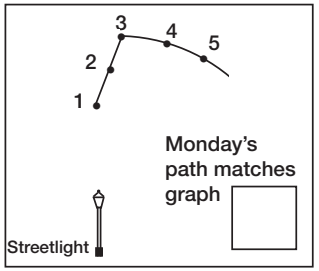
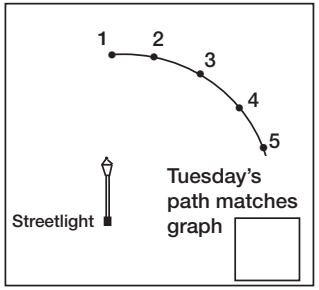
## RESPONSE SHEET—SUN TRACKING

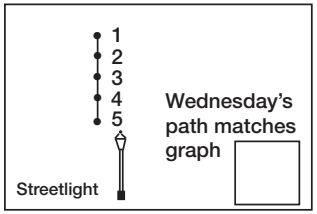
**Directions:** Read the three stories below and look at the pictures. Figure out which graph (X, Y, Z) goes with each story. Write the letter of the graph in the box in the picture.




**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.

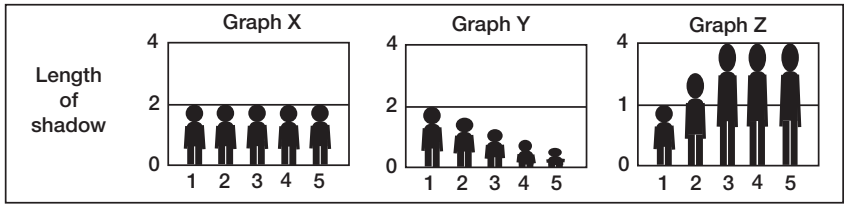



**Story 2.** On Tuesday night you began from the same place near the streetlight and walked a different path. Your friend measured the length of your shadow at each of the five stops.




**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.

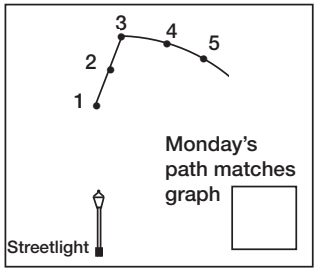
Your friend made a bar graph of the shadow lengths for each night's walk. Below are the graphs your friend made. Match each graph with the path walked and explain your answers on the back of this sheet.



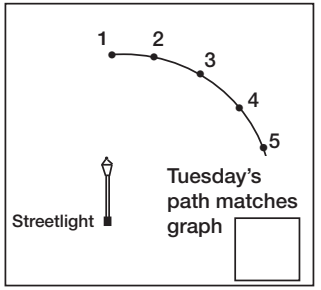



## RESPONSE SHEET—SUN TRACKING

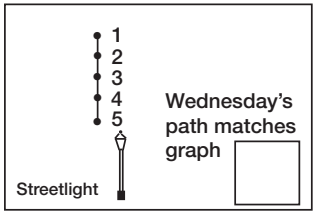
**Directions:** Read the three stories below and look at the pictures. Figure out which graph (X, Y, Z) goes with each story. Write the letter of the graph in the box in the picture.




**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.

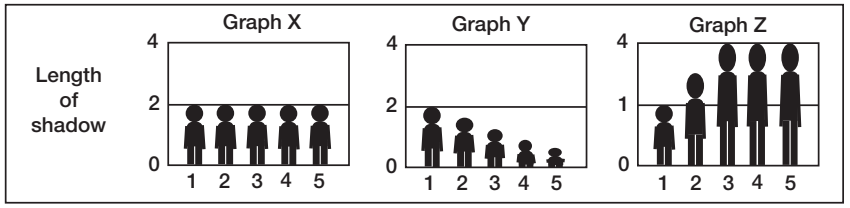



**Story 2.** On Tuesday night you began from the same place near the streetlight and walked a different path. Your friend measured the length of your shadow at each of the five stops.




