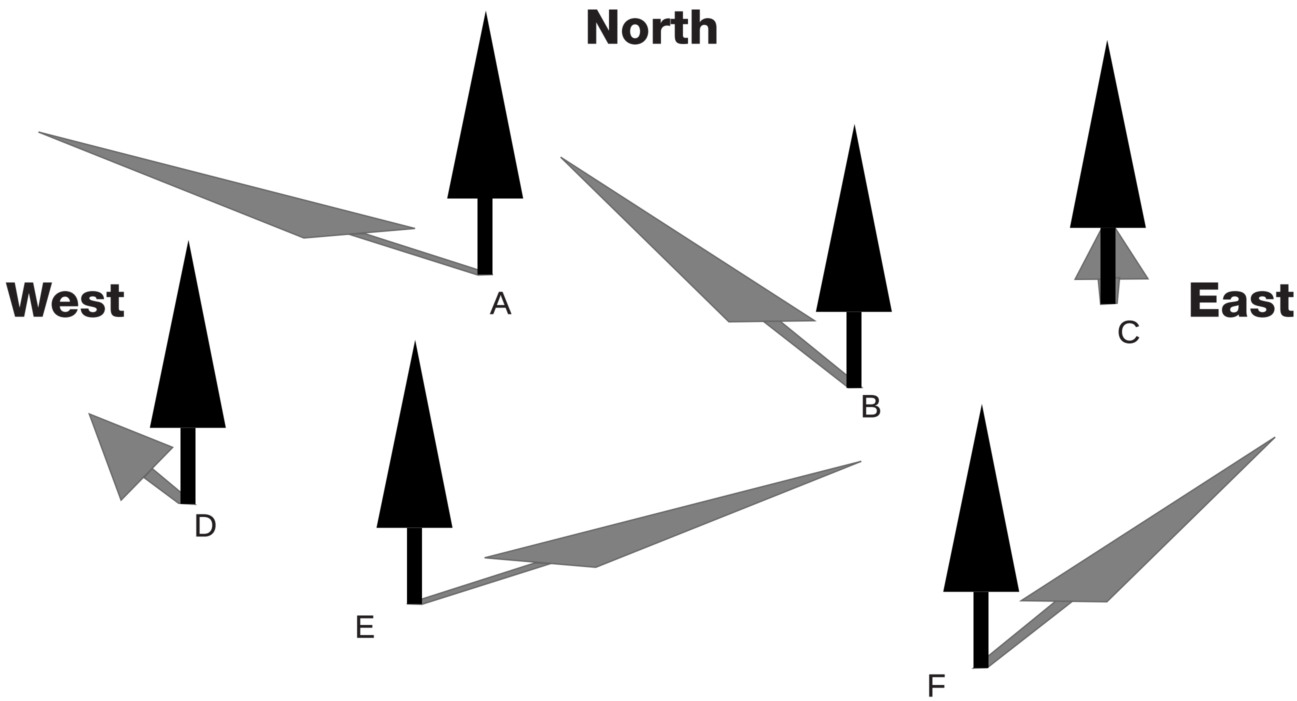
Name ______________________________

Date ______________________________

# TREE-SHADOW PUZZLE

**Directions:** Below are the shadows of a tree at different times of the day. Order the shadows so that they are in sequence from early morning to late afternoon.

Tree shadows




1. Early-morning shadow ________
2. ________
3. ________
4. ________
5. ________
6. Late-afternoon shadow ________

Name ______________________________

Date ______________________________

# TWO GROUPS' DATA: MATERIALS IN SUN AND SHADE

Time of day ______________________________ Air temperature ________________

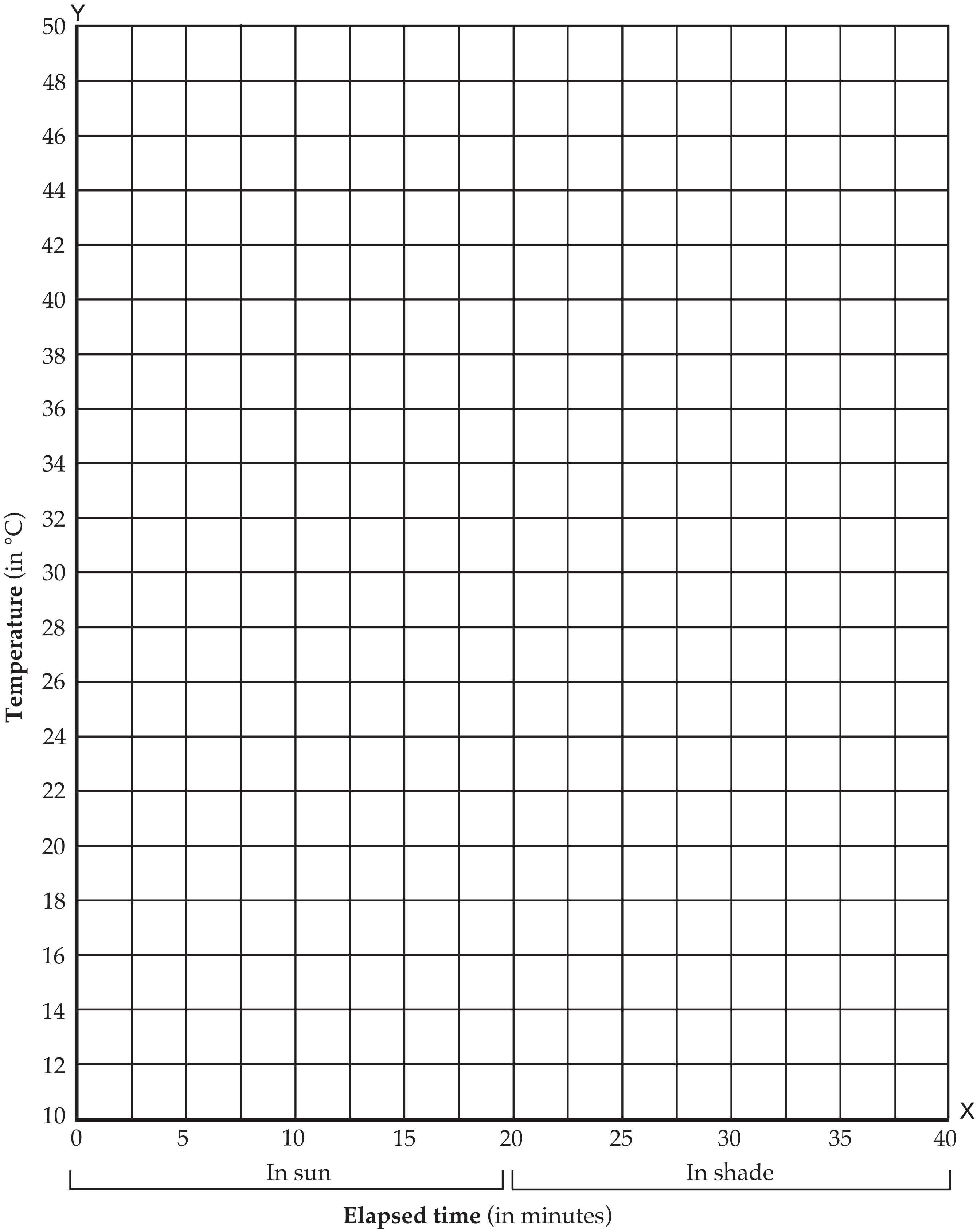
| | Elapsed time | Sand temperature | Water temperature | Dry soil temperature | Wet soil temperature |
|---|---|---|---|---|---|
| | 0 min. | | | | |
| In sun | 5 min. | | | | |
| In sun | 10 min. | | | | |
| In sun | 15 min. | | | | |
| In sun | 20 min. | | | | |
| In shade | 25 min. | | | | |
| In shade | 30 min. | | | | |
| In shade | 35 min. | | | | |
| In shade | 40 min. | | | | |

| | | | | |
|---|---|---|---|---|
| Temperature change after 20 minutes in the sun | | | | |
| Temperature change after 20 minutes in the shade | | | | |

Name ____________________

Date ____________________

# GRAPH OF EARTH-MATERIALS TEMPERATURES



Name ________________________________

Date ________________________________

# RESPONSE SHEET—HEATING THE EARTH

Josh and Natalie decided to set up an investigation using earth materials. They used the same setup as you did, only this time they used light-colored sand and black sand. They set up four containers like this.

