Observation/Inference Lab

Name: Period:

Vocabulary

Observation:

Inference:

Instrument:

Measurement:

Procedure:

On the last page is a picture. From what you see, something obviously happened, but its impossible to know what for certain. You will collect good observations based on what you see (at least one of them must be a measurement of some kind), and then USE those observations to make inferences about what happened in the picture.
(Hint: Remember, Observations must be FACTS, things that you can know for certain. Inferences are guesses BASED on those observations).

On the following page put the Observations in the right column, and the Inferences in the left one (Remember, one of the Observations must be a measurement). **NEXT**, after every inference you must indicate which observation(s) that inference is based on by putting the number of that observation next to it. Each inference must be based on one or more of the observations in the right column.

You are required (for a passing grade) to come up with at least 8 good observations, and at least 3 good Inferences based on those observations.
*(If you want more room than pages provided, you may put your answers on loose leaf)

Observations:

Inferences:

Instrument:

Measurement:

Procedure

On the last page is a picture. Most of what you see actually happened, [illegible] impossible to know what for certain. You will collect good observations based on what [illegible] (at least one of them must be a measurement of some kind), and then USE those observations to make inferences about what happened in the picture.

(Remember, observations must be FACTS, things that you can know for certain; inferences are guesses BASED on those observations.)

On the following page put the observations in the right column and the inferences in the left one. (Remember, one of the Observations must be a measurement). NEXT, after every inference you must indicate which observation(s) that inference is based on by putting the number of that observation [illegible] must be based on one or more of the observations in the column.

CONCLUSION QUESTIONS: (answer all of these in complete sentences)

1. What do we use to make observations? (Be very specific)

2. How, exactly, are Observations and Inferences different?

3. A cloud is measured to be 4.4 km above the ground. Is this an observation or an inference, explain:

4. Give as many reasons as you can think of why we use instruments:

5. Come up with a one or two word definition for 'Observation' and 'Inference':

6. Pick any object which you might expect to find in a school. List five Observations for that object (include at least one measurement). Try to pick observations which would allow someone to make a good inference about what the object is, without totally 'giving it away'. (Make your own Observation Puzzle, see if you can stump the teacher!)

1.

2.

3.

4.

5.

NAME______________________________ PERIOD_______ DATE____________

LAB PARTNERS____________________________________ LAB # 2

ANALYZING GRAPHS

INTRODUCTION

Scientists study the ways in which different objects and phenomena in the universe are related to one another. They frequently plot graphs with the information they collect in order to understand it better. The characteristics of the graphs usually reveal much about the relationships. Graphs indicate whether the relationships are direct, inverse, constant, or cyclic.

DIRECT: As the measurements for one variable increase, so do the values for the other.
INVERSE: As the measurement for one variable increase, those for the other decrease.
CONSTANT: As the values for one variable change, those for the other stay the same.
CYCLIC: A relationship which shows an orderly series of events that repeat at regular intervals.

DEPENDENT VARIABLE: The data that you are measuring in your observations.
Usually placed on the vertical axis.
INDEPENDENT VARIABLE: The data that you know in advance such as the time.
Usually placed on the horizontal axis.

OBJECTIVES

During this investigation you will be able to:

1. Determine the proper scale and label both axes.
2. Plot data points.
3. Draw a smooth curve through the points.
4. Determine the type of relationship shown by a graph.
5. Interpolate and extrapolate on a graph to get new data points.
6. Describe how the slope of a graph can give additional information.
7. Determine which axis dependent and independent variable data should be labeled.

