EP-1





# The Effect of the Great Lakes on Temperature

by
James D. Meinke, Lakewood Public Schools,
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**TEACHER GUIDE**

OEAGLS-Oceanic Education Activities for Great Lakes Schools

# OEAGLS Investigation #1

Completed February 1979
Revised December 1979, August 1980, January 1983, and August 1988

This instructional activity was prepared with the support of the National Oceanic and Atmospheric Administration, Sea Grant College Program Office, U.S. Department of Commerce, under Ohio Sea Grant Project #710678. Funding support was also provided by The Ohio State University's School of Natural Resources and College of Education. Any opinions, findings, conclusions or recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NOAA or the University.

# TEACHER GUIDE

# THE EFFECT OF THE GREAT LAKES ON TEMPERATURE TEACHER GUIDE


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James D. Meinke, Beth A. Kennedy and Rosanne W. Fortner
Ohio Sea Grant Education

## OVERVIEW

When a large container of water is placed in a room with foods, as described in the Introduction to the Investigation, the water will prevent the foods from freezing since water acts as a heat source if it is at a higher temperature than its surroundings. Water adds heat energy to the atmosphere thereby keeping the room warm and the food from freezing.

In Activity A students study the ideas of **heat source** and **heat sink**. They conduct an experiment on the effect of solar heating on soil and water using a lamp as a source of radiation. They collect and analyze data on the temperature differences between soil and water and the air immediately above them.

In Activity B they apply this knowledge of heat sources and sinks to Lake Erie and Ohio, and to the oceans and land masses of the world to study the effect of large bodies of water on climate.

## PREREQUISITE STUDENT BACKGROUND

The students should know how to graph data.

## MATERIALS

Each lab group should have four thermometers, a container of dark soil and one of water, two 30 cm rulers, masking tape, ringstand, graph paper, and a light with reflector. The light should be at least 150 watts.

## SUGGESTED APPROACH

Activity A could be done in larger groups to help cut down on the amount of equipment needed.

Activity B could be done in these same groups, or done individually.

## OBJECTIVIES

When the students have completed these activities, they should be able to:

1. Describe how soil and water differ in their ability to absorb and release heat energy.
2. Describe how this difference in heat absorbed or released affects the atmosphere immediately above the land and immediately above the water.
3. Describe the effects of the Great Lakes upon the temperature of Ohio.

NOTE: Information to teachers is enclosed in boxes in this guide.

# THE EFFECT OF THE GREAT LAKES ON TEMPERATURE

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## INTRODUCTION

Even as far back as the "log cabin days," people knew that water absorbs a great deal of heat energy and can in turn release this heat. Pioneers would prevent foods from freezing on cold nights by placing a large container of water in the room. Can you think of why this might work?

In this investigation we will explore how bodies of water can affect the surrounding areas.

## ACTIVITY A: WHAT ARE HEAT SOURCES AND HEAT SINKS?

**KEYWORDS:** Heat source, heat sink, isotherm.

The introduction to Activity A is meant to introduce the most widely observed effect of heat sources and heat sinks. What is happening? The spring sunshine has warmed the land's surface rapidly, thus the land was a heat sink for a short period of time. Then the land became a heat source as it re-radiated or gave up its heat to the air above it thus adding more heat to the air. The water, however, acts as a heat sink for a much longer period of time and warms up much slower; this is why water is cooler during the days of spring and early summer than the surrounding air.

In the early spring when the weather is warming, some days are so hot we would like to jump in the lake and take a swim. We would find, however, that even though the air is hot, the water is very cold.

**MATERIALS:** Four thermometers, a container of soil and one of water, two 30 cm rulers, masking tape, ringstand, graph paper, pencil, light with reflector.

### PROCEDURE

Set out the soil and water a day ahead to allow them to come to room temperature.

Steps A-G describe the experiment set-up shown in Figure 1 of the student guide. Each student set-up should be examined by you before the students turn on the lamp. Check to make sure that the thermometer bulbs are shaded from the direct light. You should point out the importance of taking accurate temperature readings.

Set up your materials according to the following directions. (See Figure 1.)

A. Place the containers of earth and water about 3 cm apart.

B. Lay one ruler across each container, resting it on the container's rim.

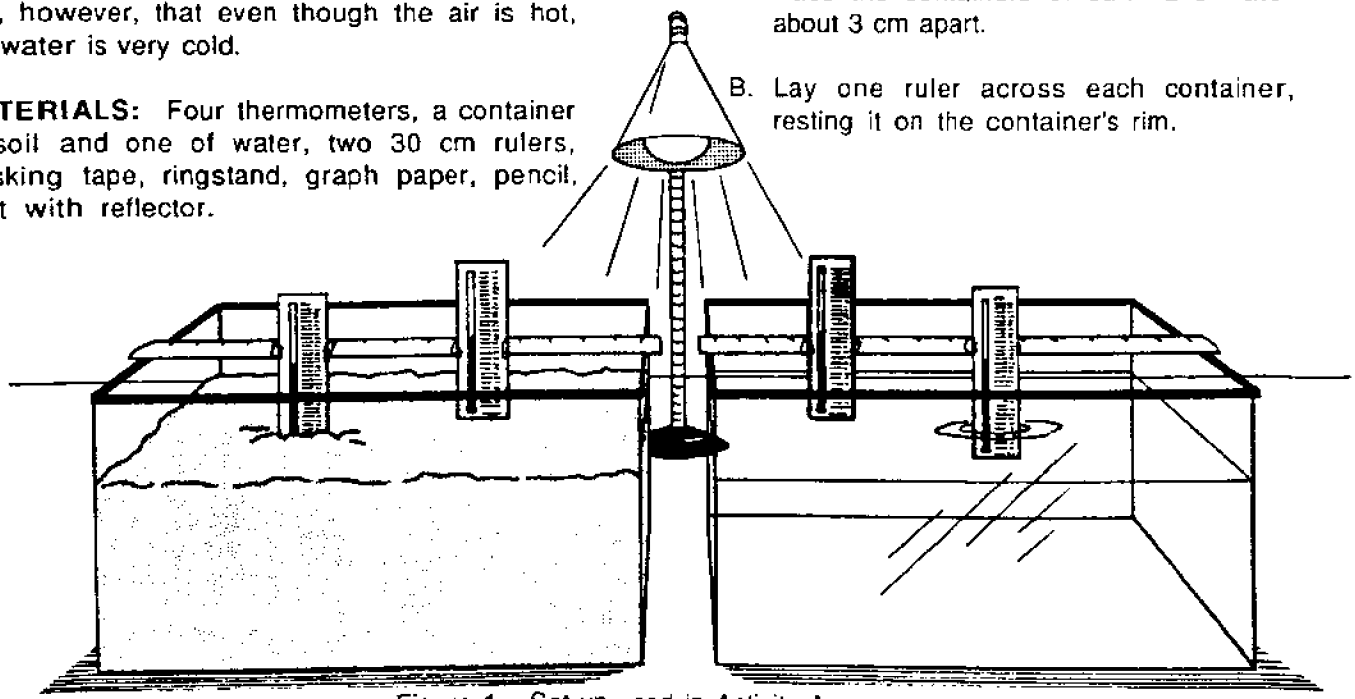


Figure 1. Set-up used in Activity A.