**Container 1** 100 ml of dry light-colored sand
**Container 2** 100 ml of dry light-colored sand plus 50 ml of water
**Container 3** 100 ml of dry black sand
**Container 4** 100 ml of dry black sand plus 50 ml of water

Temperature Data (air temperature: 22°C)

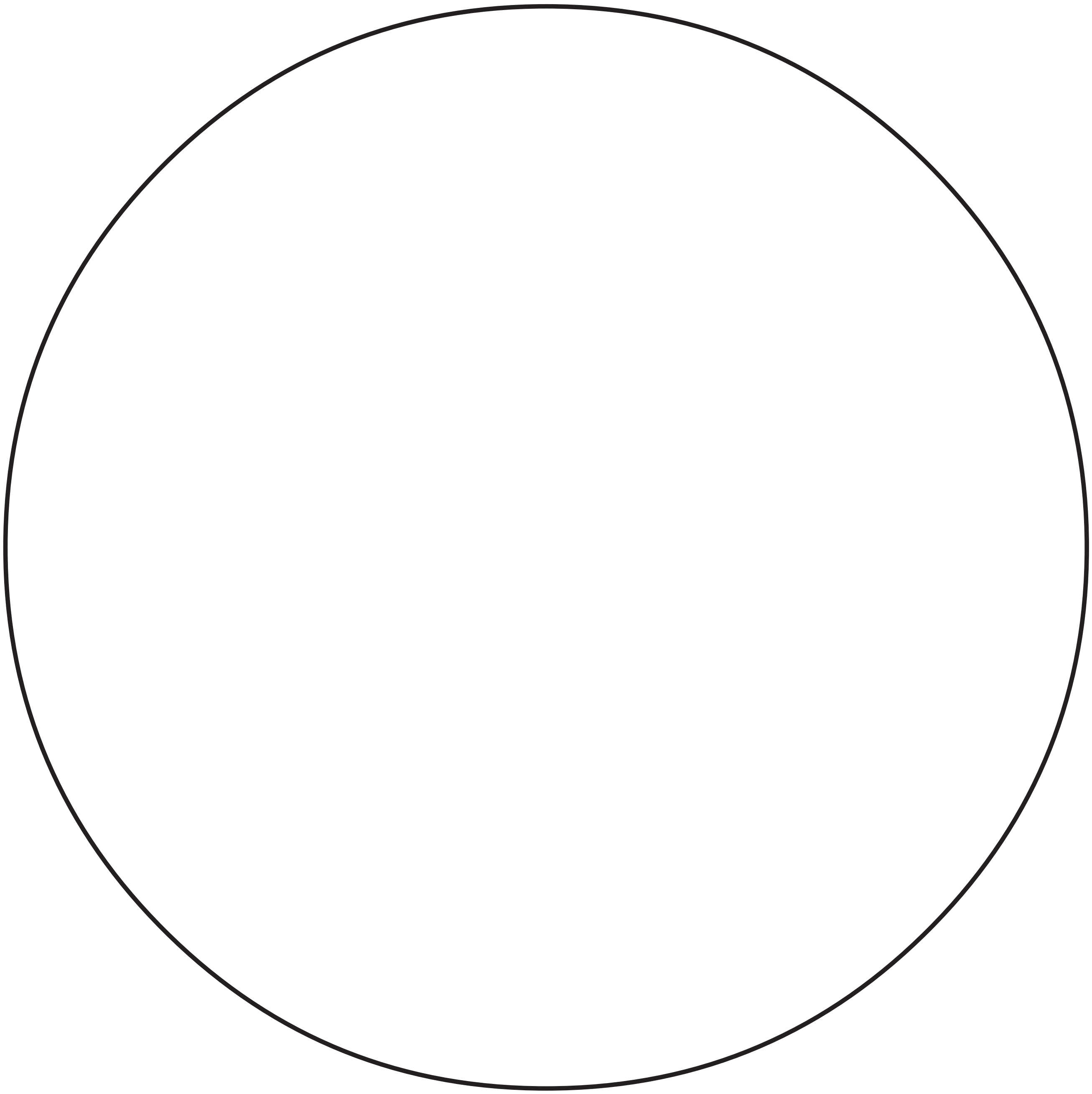
| | Elapsed time | Dry light-colored sand | Wet light-colored sand | Dry black sand | Wet black sand |
|---|---|---|---|---|---|
| | 0 minutes | 22°C | 22°C | 22°C | 22°C |
| Sun | 5 minutes | 32°C | 25°C | 32°C | 27°C |
| Sun | 10 minutes | 37°C | 28°C | 36°C | 30°C |
| Sun | 15 minutes | 39°C | 31°C | 39°C | 32°C |
| Sun | 20 minutes | 40°C | 33°C | 41°C | 34°C |
| Shade | 25 minutes | 31°C | 32°C | 32°C | 32°C |
| Shade | 30 minutes | 27°C | 31°C | 28°C | 30°C |
| Shade | 35 minutes | 25°C | 29°C | 25°C | 28°C |
| Shade | 40 minutes | 22°C | 26°C | 23°C | 27°C |
| | Temp. change in sun | +18°C | +11°C | +20°C | +12°C |
| | Temp. change in shade | –18°C | –7°C | –18°C | –7°C |

They took the containers outside, set them in the shade for 5 minutes, and recorded the starting temperature. Then they set the containers in the sun for 20 minutes and in shade for 20 minutes. Their data table looked like this.

Josh told Natalie that he thought that the containers with the water must have gotten less solar energy than the dry containers because they had less change in temperature. Natalie didn't agree with his idea. She thought that all the containers must have received the same amount of energy because they were all in the sunlight for the same amount of time.

What do you think? Do you agree with Josh or Natalie? Give your reasons. What do you think caused the temperature differences? Use the back of this sheet if you need more room for your answer.

# CIRCLE TEMPLATE



# SOLAR WATER HEATERS: CLASS CHART

## *CONFERENCE DATA*

| Black/Covered | |
|---|---|
| Elapsed time | Average temperature change (from starting temperature) |
| 5 min. | |
| 10 min. | |
| 15 min. | |
| 20 min. | |

| White/Covered | |
|---|---|
| Elapsed time | Average temperature change (from starting temperature) |
| 5 min. | |
| 10 min. | |
| 15 min. | |
| 20 min. | |

| Black/Uncovered | |
|---|---|
| Elapsed time | Average temperature change (from starting temperature) |
| 5 min. | |
| 10 min. | |
| 15 min. | |
| 20 min. | |

| White/Uncovered | |
|---|---|
| Elapsed time | Average temperature change (from starting temperature) |
| 5 min. | |
| 10 min. | |
| 15 min. | |
| 20 min. | |

Name ______________________________

Date ______________________________

# SOLAR WATER HEATERS

Time of day ____________________ Air temperature ______________________

Experimental setup

Our plastic collector was (circle one) black white

Our water heater was (circle one) covered uncovered

Place
**Solar Water Heater**
here.

| Elapsed time | Water temperature | Temperature change |
| --- | --- | --- |
| 0 min. | | |
| 5 min. | | |
| 10 min. | | |
| 15 min. | | |
| 20 min. | | |

What did you observe about the black and white plastic squares?