**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.




FOSS Solar Energy Module
© The Regents of the University of California
Can be duplicated for classroom or workshop use.
Investigation 1: Sun Tracking
No. 5—Student Sheet

## THERMOMETER IN SUN AND SHADE

Time of day _____

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


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## THERMOMETER IN SUN AND SHADE

Time of day _____

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

FOSS Solar Energy Module
Investigation 2: Heating the Earth
No. 7—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## EARTH MATERIALS IN SUN AND SHADE

Time of day _____ Air temperature _____

Earth material investigated _____

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


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## EARTH MATERIALS IN SUN AND SHADE

Time of day _____ Air temperature _____

Earth material investigated _____

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

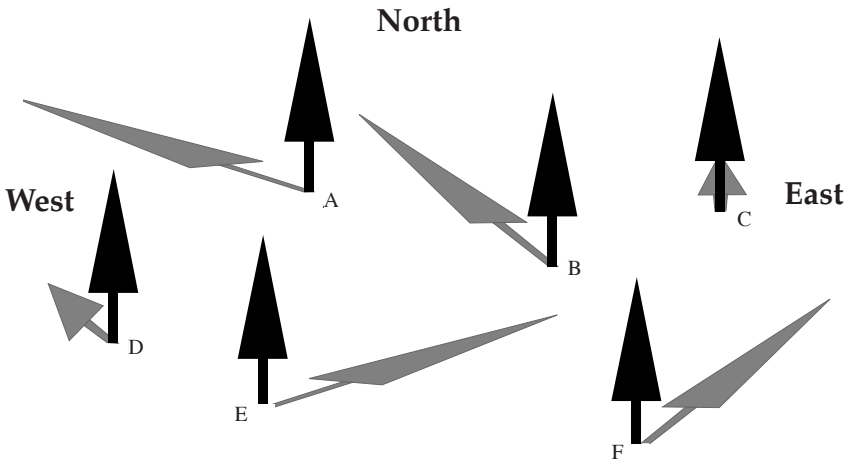
Temp. change = _____

FOSS Solar Energy Module
Investigation 2: Heating the Earth
No. 8—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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



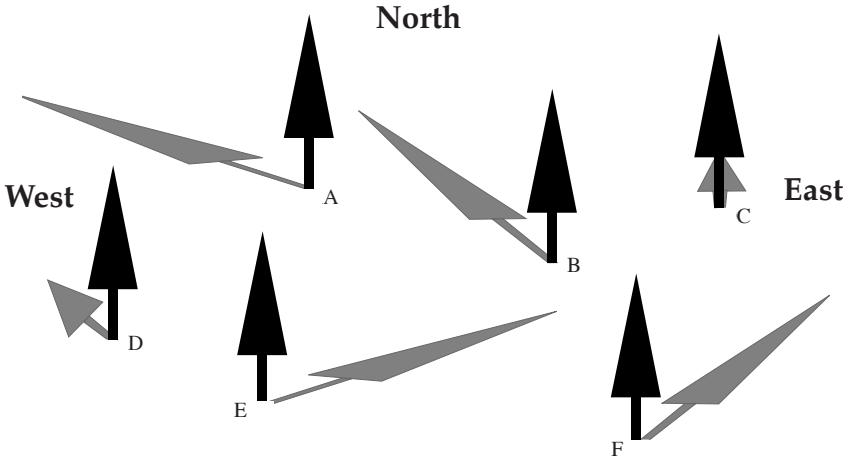

1. Early-morning shadow _____
2. _____
3. _____
4. _____
5. _____
6. Late-afternoon shadow _____


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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 _____

FOSS Solar Energy Module
Investigation 2: Heating the Earth
No. 9—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

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

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


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## TWO GROUPS' DATA: MATERIALS IN SUN AND SHADE