C. Place one thermometer in the soil with the thermometer bulb just barely covered. Attach with masking tape to the ruler.

D. Place another thermometer close to the first one, but about 1 cm above the soil. Attach with masking tape to the ruler.

E. Repeat steps C and D for the container of water.

F. Place the lamp on a ringstand with the reflector pointing down.

G. Position the lamp 30 cm above and centered between the containers.

H. Be certain that the bulb of each thermometer is shielded from the direct rays of the lamp.

After your teacher has examined your set-up, do the following:

1. Construct a data table according to the instructions of your teacher.

T1. Explain how to set up their data tables. See Figure TG 1 below.

| Time Elapsed | Thermometer 1 (above earth) | Thermometer 2 (in earth) | Thermometer 3 (above water) | Thermometer 4 (in water) |
|---|---|---|---|---|
| 1 min. | | | | |
| 2 min. | | | | |
| 3 min. | | | | |

Figure TG 1. Sample Data Table.

Remind students to turn off the lamp after their 12-minute reading. They should continue to take readings every minute for another 12 minutes.

2. Turn the lamp on. At one-minute intervals record the temperatures indicated on each of the four thermometers. Continue for 12 minutes.

3. Turn the lamp <u>off</u>. Continue recording temperatures at one-minute intervals for 12 minutes.

4. Plot your data on the time-temperature graph in your work sheet. Use a different color for the data from each thermometer.

T2-4. To help make the graphs easier to interpret, it is best if all the initial temperature readings for each set-up are the same. If the students' thermometers did not read the same at the beginning, then the temperature readings should be adjusted so that the initial temperatures are equal. This is done by finding the difference between the thermometer with the lowest reading and each of the others. The difference for each of the other thermometers is then subtracted from each reading given by the thermometer.

Answer questions 5-7 using data from the <u>first</u> 12-minute intervals on the data table and time-temperature graph. Put your answers on your work sheet.

5. With the light on, does air heat up faster over the soil or over the water?

T5. The air heats up faster over the soil.

6. Which changes more, the temperature of soil or the temperature of the water?

T6 and 8. While the lamp is on, the soil should be heating up more rapidly than the water since soil has a lower **specific heat** and it absorbs all radiation close to the surface. Specific heat is the amount of heat (in calories) required to raise the temperature of one gram of substance by one degree Celsius. The specific heat of water is 1. For all other common liquids and solids the specific heat is less than 1.

After the light is turned off, the soil should cool more rapidly than the water because of its lower specific heat. (See Figure TG 2). Note that the curves for soil and water do show a drop at different rates in Section B of the graph. Most students should be able to notice the difference on this part of their curves.

7. Which absorbs more energy, soil or water?

T7 and 9. The water will absorb more energy. It will be very difficult for students to understand this. The clue is in the "air" curves. The air over the soil heats up much more rapidly than that over the water. This is because soil cannot hold on to the heat energy and gives it right back to the atmosphere. The difference in the two curves therefore implies that the water has a greater capacity for storing heat energy. This idea is further supported by the ends of the two curves. Note that they cross at about 19 minutes. Note that the curves continue to diverge after 19 minutes. Water is acting as a source of heat energy for the atmosphere.

Use the data for the last 12-minute intervals to answer questions 8-11.

8. With the light off, which changes more: the temperature of soil or the temperature of the water?

9. Which changes most after the light is turned off, the temperature above the soil or the temperature above the water?

10. Which loses heat faster, soil or water?

T10. Soil loses heat faster than water.

11. Which keeps heat energy longest, soil or water?

T11. Water keeps its energy the longest. If students place their thermometers too deeply in the soil their temperatures will show a continuing rise in temperature after the light is turned off. This happens because some of the energy from the surface is conducted downward into the soil.

Anything that adds heat energy to the atmosphere is called a **heat source**. A **heat sink** takes energy from the atmosphere.

12. Could soil or water be considered a heat sink while the light was on? Discuss.

T12. Normally soil will function very briefly as a heat sink after the light is turned on. Shortly, however, it will begin radiating energy back to the atmosphere (become a heat source) as indicated by the heating of the air above the soil. Water should remain a heat sink, however, and produce only a minimum rise in temperature of the air above. Figure TG 2 does not show this relationship.

13. After the light was turned off, was the soil a heat source? Was the water a heat source? Discuss.

T13. After the light is turned off soil functions only briefly as a heat source. Water, however, continues as a source to the end of the recording period. Since the air temperature above the water remains higher than that of the water itself, it will continue to act as a heat source until the surface water is the same temperature as the air over it.