Name ____________________

Date ____________________

# SOLAR WATER HEATERS: CONFERENCE CHART

Circle your experiment.

| | |
|---|---|
| Black/Covered | White/Covered |
| Black/Uncovered | White/Uncovered |

| Elapsed time | Temperature change | | | | Average |
|---|---|---|---|---|---|
| | Team names | Team names | Team names | Team names | |
| 5 min. | | | | | |
| 10 min. | | | | | |
| 15 min. | | | | | |
| 20 min. | | | | | |

**Directions**

1. Each team gets its own conference chart. Put your name at the top.
2. Circle the experiment you did.
3. Write your team's names in one of the temperature-change columns.
4. Record your team's temperature changes in your column.
5. Pass your sheet around the conference group so the other teams can record their data in one of the other columns.
6. When you get your conference chart back, calculate the average temperature change after 5, 10, 15, and 20 minutes.
7. Write the average temperature changes in the column on the right.
8. Check your averages for accuracy with the other teams in your conference group.

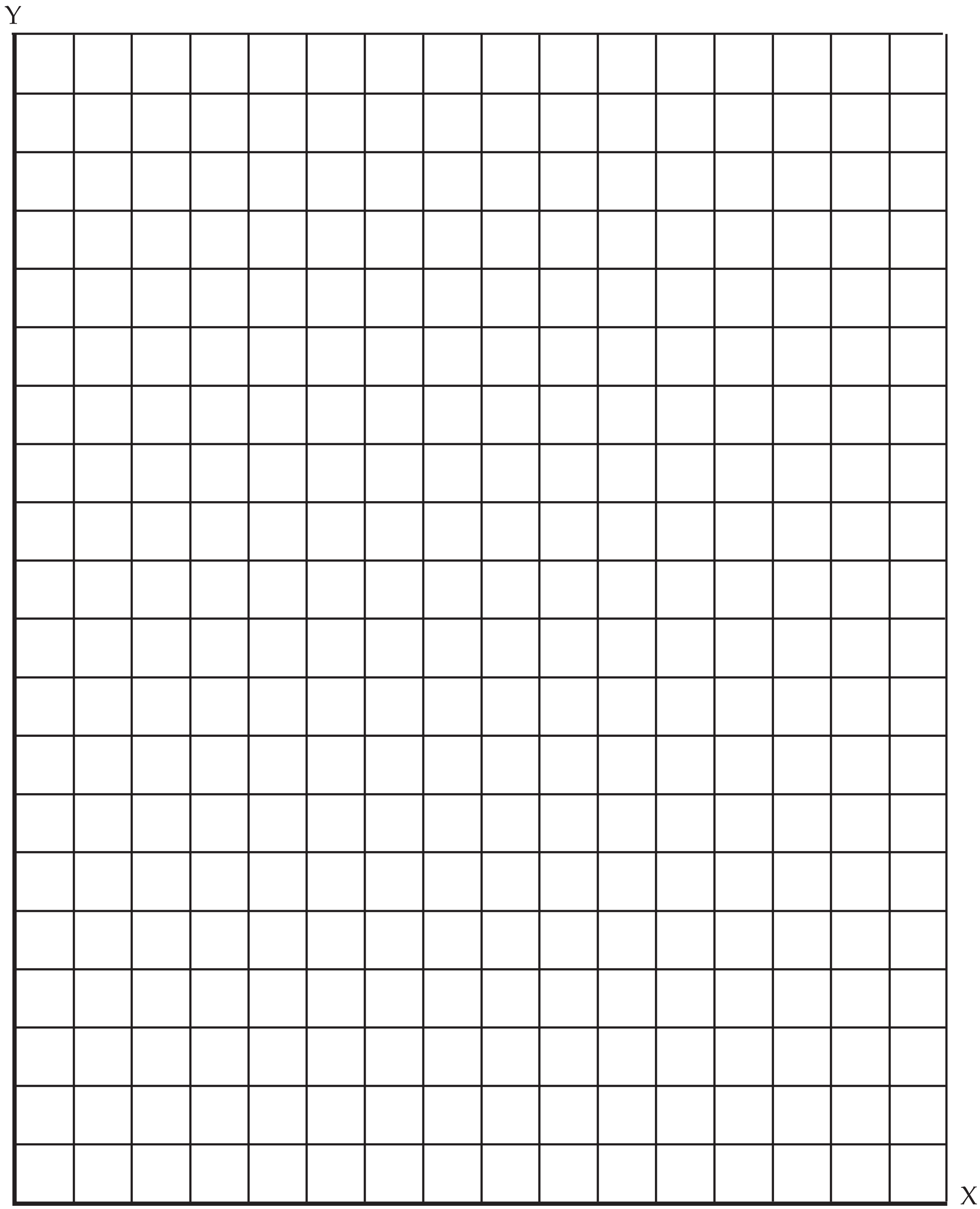
Name ______________________

Date ______________________

# SOLAR-ENERGY GRAPH

***INVESTIGATION TITLE*** ______________________

Air temperature ______________



Name ______________________

Date ______________________

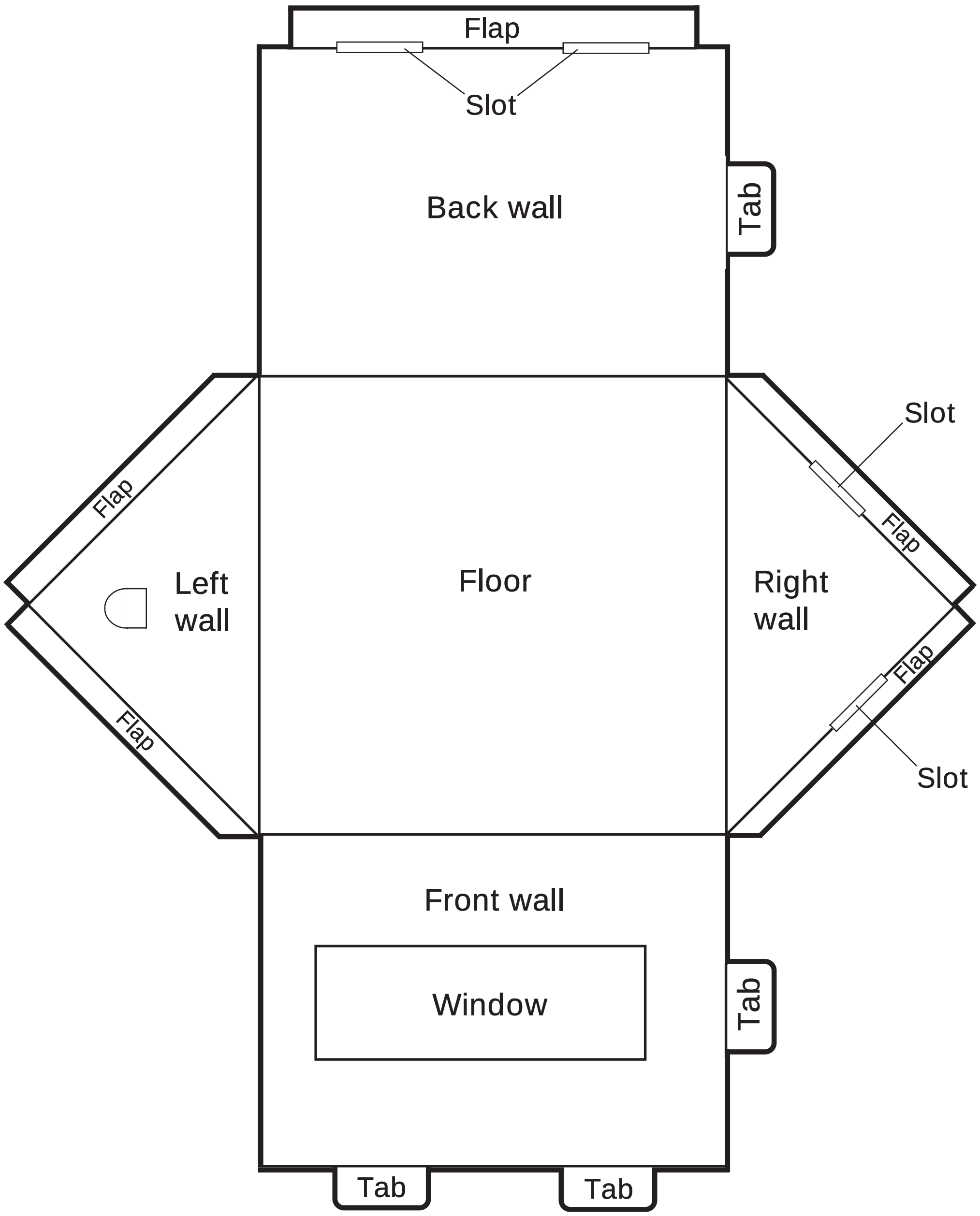
# RESPONSE SHEET—SOLAR WATER HEATERS

Samantha's father was thinking about buying a solar water heater for their house. He looked at several systems and narrowed the choices down to one simple design. The system used a black flat-plate collector. Water flowed through pipes across the surface of the collector plate. There were two models to choose from. Below are the specifications for each model.

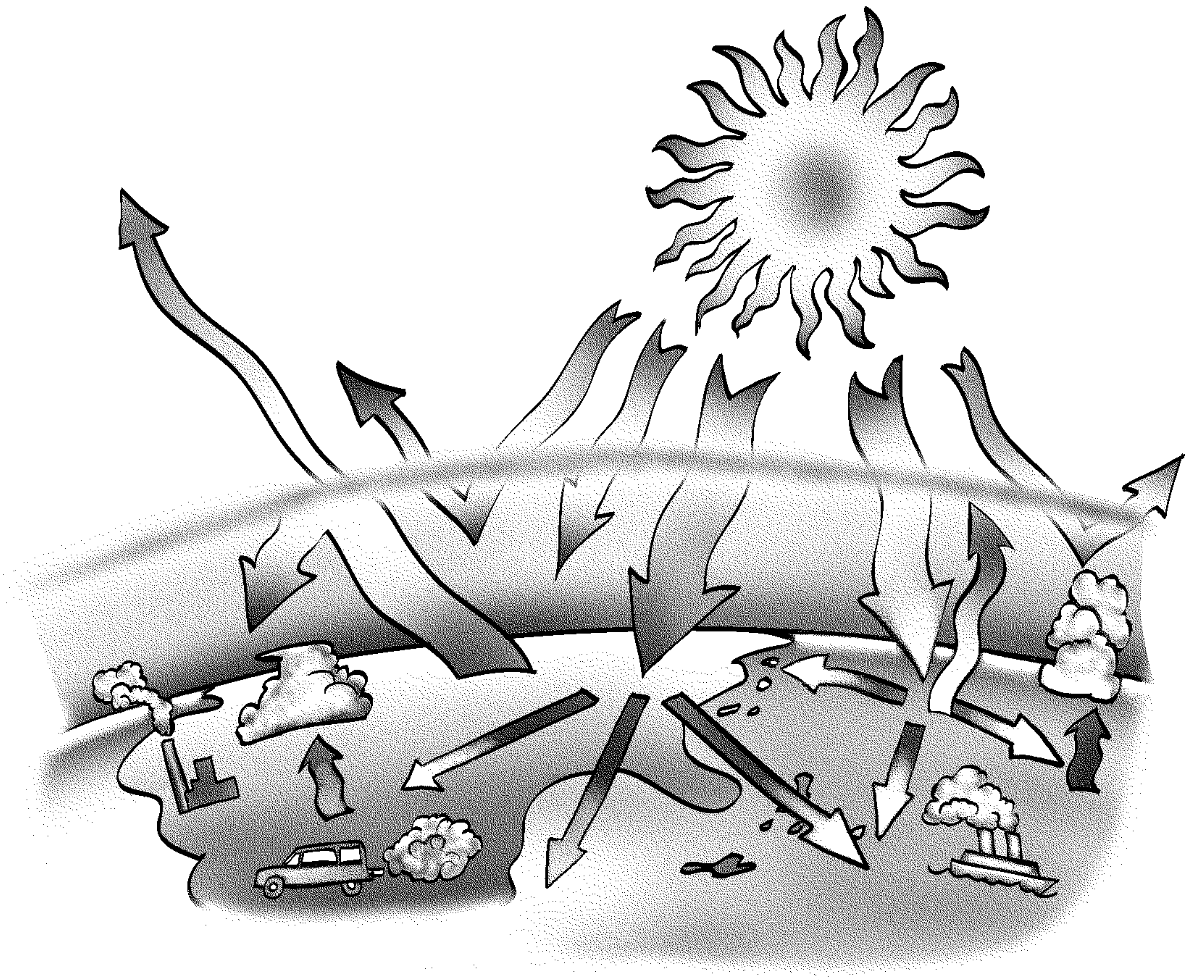
| Model | Amount of water | Collector size | Length of tubing | Price |
|---|---|---|---|---|
| SWH—10 | 100 Liters | 100 cm × 100 cm | 10 m | $600 |
| SWH—20 | 100 Liters | 100 cm × 100 cm | 20 m | $800 |

If you were Samantha's father, which model would you buy? Be sure to explain all the factors you need to think about before making the decision.

# MODEL-SOLAR-HOUSE DIAGRAM



# THE GREENHOUSE EFFECT



Name ____________________