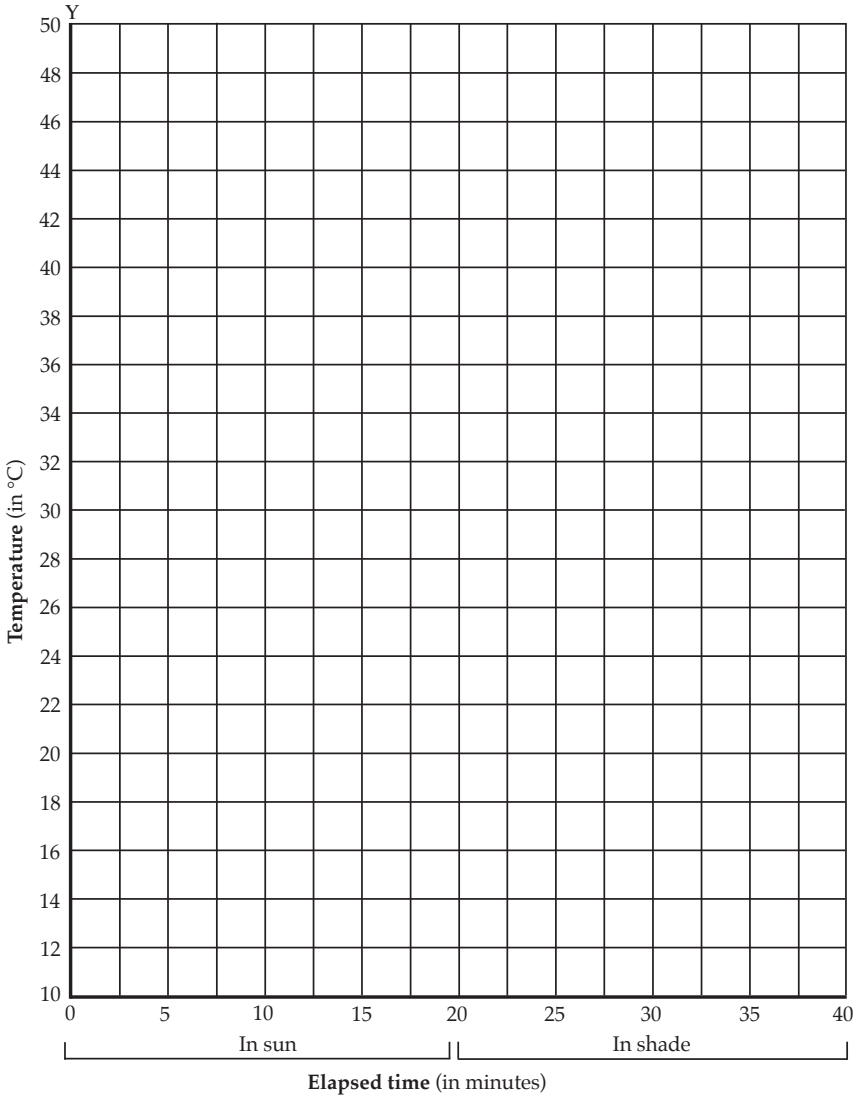
Time of day _____ Air temperature _____

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

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

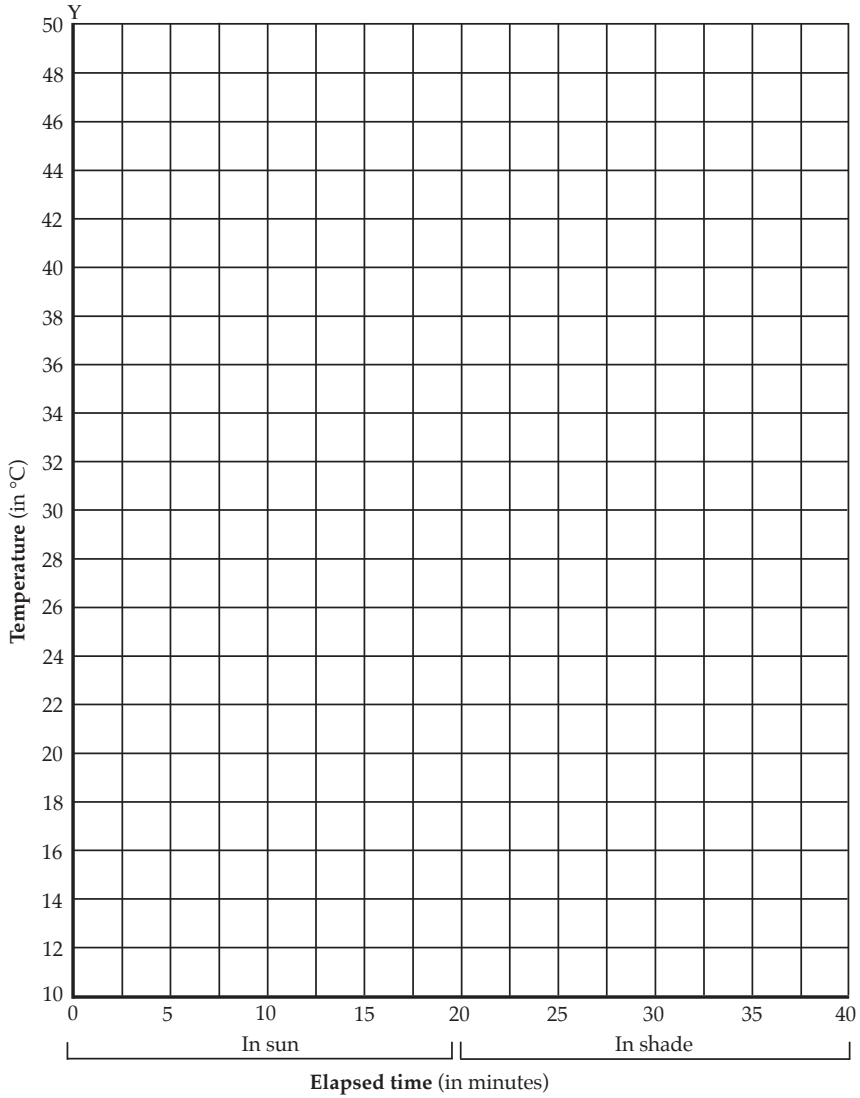
FOSS Solar Energy Module
Investigation 2: Heating the Earth
No. 10—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## GRAPH OF EARTH-MATERIALS TEMPERATURES