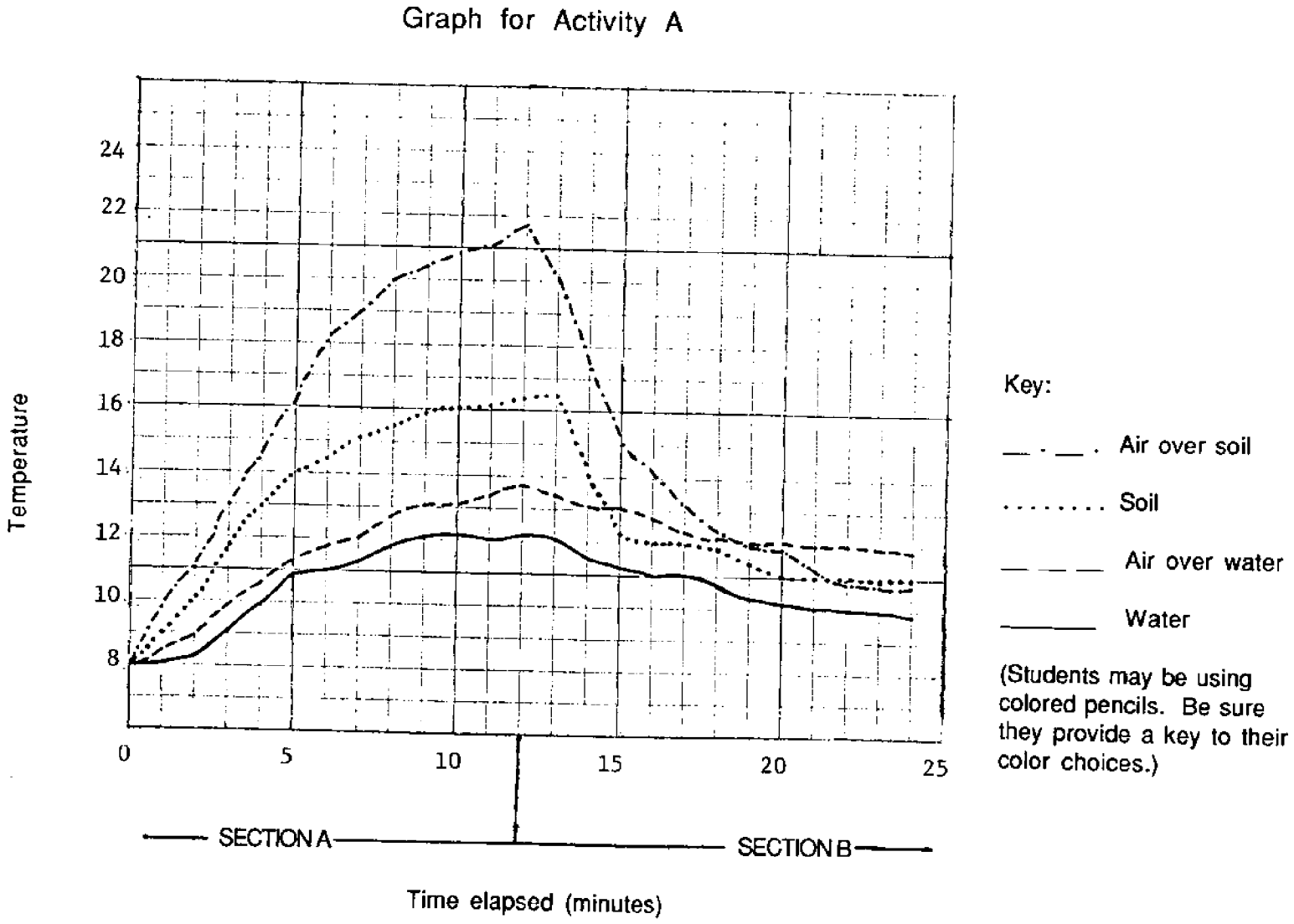



Figure TG 2. Sample of Completed Graph.

## ACTIVITY B: HOW DO THE GREAT LAKES AND THE OCEANS AFFECT CLIMATE?

**KEYWORDS: isotherm**

This activity applies the idea of heat sources and heat sinks to the climate of Ohio and the world.

In Activity A, you learned that the pan of water was a good **heat sink** while the lamp was on and a good **heat source** while the light was off. Soil also acts as a heat sink and source, but its capacity to hold energy is much lower than that of water. Therefore, soil will become a heat source soon after the light is turned on and will quit acting as a heat source not long after the light is turned off.

A body of water such as a lake acts much the same way during the summer. During the day the water is a heat sink, storing up heat from the atmosphere. At night it becomes a heat source, giving up heat throughout the night. If you live near a lake you have experienced land sea breezes which are caused by the lake. Lake water tends to increase in temperature all summer. This indicates that it is storing up extra energy from the atmosphere. It acts as a heat sink throughout the summer. In the winter, however, there is less radiation from the sun. Then lakes become heat sources giving up their energy to the atmosphere.

### PROCEDURES

Figures 2 and 3 are maps of Ohio with isotherms drawn on them. An **isotherm** is a line that connects points of equal temperature. Those on Figure 2 represent the average temperature in Fahrenheit for the month of July. The isotherms in Figure 3 represent average temperatures for the month of January.

1. What happens to the average temperature along line AB in Figure 2 as Lake Erie is approached from the west?

T1. As you approach the lake the temperature decreases.

2. What happens to the average temperature along line CD in Figure 3 as Lake Erie is approached from the west?

T2. As you approach the lake from the west, the temperature increases.

3. Explain the differences in temperature patterns between July and January.

T3. During the summer the lake absorbs energy but the land re-radiates energy to the atmosphere. Therefore, air over land is warmer than that over the water. In the winter the energy absorbed by the lake water is gradually released to the atmosphere, making the air over the water warmer than that over the land.

4. Is Lake Erie a heat source or sink? Discuss.

T4. Lake Erie is both a heat source and a heat sink depending on the season. In the late spring and summer, it is a heat sink, but in the fall and winter it is a heat source.

5. Describe the effects of Lake Erie on the temperature of northern Ohio.

T5. Lake Erie acts as a moderator for northern Ohio's climate. It keeps the air cooler in the early summer and warmer in the rest of the fall and the winter, than other parts of the state.

Oceans are also large bodies of water. They affect temperature in much the same way as large lakes. Figure 4 is a map of the world on which are drawn isotherms representing the average temperatures in January. Notice that the average temperatures in Figures 4 and 5 are given in degrees Celsius. The Ohio temperature maps are in degrees Fahrenheit.

6. Follow parallel 60°N latitude across Figure 4. How is temperature affected by the continents? By the oceans?

T6. As you follow 60°N parallel across the map for July the temperature rises over the continents and falls over the oceans.

If your students are familiar with how to make a topographic profile, they could make a temperature profile here to show this more graphically.

You might also wish to look at other latitudes such as 30°S for examples of temperature differences.

7. Do the same for Figure 5. Describe the differences in average temperatures.

T7. As you follow 60°N parallel across the map for January, the temperature falls over the continents and rises over the oceans.