Date ____________________

# SPACE HEATING

**Time of day** ____________________ **Air temperature** __________

## *SOLAR HOUSE 1*

Orientation of house ________________

Color of interior ________________

| | Elapsed time | Temperature |
|---|---|---|
| | 0 min. | |
| In sun | 5 min. | |
| In sun | 10 min. | |
| In sun | 15 min. | |
| In sun | 20 min. | |
| In shade | 25 min. | |
| In shade | 30 min. | |
| In shade | 35 min. | |
| In shade | 40 min. | |

## *SOLAR HOUSE 2*

Orientation of house ________________

Color of interior ________________

| | Elapsed time | Temperature |
|---|---|---|
| | 0 min. | |
| In sun | 5 min. | |
| In sun | 10 min. | |
| In sun | 15 min. | |
| In sun | 20 min. | |
| In shade | 25 min. | |
| In shade | 30 min. | |
| In shade | 35 min. | |
| In shade | 40 min. | |

Name ___________________________

Date ___________________________

# RESPONSE SHEET—SOLAR HOUSES

Ryan and Allyson really liked to visit their Uncle Rod in northern Minnesota during the summer. His house was on the east shore of Lake Wintuk. His living room had a great view of the lake. The only problem was that his house often got uncomfortably warm in the middle of the sunny afternoons and took a long time to cool off at night. They were hoping that this summer they might be able to help Uncle Rod figure out an energy-efficient way to keep his house cooler and still stay warm in the winter.

What do you know about the house?

What else would you like to know about Uncle Rod's house that would help you figure out how to keep it cooler?

Name ______________________

Date ______________________

# HOT-AIR CHALLENGES

### *HEAT SINK*

Solar engineers include heat sinks in their solar-house designs. Heat sinks are large objects that are warmed by sun during the day and give off heat during the night.

Design a solar house that will stay warm after sundown.

### *INSULATION*

Solar engineers have determined that a lot of space heat is lost through the walls, roof, and floors of houses. To keep heat loss to a minimum, houses are insulated with layers of material that slow the movement of heat.

Design a solar house that reduces heat loss through the walls, roof, and floor.