## GRAPH OF EARTH-MATERIALS TEMPERATURES




FOSS Solar Energy Module
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

Investigation 2: Heating the Earth
No. 11—Student Sheet

## 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 |

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.

Temperature Data (air temperature: 22°C)

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

Do you agree with Josh or Natalie? Give your reasons.
What do you think caused the temperature differences? Write your answer in your science notebook.


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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 |

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.

Temperature Data (air temperature: 22°C)

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

Do you agree with Josh or Natalie? Give your reasons.
What do you think caused the temperature differences? Write your answer in your science notebook.

FOSS Solar Energy Module
Investigation 2: Heating the Earth
No. 12—Teacher Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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

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

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


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

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

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

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

FOSS Solar Energy Module
Investigation 3: Solar Water Heaters
No. 15—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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.


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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**

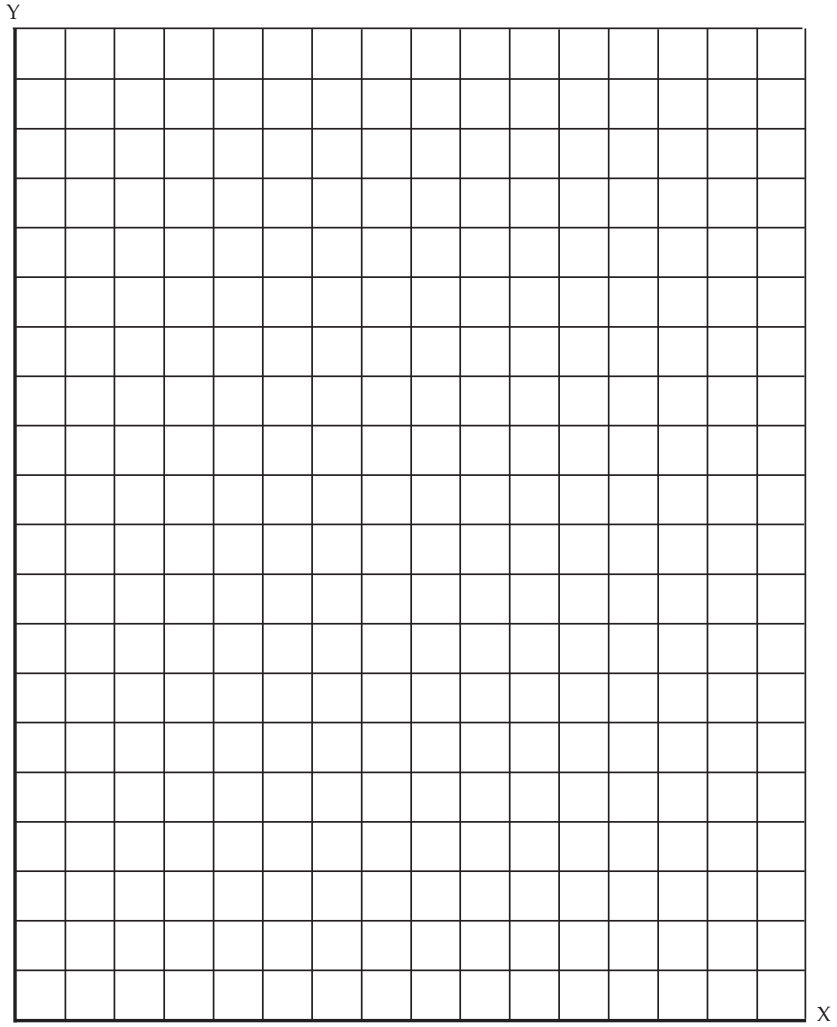
1. Each team gets its own conference chart. Put your name at the top.
2. Circle the experiment you did.
3. Write your team's names in one of the temperature-change columns.
4. Record your team's temperature changes in your column.
5. Pass your sheet around the conference group so the other teams can 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.