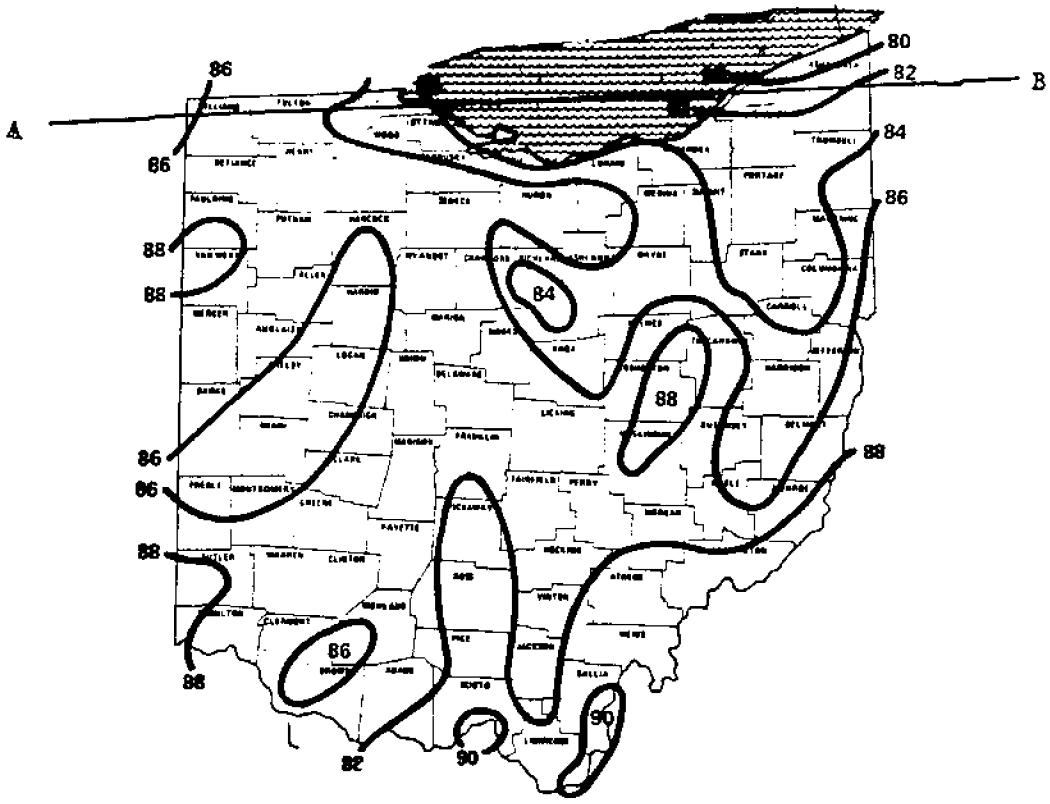



Figure 2. Mean Maximum Temperature of an average July (°F).

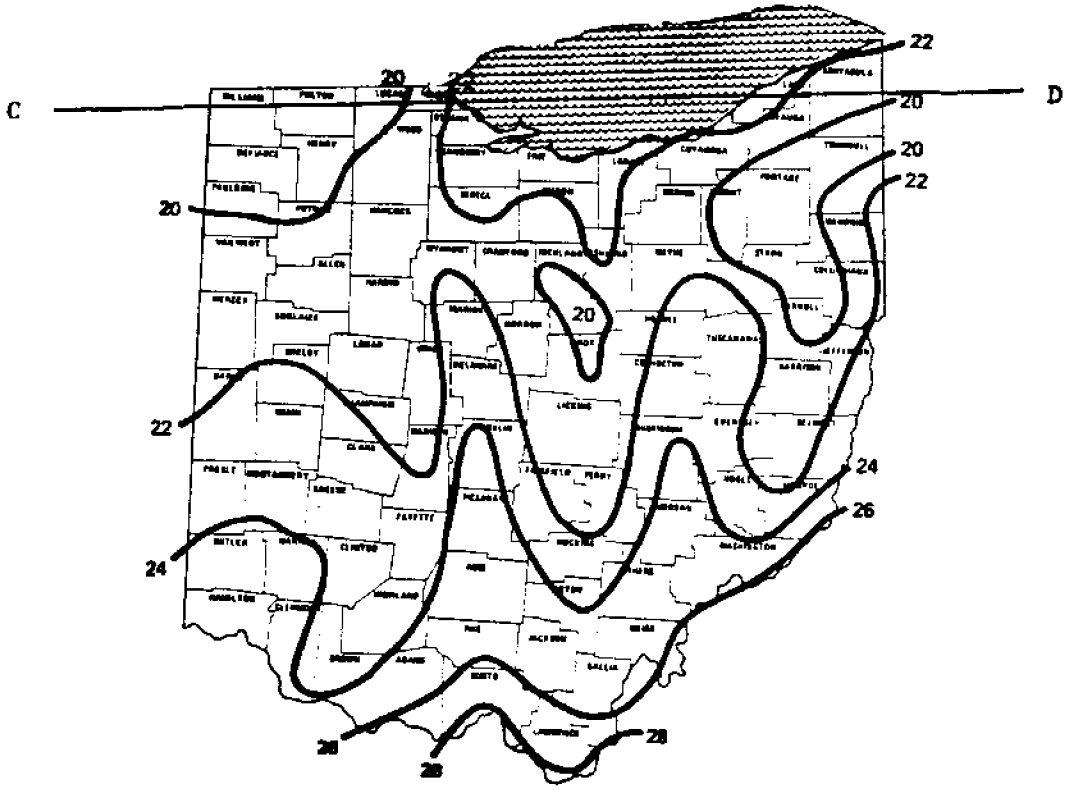



Figure 3. Mean Minimum Temperature of an average January (°F).

The oceans affect the temperature of Ohio. When we have warm winter temperatures we are under the influence of air that starts over the oceans. The cold, frigid winter air comes from northern Canada, where the oceans do not have an effect.

8. Do oceans act as heat sources or sinks? How do you know?

T8. Oceans act as heat sources in winter and heat sinks in summer, just as Lake Erie does.

9. Do continents ever act as heat sources? Explain.

T9. The continents act as heat sources in summer and heat sinks in winter, just as the land in Ohio does.


Figure 4. World Map of Average Temperatures in July ($^{o}$C).

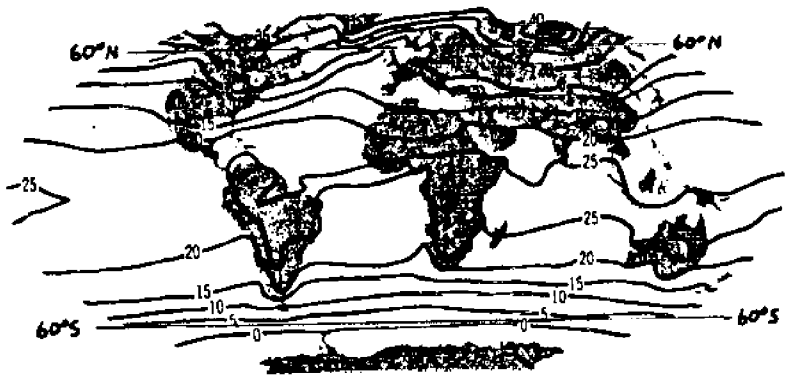



Figure 5. World Map of Average Temperatures in January ($^{o}$C).

**Teacher Note:** Two on-line databases are available to enhance this activity by bringing into the classroom the current temperatures in your local area.

The Ohio Autoweather Network has hourly and daily data on solar radiation, air and soil temperature, wind speed and direction, relative humidity and rainfall. There is a user-friendly access system. Contact the Agricultural Engineering Department at OARDC in Wooster (216)

Accu-Weather, Inc, provides similar data plus mapping and graphing displays and printouts for worldwide weather, both current and historical. The Accu-Data services are available over an 800 toll free line, and educational discounts are available for 300 to 2400 band transmission. Details from ACCU-WEATHER, Inc., 619 W. College Ave., State College, PA 16803. (814) 234-9601.