### *DOUBLE GLAZING*

Solar engineers have found that a lot of heat is lost through window glass. To reduce heat loss and still be able to see out, people install two panes of glass in windows, with an air space between the panes. This is double glazing.

Design a solar house that reduces heat loss by using double glazing.

### *CURTAINS*

Solar engineers have found that one of the places that heat escapes is through windows. One way to reduce heat loss during the evening is by pulling heavy curtains over the windows.

Design a solar house that retains heat at night by curtains pulled over the windows.

Name ________________________________

Date ________________________________

# PROJECT IDEAS

- How can you use what you know about solar energy to make a home that stays cool in the desert?
- How is solar energy used in your community?
- What are some other designs for heat sinks that you can construct and test in a solar house?
- What are some house designs used in other cultures that use solar heating and/or insulation?
- Construct a solar oven and use it to cook a hot dog.
- How would people have to change their homes and lives if solar energy were the only source of energy?
- Use a refrigerator box or other large shipping carton to construct a solar house that would keep you warm on a cold day.
- Look at *FOSS Science Stories* or other books in the library for ideas about projects you might like to present to the class.
- Build a solar water heater that could heat enough water to wash a load of dishes.
- Compare the amount of temperature change in other earth materials, such as gravel and clay, or in mixtures of earth materials, to your results with sand, soil, and water.
- How does temperature change when you place different amounts of earth materials in the sun?
- Design a solar-powered device that really works, using photoelectric cells.
- Find out what an analemma is and how it works.
- Construct a sundial out of durable materials that you could place outside. Make sure it is constructed and oriented properly for your latitude.
- How does the temperature change in earth materials compare on sunny and cloudy days?
- Find out what photochemical solar energy is and how it is used.

Name ______________________

Date ______________________

# PROJECT PROPOSAL

**1. What is the question or the project that you are proposing?**

**2. What materials or references will you need to complete the project?**

**3. What steps will you follow to complete the project?**

Name ______________________________

Date ______________________________

# PRESENTATION GUIDELINES

You will have exactly 3 minutes to present your project to the class. In those 3 minutes you should answer these questions.

- What were you trying to find out (your question)?
- What materials or references did you need to do your project?
- What procedure did you follow to complete your project?
- What did you learn from doing your project?

When you begin speaking, you will see the *green card* held up for 2 1/2 minutes. When you see the *yellow card,* you have 30 seconds left. When you see the *red card,* it means you can finish your sentence, but you must stop within the next few seconds.

Practice your presentation so you will be sure it is at least 2 1/2 minutes long, but not more than 3 minutes long. Be sure you have included all of the information asked for above.

Name ______________________________

Date ______________________________

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- What were you trying to find out (your question)?
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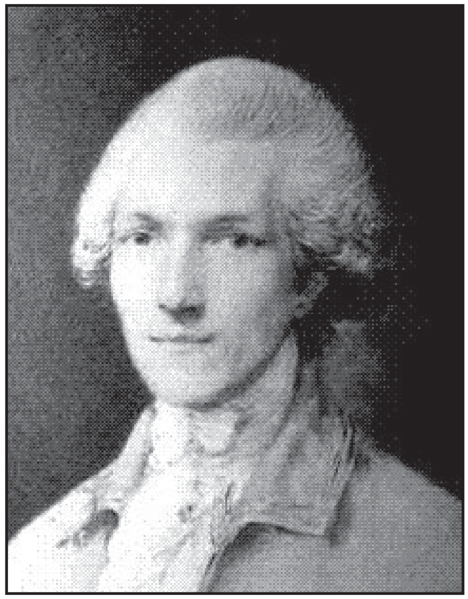
Practice your presentation so you will be sure it is at least 2 1/2 minutes long, but not more than 3 minutes long. Be sure you have included all of the information asked for above.

# HOT DISCUSSION TOPIC—FINDING OUT WHAT HEAT IS

Aristotle was a Greek philosopher who lived in the fourth century B.C.E. He taught that everything in the world was made up of four basic materials: earth, air, fire, and water. He thought that some objects have more fire and some have less. The more fire an object has, the hotter it is.



Over the centuries, ideas change. By the time that Anders Celsius was making a thermometer scale, heat was thought to be a fluid. The fluid was called *caloric*, and it was thought to be present in every material. Some materials have more of it, and some have less. Even though you could not see it, people believed that caloric flows from warm objects to cooler ones, that you can squeeze caloric out of materials, that you can add caloric to materials by holding them over flames, and that when caloric combines with ice, the ice turns to water.

Some thinkers did not agree with the caloric explanation of heat. One of them was Count Rumford, an American who was the minister of war for Bavaria in the late 18th century. He suspected that heat is not a form of material that could flow. Materials, he reasoned, have weight. If heat were a fluid or made up of particles, it would have mass. A warm material should weigh more than a cold one.

Rumford tried many experiments to see if heat has mass. He filled jars with alcohol and water and placed them in containers with temperatures hot enough to boil the liquids or cold enough to freeze them. He weighed the jars before and after. He compared their weights. He could find no signs that heat has mass.

As part of his job as minister of war, Rumford had to inspect the places that manufactured cannons. He watched the workmen as they took a solid brass cylinder and drilled a hole down the length of the rod. During the drilling, the brass got very hot.

Count Rumford asked himself where this heat came from. He measured the temperature of chips of metal that were drilled out of the rod. Although they were hotter than boiling water, the metal was not changed in any way. The only change that happened during the making of the cannon was the movement of the drill against the metal. Did the movement cause the heat? It seemed clear to Rumford that there was a connection between heat and motion.

Do you agree with Count Rumford? What do you think heat is? Record your ideas in your *Solar Energy Journal.*