FOSS Solar Energy Module
Investigation 3: Solar Water Heaters
No. 16—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## SOLAR-ENERGY GRAPH

***INVESTIGATION TITLE*** _____

Air temperature _____





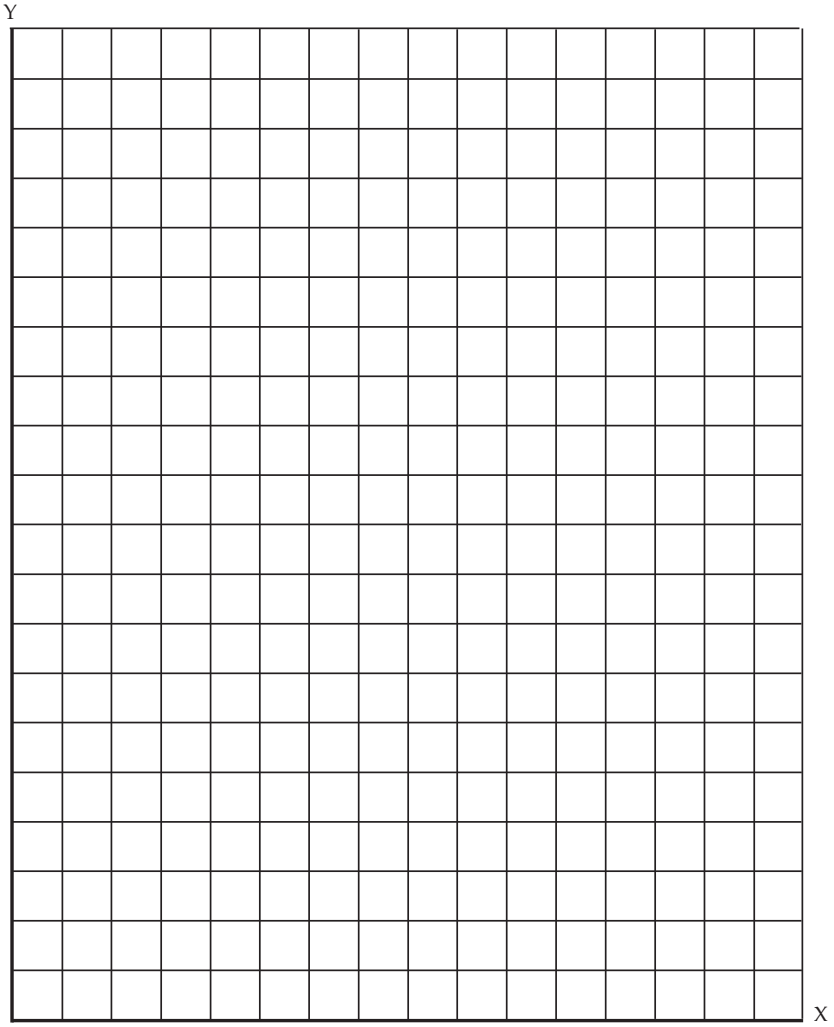
© The Regents of the University of California

Can be duplicated for classroom or workshop use.

## SOLAR-ENERGY GRAPH

***INVESTIGATION TITLE*** _____

Air temperature _____




FOSS Solar Energy Module
Investigation 3: Solar Water Heaters
© The Regents of the University of California
No. 17—Student Sheet
Can be duplicated for classroom or workshop use.

## 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.


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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.

FOSS Solar Energy Module
Investigation 3: Solar Water Heaters
No. 18—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## SPACE HEATING

**Time of day**_____ **Air temperature** _____

***SOLAR HOUSE 1***

Orientation of house _____

Color of interior _____

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

***SOLAR HOUSE 2***

Orientation of house _____

Color of interior _____

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


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## SPACE HEATING

**Time of day**_____ **Air temperature** _____

***SOLAR HOUSE 1***

Orientation of house _____

Color of interior _____

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

***SOLAR HOUSE 2***

Orientation of house _____

Color of interior _____

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

FOSS Solar Energy Module
Investigation 4: Solar Houses
No. 21—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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?


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## 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?

FOSS Solar Energy Module
Investigation 4: Solar Houses
No. 22—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.

## FOSS SOLAR ENERGY MODULE

### *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 do you need to take to complete the project?


© The Regents of the University of California
Can be duplicated for classroom or workshop use.

FOSS SOLAR ENERGY MODULE

*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 do you need to take to complete the project?

FOSS Solar Energy Module
Investigation 4: Solar Houses
No. 25—Student Sheet
© The Regents of the University of California
Can be duplicated for classroom or workshop use.