## REVIEW QUESTIONS

1. What is a heat source? What is a heat sink?

R1. A heat source adds heat energy to the atmosphere. A heat sink takes energy from the atmosphere.

2. When do large bodies of water, such as Lake Erie, act as heat sources? Heat sinks?

R2. Large bodies of water such as Lake Erie act as heat sources in the fall and winter when they are giving up heat to the atmosphere. They act as heat sinks in the late spring and summer when they are absorbing heat from the sun and atmosphere.

3. How does the temperature of northern Ohio differ from that of central Ohio? What causes this difference?

R3. The climate in northern Ohio is more moderate than the climate in central Ohio. The difference is caused by the moderating effect of Lake Erie.

**REFERENCES**


American Geological Institute, Investigating the Earth, Boston: Houghton Mifflin Company, 1967. Activity A is adapted from an investigation on page 172.

Fortner, R. W. and V. J. Mayer, eds. The Great Lake Erie (Chapter 4. The Effect of Lake Erie on Climate, by Val. L. Eichenlaub). Columbus: The Ohio State University, 1987.


**EVALUATION ITEMS**

1. A heat sink

   a. has a higher temperature than its surroundings.
   b. "gives off" excess heat.
   *c. absorbs and stores excess heat.
   d. is the Great Lakes in the wintertime.

2. Generally, the average summer air temperature at the shore of a large lake is

   a. warmer than 50 miles inland.
   *b. cooler than 50 miles inland.
   c. the same as 50 miles inland.
   d. dependent upon the direction of the prevailing winds.
   e. usually the same as the average temperature in winter.

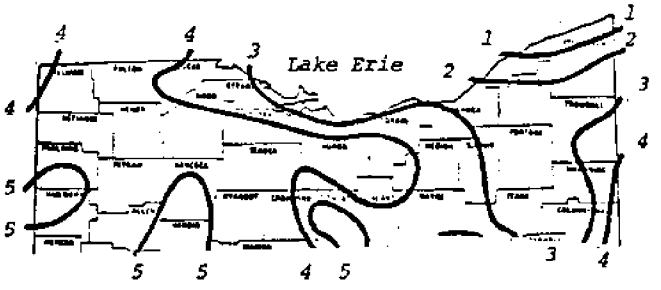
3. If you place a bucket of water and a bucket of soil out in the sun in the morning, what would happen to their temperature?

   a. Their temperatures would not change.
   b. Both would warm up at the same rate.
   c. Water would warm up faster than the soil.
   *d. Soil would warm up faster than the water.

4. If you kept those same two buckets outside until after the sun set, what would happen to the temperatures?

   a. Both would cool at the same rate.
   *b. Soil would cool faster.
   c. Water would cool faster.
   d. Their temperatures would not change.

5. The isotherms in the map of Northern Ohio below represent the average daily high temperature for a month with one being the lowest and five being the highest average daily temperature.



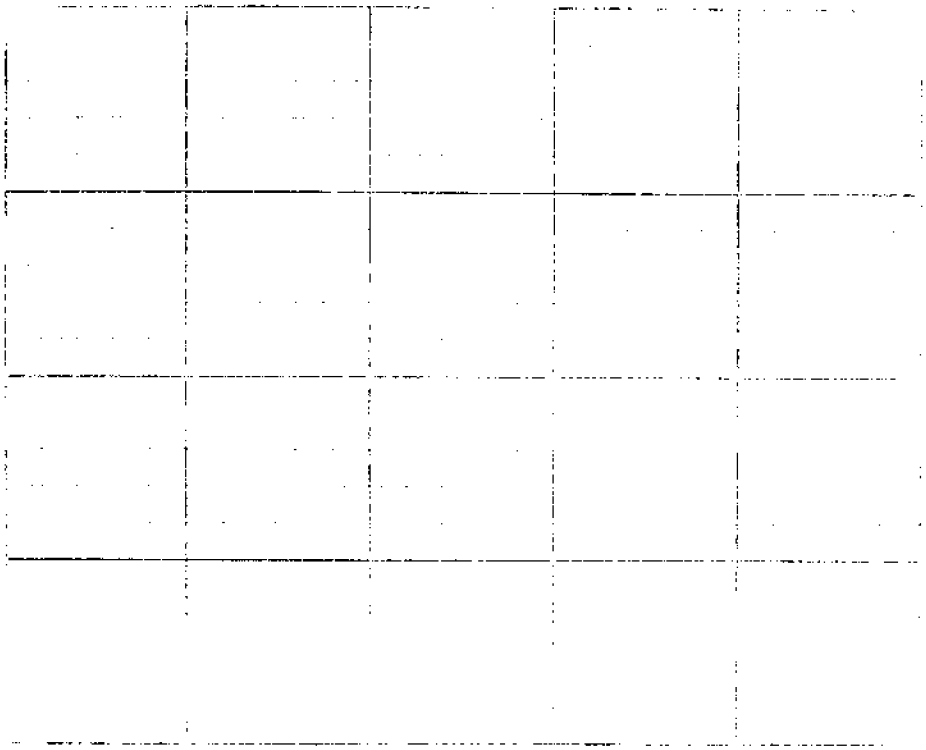

This map represents
   *a. summer temperatures.
   b. winter temperatures.
   c. early fall temperatures.
   d. cannot tell.

Name _____

# THE EFFECT OF THE GREAT LAKES ON TEMPERATURE
# WORK SHEET

**Activity A: What are Heat Sources and Heat Sinks?**

1-4) Follow instructions and put the answers on the graph below.



Time elapsed (minutes)

Key to graph lines:
Air over soil-
Air over water-
Soil-
Water-

5. With the light on, does air heat up faster over the soil or over the water?

_____

6. Which changes more, the temperature of soil or the temperature of the water?

_____

7. Which absorbs more energy, soil or water? _____

8. With the light off, which changes more, the temperature of soil or the temperature of the water? _____

9. Which changes most after the light is turned off, the temperature above the soil or the temperature above the water? _____

10. Which loses heat faster, soil or water? _____

11. Which keeps heat energy longest, soil or water? _____

12. Could soil or water be considered a heat sink while the light was on? Discuss. _____

_____

13. After the light was turned off, was the soil a heat source? Was the water a heat source? Discuss. _____

_____

**Activity B: How do the Great Lakes and the Oceans Affect Climate?**

1. What happens to the average temperature along line AB in Figure 2 as Lake Erie is approached from the west? _____

2. What happens to the average temperature along line CD in Figure 3 as Lake Erie is approached from the west? _____

3. Explain the differences in temperature patterns between July and January. _____

_____

4. Is Lake Erie a heat source or sink? Discuss. _____

_____

5. Describe the effects of Lake Erie on the temperature of northern Ohio. _____

_____

6. Follow parallel $60^{o}$N latitude across Figure 4. How is temperature affected by the continents? By the oceans? _____