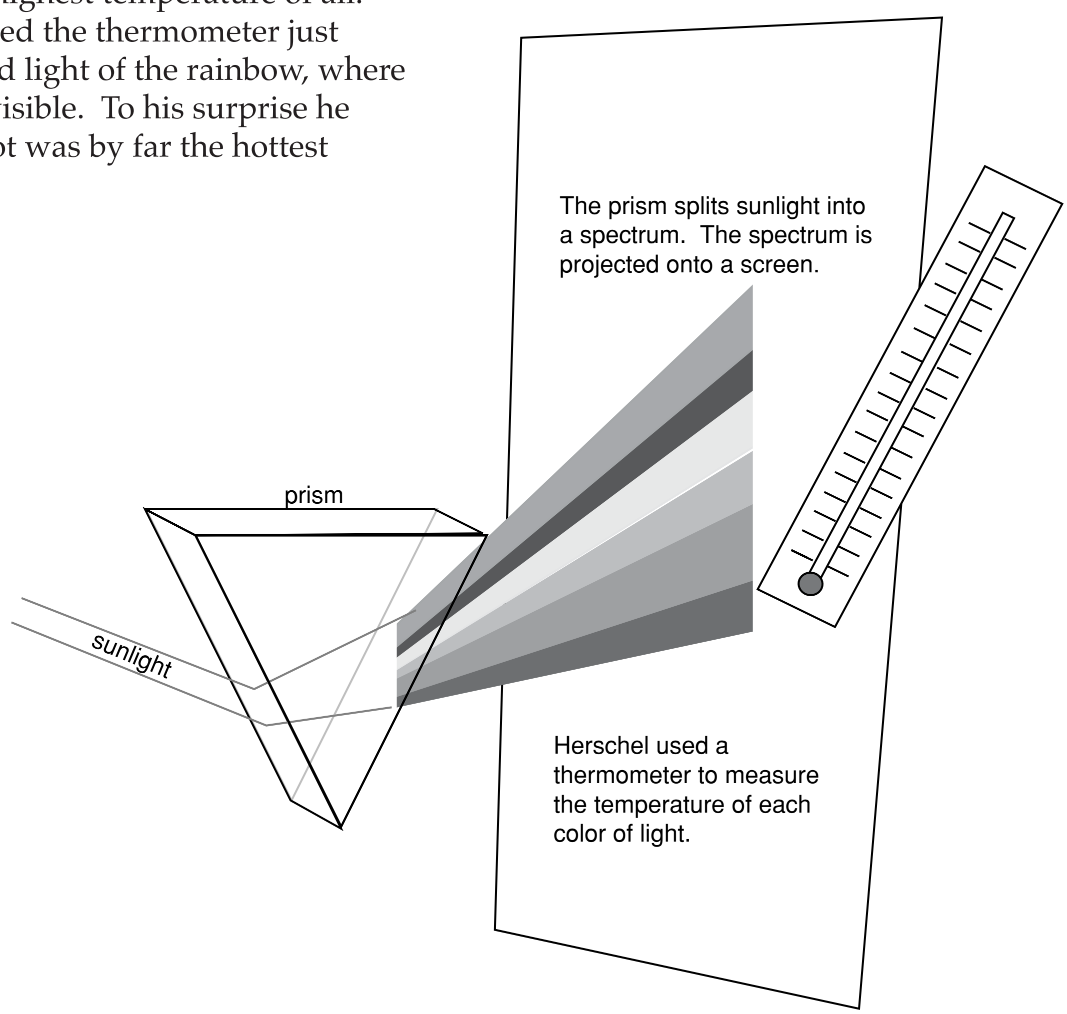
# HOT DISCUSSION TOPIC—HEAT AND LIGHT

In 1800 Sir William Herschel, an English scientist, wondered if there was a connection between heat and light. He was studying light so that he could learn more about the Sun and the stars. He knew that, when he held a prism in a beam of light, the white light broke up into all the colors of the rainbow.

Herschel measured the temperature of each color of light coming out of a prism. As he studied the colors of the rainbow, starting with violet light and moving toward red light, he found that the temperature increased. In fact, the red light had the highest temperature of all. Herschel moved the thermometer just beyond the red light of the rainbow, where no light was visible. To his surprise he found this spot was by far the hottest place!

He decided that there must be some radiation that we cannot see but that is real, all the same. He called this radiation *infrared,* which means "beyond the red."

What do you know about infrared radiation? What would you like to find out? How would you find out? Record your responses and ideas in your *Solar Energy Journal.*



# HOT DISCUSSION TOPIC—THERMOMETERS

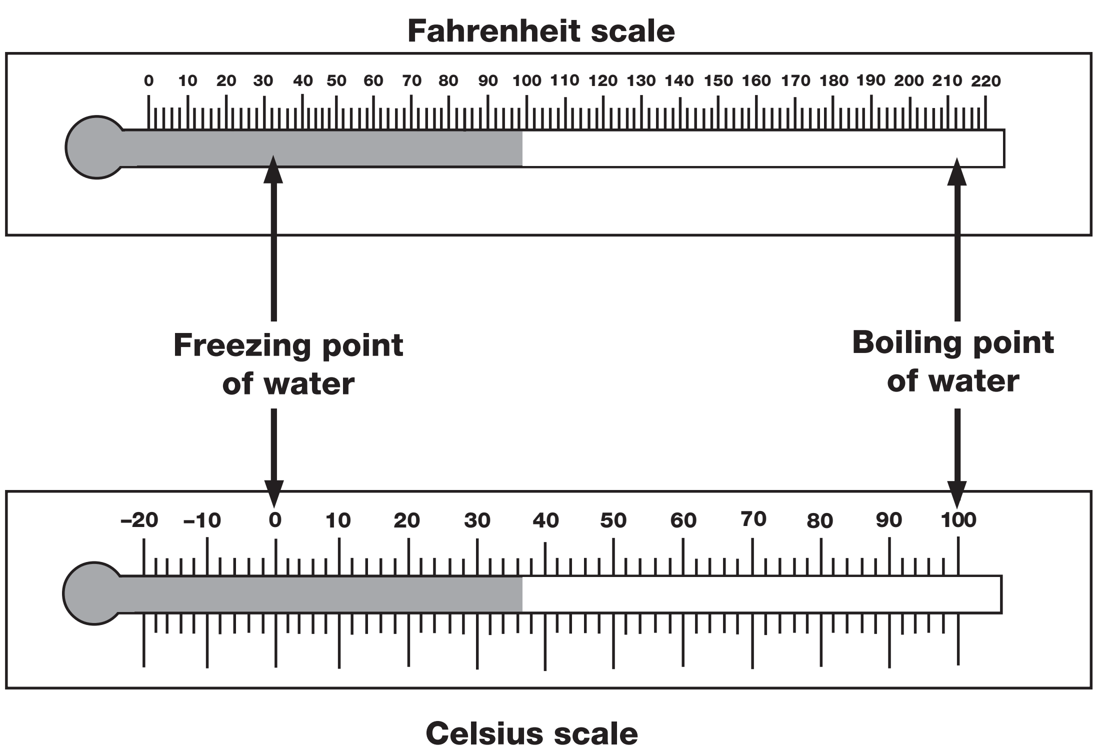
One thermometer scale that is used in the U.S. is the Fahrenheit scale. It was developed in the beginning of the 18th century by Daniel Gabriel Fahrenheit, a German physicist. For the low point of his scale, he took the temperature of a mixture of ice and salt, and marked the level of the thermometer as zero degrees.

The symbol for degrees is °. Temperatures on the Fahrenheit scale are followed by the letter F. Thus you can write zero degrees Fahrenheit as 0°F.

For a high point, Fahrenheit used what he thought was the normal temperature of the human body, and marked it 96°F. He made a scale from his fixed points. Using his scale, he found the temperature of boiling water to be 212°F, and the temperature of melting ice to be 32°F.

At about the same time, Anders Celsius, a Swedish astronomer, invented another thermometer scale. Temperatures on this scale are followed by the letter C. He marked the freezing and boiling points of water 0°C and 100°C. Today, scientists the world over use the Celsius scale.

Look at the diagram of the two scales below. With your friends, determine the answers to the following questions. How many degrees does each line on each scale represent? What Celsius temperature is equal to 98°F (body temperature)? What Celsius temperature is equal to 32°F? Which scale do you find the easiest to use? Why? Record your responses and ideas in your *Solar Energy Journal.*



# HOT DISCUSSION TOPIC—COLORED-WATER EXPERIMENT

Discuss the investigation below with your friends, and decide what the students learned from their observations.

Rachel and Cory wondered if heat from the Sun affects dark water differently than clear water. They filled two 1/2-liter jars with clear water and added drops of several colors of food coloring to one of the jars until the water was almost black. They put a thermometer in each jar, placed both in the sunlight, and recorded the temperature in each jar every 15 minutes for 1 hour. Record your responses to the following questions in your *Solar Energy Journal.*

Draw a chart showing what you think their data looked like.

Did Rachel and Cory design a good procedure to get information about their question?

What do you think Rachel and Cory learned from their study?

Name ______________________

Date ______________________

# MATH EXTENSION—PROBLEM OF THE WEEK

## *INVESTIGATION 1: SUN TRACKING*

Emily made a new shadow tracker and measured the shadows on a day in late December. The table shows the data she collected.

Create a graph using Emily's shadow measurements.

Use your graph to answer the following questions. Use the back of this sheet for your answers.

| Time | Shadow Length (cm) |
|---|---|
| 9:30 a.m. | 13.0 |
| 11:45 a.m. | 8.0 |
| 12:20 p.m. | 7.5 |
| 1:00 p.m. | 8.2 |
| 1:45 p.m. | 10.0 |
| 2:15 p.m. | 12.0 |
| 3:30 p.m. | 14.4 |

1. If Emily had measured the shadow at 10:00 a.m., what would its length have been? How do you know?
2. If Emily measures the shadow at 5:00 p.m., what would the shadow length be? How do you know?
3. What problems, if any, do you see with Emily's measurements?
4. Jeff also set up a shadow tracker on the same day and measured a shadow 10 cm long at 12:00 noon. Is his measurement correct? Why or why not?