_____

_____

7. Do the same for Figure 5. Describe the differences in average temperatures. _____

_____

_____

8. Do oceans act as heat sources or sinks? How do you know? _____

_____

_____

9. Do continents ever act as heat sources? Explain. _____

_____

_____

**Review Questions**

1. What is a heat source? What is a heat sink? _____

_____

_____

2. When do large bodies of water, such as Lake Erie, act as heat sources? Heat sinks? _____

_____

_____

3. How does the temperature of northern Ohio differ from that of central Ohio? What causes this difference? _____

_____

_____

# Other titles of Oceanic Education Activities for Great Lakes Schools

**for middle schools:**

The Effect of the Great Lakes on Temperature
The Effect of the Great Lakes on Climate
Ancient Lake Shores
How to Protect a River
Changing Lake Levels on the Great Lakes
Erosion Along the Great Lakes
Coastal Processes and Erosion
Pollution in Lake Erie: An Introduction
Yellow Perch in Lake Erie
Evidence of Ancient Seas in Ohio
To Harvest a Walleye
Oil Spill!
Shipping on the Great Lakes
Geography of the Great Lakes
Ohio Canals
The Estuary: A Special Place
The Great Lakes Triangle
Knowing the Ropes
Getting to Know Your Local Fish
Shipping: The World Connection
We Have Met the Enemy
It's Everyone's Sea: Or Is It?
PCBs in Fish: A Problem?
A Great Lake Vacation
Storm Surge
River Trek
Waves on the Great Lakes

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Build a Fish to Scale
A Day in the Life of a Fish
Supplemental Curriculum Activity for Holling Clancy Holling's Paddle-to-the Sea

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Dominica A. Rigby, Layout Editor

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Ohio Sea Grant

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In this investigation we will explore how bodies of water can affect the surrounding areas.

**OBJECTIVES:** When you have completed this investigation, you should be able to:

1. Describe how soil and water differ in their ability to absorb and release heat energy.
2. Describe how this difference in heat absorbed or released affects the atmosphere immediately above the land and immediately above the water.
3. Describe the effects of Lake Erie upon the temperature of Ohio.

## ACTIVITY A: WHAT ARE HEAT SOURCES AND HEAT SINKS?

In the early spring when the weather is warming, some days are so hot we would like to jump in the lake and take a swim. We would find, however, that even though the air is hot, the water is very cold.

**MATERIALS:** Four thermometers, a container of soil and one of water, two 30 cm rulers, masking tape, ringstand, graph paper, pencil, light with reflector.

**PROCEDURE**

Set up your materials according to the following directions. (See Figure 1.)

A. Place the containers of earth and water about 3 cm apart.

B. Lay one ruler across each container, resting it on the container's rim.

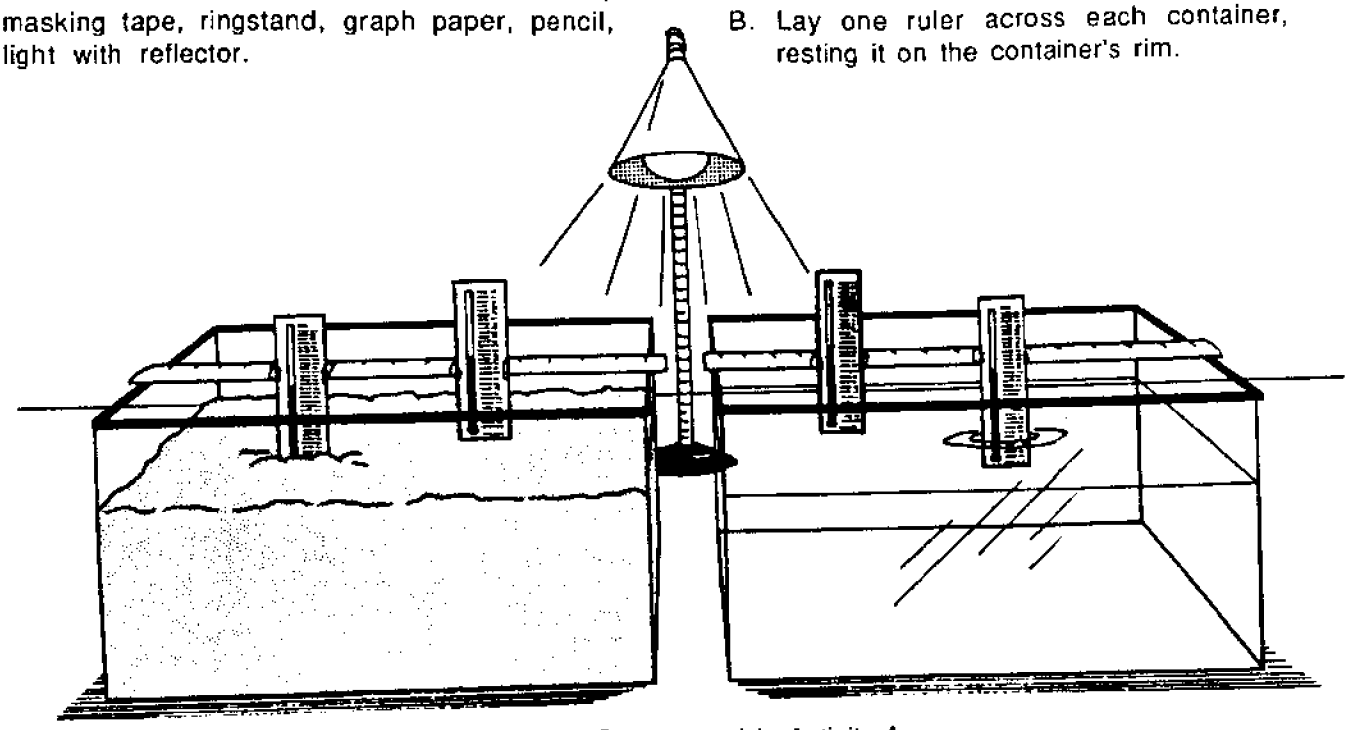

Figure 1: Set-up used in Activity A.

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D. Place another thermometer close to the first one, but about 1 cm above the soil. Attach with masking tape to the ruler.

E. Repeat steps C and D for the container of water.

F. Place the lamp on a ringstand with the reflector pointing down.

G. Position the lamp 30 cm above and centered between the containers.

H. Be certain that the bulb of each thermometer is shielded from the direct rays of the lamp.

After your teacher has examined your set-up, do the following:

1. Construct a data table according to the instructions of your teacher.

2. Turn the lamp on. At one-minute intervals record the temperatures indicated on each of the four thermometers. Continue for 12 minutes.

3. Turn the lamp <u>off</u>. Continue recording temperatures at one-minute intervals for 12 minutes.

4. Plot your data on the time-temperature graph on your work sheet. Use a different color for the data from each thermometer.

Answer questions 5-7 using data from the first 12-minute intervals on the data table and time-temperature graph. Put your answers on your work sheet.

5. With the light on, does air heat up faster over the soil or over the water?

6. Which changes more, the temperature of soil or the temperature of the water?

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Use the data for the last 12-minute intervals to answer questions 8-11.

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Anything that adds heat energy to the atmosphere is called a **heat source**. A **heat sink** takes energy from the atmosphere.

12. Could soil or water be considered a heat sink while the light was on? Discuss.

13. After the light was turned off, was the soil a heat source? Was the water a heat source? Discuss.

## ACTIVITY B: HOW DO THE GREAT LAKES AND THE OCEANS AFFECT CLIMATE?

In Activity A, you learned that the pan of water was a good **heat sink** while the lamp was on and a good **heat source** while the light was off. Soil also acts as a heat sink and source, but its capacity to hold energy is much lower than that of water. Therefore, soil will become a heat source soon after the light is turned on and will quit acting as a heat source not long after the light is turned off.

A body of water such as a lake acts much the same way during the summer. During the day the water is a heat sink, storing up heat from the atmosphere. At night it becomes a heat source, giving up heat throughout the night. If you live near a lake you have experienced land sea breezes which are caused by the lake. Lake water tends to increase in temperature all summer. This indicates that it is storing up extra energy from the atmosphere. It acts as a heat sink throughout the summer. In the winter, however, there is less radiation from the sun. Then lakes become heat sources giving up their energy to the atmosphere.

### PROCEDURES

Figures 2 and 3 are maps of Ohio with isotherms drawn on them. An **isotherm** is a line that connects points of equal temperature. Those on Figure 2 represent the average temperature in Fahrenheit for the month of July. The isotherms in Figure 3 represent average temperatures for the month of January.

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4. Is Lake Erie a heat source or sink? Discuss.

5. Describe the effects of Lake Erie on the temperature of northern Ohio.

Oceans are also large bodies of water. They affect temperature in much the same way as large lakes. Figure 4 is a map of the world on which are drawn isotherms representing the average temperatures in January. Notice that the average temperatures in Figures 4 and 5 are given in degrees Celsius. The Ohio temperature maps are in degrees Fahrenheit.

6. Follow parallel $60^{\circ}$N latitude across Figure 4. How is temperature affected by the continents? By the oceans?

7. Do the same for Figure 5. Describe the differences in average temperatures.

The oceans affect the temperature of Ohio. When we have warm winter temperatures we are under the influence of air that starts over the oceans. The cold, frigid winter air comes from northern Canada, where the oceans do not have an effect.

8. Do oceans act as heat sources or sinks? How do you know?

9. Do continents ever act as heat sources? Explain.

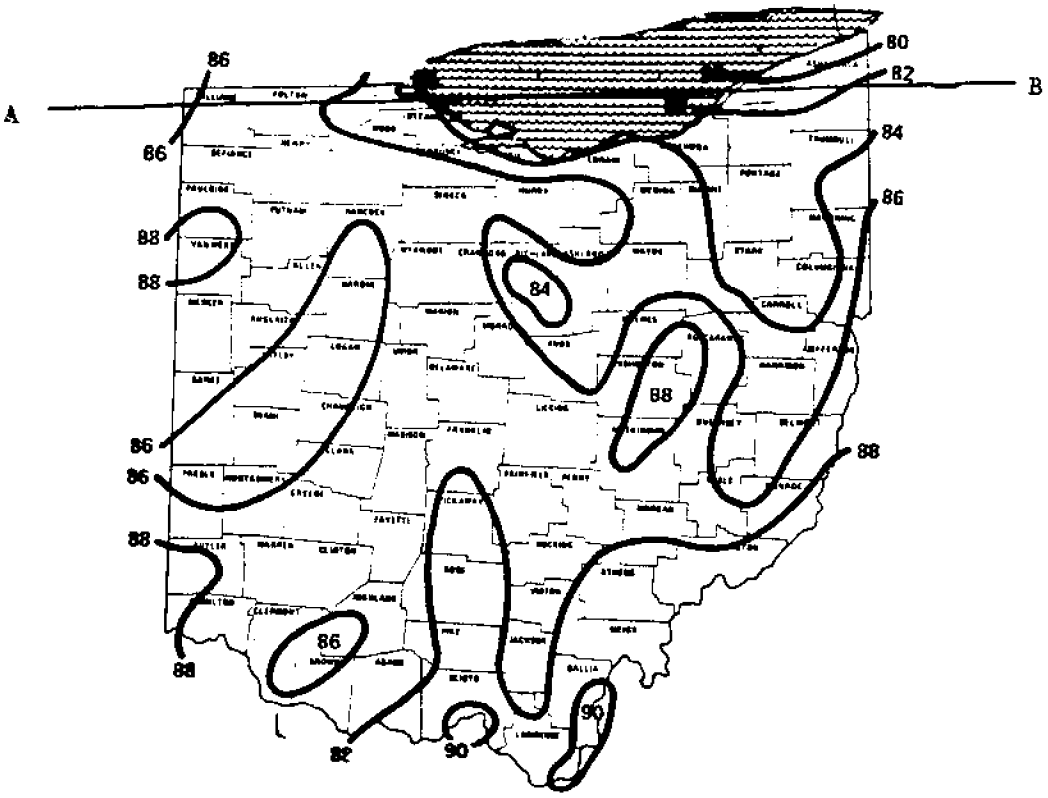



Figure 2 Mean Maximum Temperature of an average July (°F).