Name ________________________________

Date ________________________________

Name ____________________

Date ____________________

# MATH EXTENSION—PROBLEM OF THE WEEK

## *INVESTIGATION 2: HEATING THE EARTH*

### *SOME SOLAR SYSTEM STATISTICS*

| Planet | Average temperature (°C) | Average distance from Sun (km) |
|---|---|---|
| **Mercury** | 179 | 57,910,000 |
| **Venus** | 482 | 108,200,000 |
| **Earth** | 15 | 149,600,000 |
| **Mars** | -63 | 227,940,000 |
| **Jupiter** | -121 | 778,330,000 |
| **Saturn** | -125 | 1,429,400,000 |
| **Uranus** | -193 | 2,870,990,000 |
| **Neptune** | -193 | 4,504,300,000 |
| **Pluto** | ? | 5,913,520,000 |

How does distance from the Sun affect a planet's temperature? The nine planets in our solar system all receive energy from the Sun. Do they all receive and absorb the same amount of energy? The information in the chart above may help you answer this question.

One way to analyze the data in the chart is to record it on a graph. You need to decide what type of graph will work best and whether you need to draw one or two graphs to see the relationship. Use the graph paper your teacher supplies.

After you complete your graph(s), answer the following questions. Use the back of this sheet for your answers.

1. There is no temperature information for Pluto. What is your estimate for its temperature? Explain your answer.

2. Describe the relationship you see between temperature and distance from the Sun.

3. Which planets, if any, don't fit the relationship? Why do you think they don't fit?

Name ____________________

Date ____________________

# MATH EXTENSION—PROBLEM OF THE WEEK

## *INVESTIGATION 3: SOLAR WATER HEATERS*

What does a utility bill look like? Many homes use a combination of electricity and natural gas to power appliances and heat water and air. The monthly bill may look something like this. Your task is to complete the calculations for the empty boxes on the bill.

John Doe     Billing Period  From: 01/21/99  To: 02/20/99  31 days

GAS CHARGES  Meter #999999X

| Prior Meter Reading | Current Meter Reading | Difference | Multiplier[1] | Total Usage |
|---|---|---|---|---|
| 8001 | 8037 | | X 1.025 | therms[2] |

| GAS | Therms | Price | Total |
|---|---|---|---|
| Baseline Quantities[3] | 18.0 | | |
| Baseline Usage | 18.0 | @ $0.58 | |
| Over Baseline Usage | | @ $0.78 | |

ELECTRICITY CHARGES  Meter #999999X

Rate Schedule:  W 2XD

| Prior Meter Reading | Current Meter Reading | Difference | Constant[4] | Usage |
|---|---|---|---|---|
| 86367 | 86742 | | 1.1 | kWh[5] |

| ELECTRIC | kWh | Price | Total |
|---|---|---|---|
| Baseline Quantities[3] | 324.0 | | |
| Baseline Usage | 324.0 | @ $0.12 | |
| Over Baseline Usage | | @ $0.13 | |

| Usage Comparison | Days | Therms Billed | Therms per day | kWh Billed | kWh per day |
|---|---|---|---|---|---|
| This Year | 31 | | | | |
| Last Year | 30 | 48 | 1.6 | 300 | 10 |
| Differences | | | | | |

TOTAL CHARGE FOR GAS ______     TOTAL CHARGE FOR ELECTRICITY ______

TOTAL ENERGY CHARGES ______

1 The multiplier is a number that converts the difference in meter readings into therms. The multiplier may be different from one location to another because of differences in elevation, delivery pressure, and the heating content of the natural gas.

2 Therms are units used to measure quantity of heat. One therm equals 100,000 British thermal units, or BTUs.

3 Baseline usage is the maximum usage that can be billed at the lower price for a particular rate schedule. Baseline quantities vary by season, climate zone, and your heat source.

4 A constant is a factor that converts electric meter reading differences into kilowatt-hours (kWh).

5 A kilowatt-hour (kWh) is a unit of work or energy equal to that expended by 1 kilowatt in 1 hour. A kilowatt equals 1000 watts. A watt equals 1/746 horsepower.

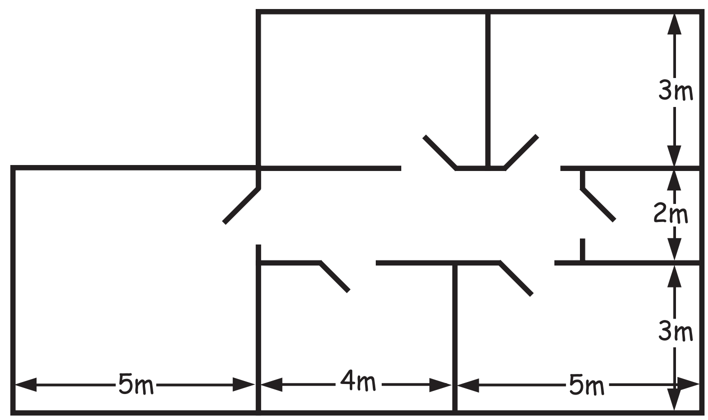
Name ______________________

Date ______________________

# MATH EXTENSION—PROBLEM OF THE WEEK

## *INVESTIGATION 4: SOLAR HOUSES*

Andy's family is building the house shown in the plan. They are going to insulate all the outside walls to keep the house warm in the winter and cool in the summer. They need to figure out how much insulating material to buy.




Floor plan


Side view

1. How many square meters of insulating material will Andy's family need to insulate the walls of the house?

2. The insulating material comes in bats (sheets) that are 1 m wide and 6 m long. How many bats will they need?

3. How many more bats will they need if they decide to insulate the ceiling, too?

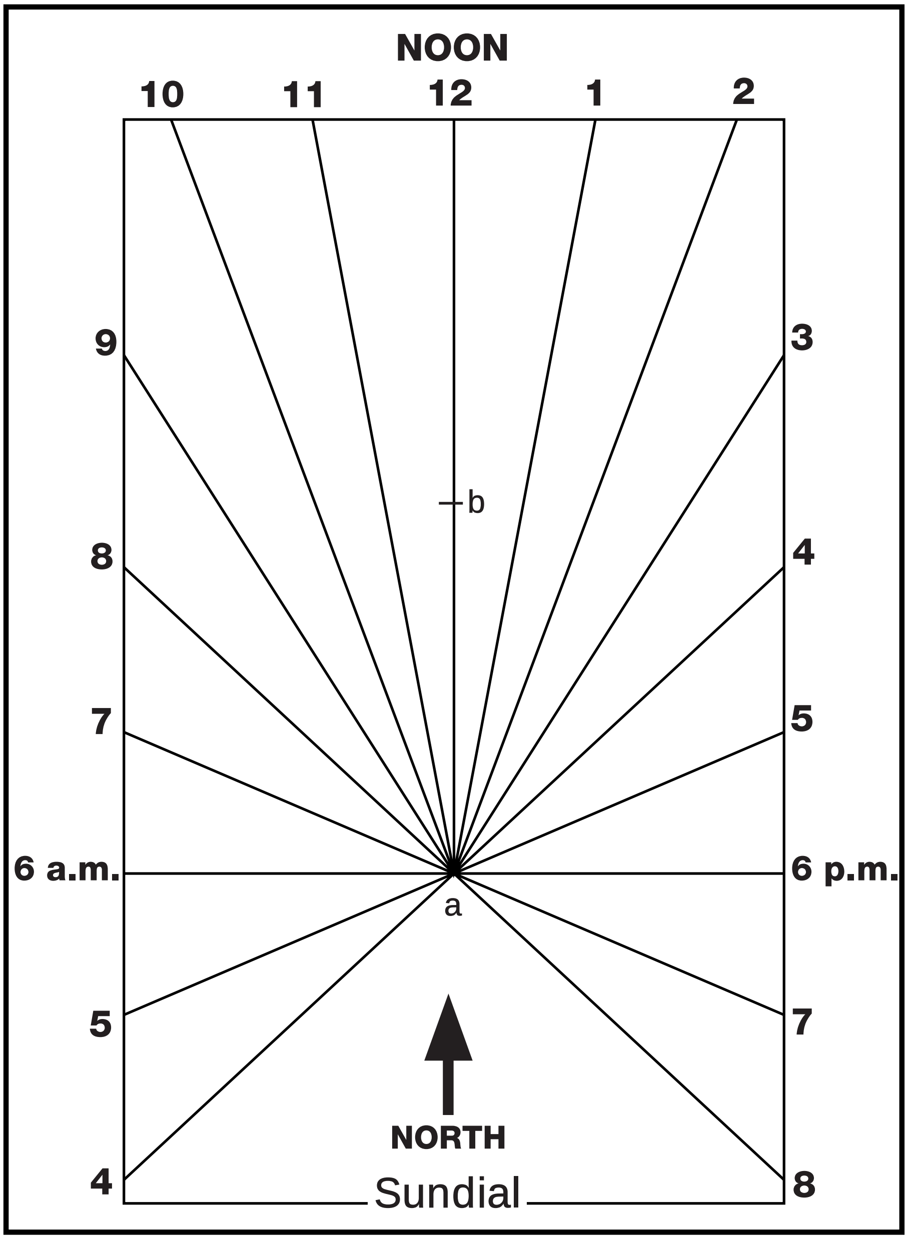
4. **Extra credit.** The insulating material is 10 cm thick. What is the total volume (cubic meters) of insulation that will be used in this project?

Name ______________________________

Date ______________________________

# HOME/SCHOOL CONNECTION

## *INVESTIGATION 1: SUN TRACKING*




**Sundial Pattern**

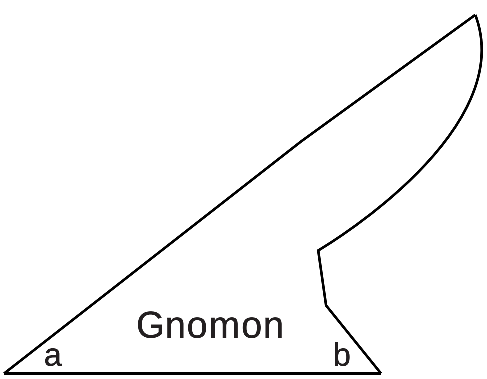
This sundial will work best at 38° latitude, the latitude of San Francisco Bay. But the gnomon can be easily modified to fit your locality. Just find out the latitude of your hometown and modify angle *a* on the gnomon to measure that angle.

**Materials**

- Cardboard
- Scissors or mat knife
- Protractor
- Glue

**Directions**

1. Glue the pattern to a piece of cardboard. Let it dry.
2. Cut out the sundial and the gnomon carefully.
3. Glue the gnomon to the sundial on the 12:00 line, matching points *a* and *b.*
4. Place the sundial outside or in a sunny window. It must be level. Point the 12:00 line and the gnomon directly north. Adjust the sundial by comparing the time you see on the dial with the time on a clock and turning the sundial until the times most nearly match. The sundial will now tell time accurately.




**Remember:** Sundials measure local apparent time, which depends on the position of the Sun in the sky. You will need to adjust to the time you read on the sundial to get standard time. Check a reference to get the correction factors required to make this adjustment.

Name ______________________

Date ______________________

# HOME/SCHOOL CONNECTION

## INVESTIGATION 2: HEATING THE EARTH

Whales are the biggest animals alive on Earth today. They need a lot to eat. Whales who are filter feeders rely on tiny, floating crustaceans and larva called krill as the main part of their diet. A blue whale can eat over 3636 kg (4 tons) of krill a day. Even the krill depend on tinier marine plants for their food. And the plants depend on sunshine for their survival. So, if you think carefully, whales depend on a whole lot of sunshine for their survival!

## HOW MANY SUN-DAYS DO YOU USE?

Plants depend on solar energy for their survival. They use the Sun's energy to make food and store the energy in their leaves, seeds, and fruit. When an animal, like yourself, eats the fruit from a plant or tree, you are eating this stored solar energy. Different kinds of plants take different numbers of day to reach the stage when their fruits are edible. You might think of it this way: one day of sunshine used and stored by a plant equals one "sun-day." For example, it can take up to 73 days for corn to grow from a seed to the stage when you can eat it off the cob. You are using 73 days of stored solar energy in the corn when you eat it.

Find out how many sun-days it takes to ripen your favorite fruits and vegetables.

- Write down your favorite fruits and vegetables in the chart below.
- To find the number of sun-days for each food, read seed packets or a seed catalog. Some seed catalogs are available on the Internet or you might try the library or a garden supply store. For the cereal, you need to find out what type of grain your cereal is made of (for example, oats or corn).

| TYPE OF FOOD | YOUR FAVORITE | NUMBER OF SUN-DAYS |
|---|---|---|
| **Vegetable** | | |
| **Fruit** | | |
| **Cereal** | | |

Here are some examples of average sun-days for some popular fruits and vegetables.

| | | | | | |
|---|---|---|---|---|---|
| Corn | 73 sun-days | Strawberries | 50 sun-days | Oats | 240 sun-days |
| Green beans | 58 sun-days | Watermelon | 78 sun-days | Wheat | 240 sun-days |
| Broccoli | 60 sun-days | Cantaloupe | 75 sun-days | Lettuce (loose-leaf) | 48 sun-days |
| Carrots | 70 sun-days | Cucumber | 55 sun-days | Radishes | 22 sun-days |

Name ___

Date ___

# HOME/SCHOOL CONNECTION

## *INVESTIGATION 3: SOLAR WATER HEATERS*

People can use different energy sources to heat water for their homes. Often they use gas or electric water heaters. Some people use solar collectors on their roofs to heat water for their home use.

What energy source does your family use to heat water? ___

The chart below shows the estimated cost per month for heating water for a home, depending on the number of people who live in the home.

| Water heater, 160-liter, with insulation blanket | | |
|---|---|---|
| Number of people in household | Electric water heater | Gas water heater |
| 1 | $17.71 | $7.06 |
| 2 | $28.93 | $10.21 |
| 3 | $40.15 | $13.36 |
| 4 | $51.37 | $16.51 |
| 5 | $62.59 | $19.66 |
| 6 | $73.81 | $22.81 |
| 7 | $85.03 | $25.86 |
| 8 | $96.03 | $29.11 |

Ask to look at a copy of the utility bill for your residence. Find the amount of gas and/or electricity your family used for a month and how much it cost. How do these amounts compare with the figures in the chart? How can you tell how much of the total utility cost is for heating water?

Here are some ways your family might reduce hot water use in your home.

- Install low-flow showerheads and put aerators on the faucets.
- Put an insulating blanket on the water heater.
- Lower the thermostat on the water heater to 49°C (120°F).
- Wash clothes in warm or cold water, not hot.
- Fix leaky faucets and showerheads.

Check with your local utility company for more energy-saving tips and information about energy sources. List three more ideas for saving energy by cutting down on hot-water use. Write your ideas on the back of this sheet.

Information adapted from U.S. Department of Energy, 1999, and Pacific Gas & Electric's SmarterEnergy web site at http://www.pge.com/customer_services/residential/ecalc/.