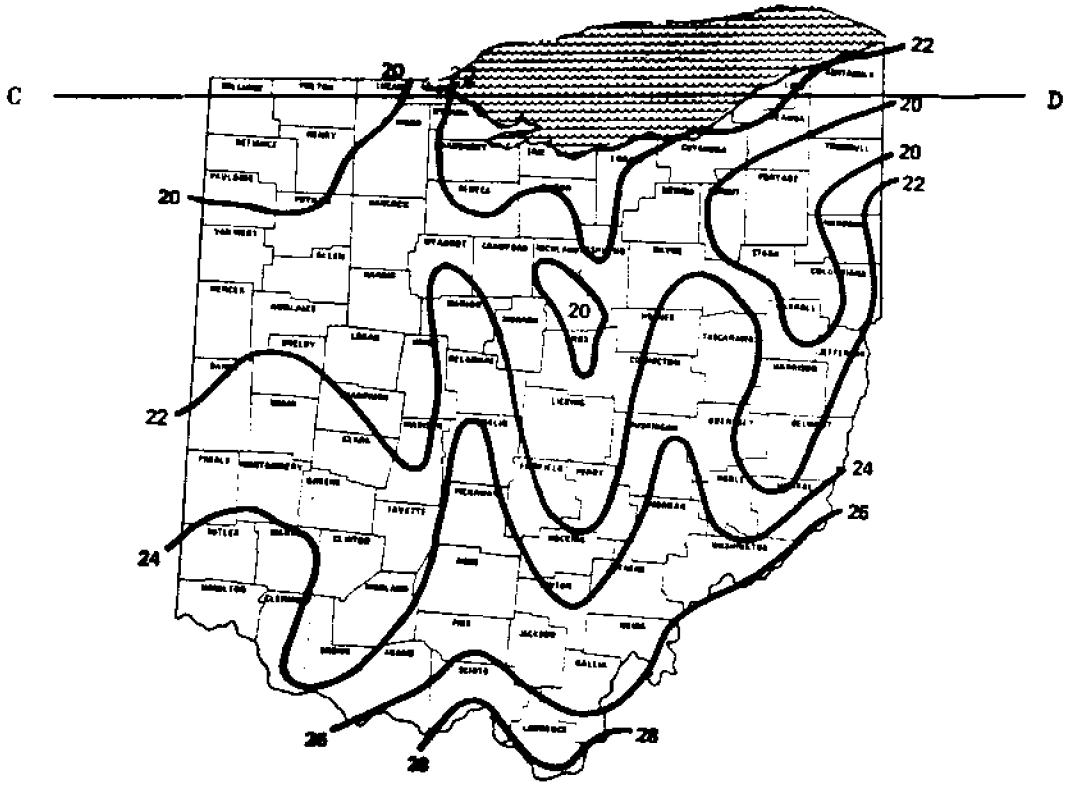



Figure 3. Mean Minimum Temperature of an average January (°F).


Figure 4. World Map of Average Temperatures in July ($^{O}$C).


Figure 5. World Map of Average Temperatures in January ($^{O}$C).

## REVIEW QUESTIONS

1. What is a heat source? What is a heat sink?

2. When do large bodies of water, such as Lake Erie, act as heat sources? Heat sinks?

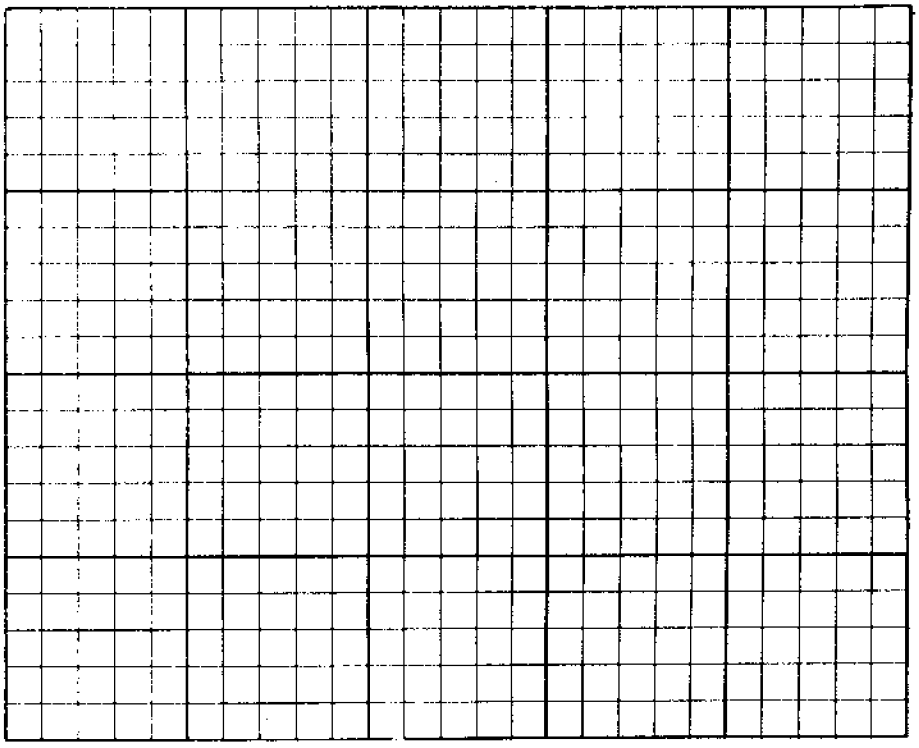
3. How does the temperature of northern Ohio differ from that of central Ohio? What causes this difference?

Name _____

# THE EFFECT OF THE GREAT LAKES ON TEMPERATURE
# WORK SHEET

**Activity A: What are Heat Sources and Heat Sinks?**

1-4) Follow instructions and put the answers on the graph below.



Time elapsed (minutes)

Key to graph lines:
Air over soil-
Air over water-
Soil-
Water-

5. With the light on, does air heat up faster over the soil or over the water?

_____

6. Which changes more, the temperature of soil or the temperature of the water?

_____

7. Which absorbs more energy, soil or water? _____

8. With the light off, which changes more, the temperature of soil or the temperature of the water? _____

9. Which changes most after the light is turned off, the temperature above the soil or the temperature above the water? _____

10. Which loses heat faster, soil or water? _____

11. Which keeps heat energy longest, soil or water? _____

12. Could soil or water be considered a heat sink while the light was on? Discuss. _____

_____

13. After the light was turned off, was the soil a heat source? Was the water a heat source? Discuss. _____

_____

**Activity B: How do the Great Lakes and the Oceans Affect Climate?**

1. What happens to the average temperature along line AB in Figure 2 as Lake Erie is approached from the west? _____

2. What happens to the average temperature along line CD in Figure 3 as Lake Erie is approached from the west? _____

3. Explain the differences in temperature patterns between July and January. _____

_____

4. Is Lake Erie a heat source or sink? Discuss. _____

_____

5. Describe the effects of Lake Erie on the temperature of northern Ohio. _____

_____

6. Follow parallel 60°N latitude across Figure 4. How is temperature affected by the continents? By the oceans? _____

_____

_____

7. Do the same for Figure 5. Describe the differences in average temperatures. _____

_____

_____

8. Do oceans act as heat sources or sinks? How do you know? _____

_____

_____

9. Do continents ever act as heat sources? Explain. _____

_____

_____

**Review Questions**

1. What is a heat source? What is a heat sink? _____

_____

_____

2. When do large bodies of water, such as Lake Erie, act as heat sources? Heat sinks? _____

_____

_____

3. How does the temperature of northern Ohio differ from that of central Ohio? What causes this difference? _____

_____

_____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