APPROXIMATE TIME 2 Periods

MATERIALS

Calculator
Pencil with eraser

PROCEDURE

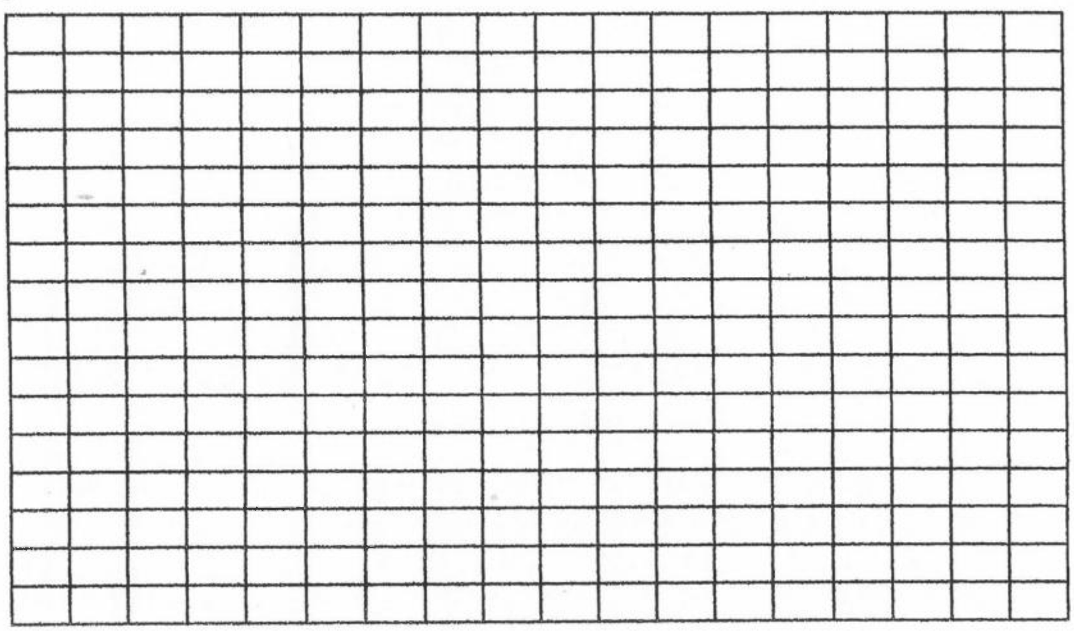
1. Graph the data listed for each of the six graphs on the following pages, after **correctly labeling (and/or numbering)** the X and Y axes.
2. Determine the type of relationship shown by each graph.
3. Complete pie graphs 7 and 8.
4. Refer to graph 9 and answer the corresponding questions.
5. Complete the lab summary questions.

GRAPH 2

Samples of a rock material were placed in a container of water and shaken vigorously for 20 minutes. At 5-minute intervals, the contents of the container were strained through a sieve. The mass of the material remaining in the sieve was measured and recorded as shown in the data table below.

MASS OF MATERIAL REMAINING IN SIEVE

SHAKING TIME (min)	0	5	10	15	20
MASS REMAINING (grams)	25.0	17.5	12.5	7.5	5.0



Using a complete sentence **describe the relationship** between shaking time and the mass remaining for the rock material.

____

____

What **kind of relationship** is this and how does the graph show this relationship? ______

____

GRAPH 4

RELATIONSHIP BETWEEN THE TIME OF DAY AND THE HEIGHT OF TIDES

TIME OF DAY	1:45 AM	4:00 AM	7:00 AM	9:00 AM	12:30 PM	3:00 PM	6:30 PM	9:00 PM	12:00 AM
HEIGHT (FEET)	9	16	8.5	3	10	15	6	2.5	9.5

Using a complete sentence **describe the relationship** between the time of day and the height of the tides.

What **kind of relationship** is this and how does the graph show this relationship? ______

GRAPH 6

RELATIONSHIP BETWEEN THE AVERAGE DISTANCE FROM THE SUN AND THE AVERAGE ORBITAL SPEED OF THE NINE PLANETS

PLANET	MERC	VENUS	EARTH	MARS	JUPIT	SATUR	URAN	NEPTU	PLUTO
AVERAGE DISTANCE FROM SUN (AU)*	0.4	0.7	1.0	1.5	5.2	9.6	19.0	30.0	39.0
AVERAGE ORBITAL SPEED (km/s)	48.0	35.0	30.0	24.0	13.0	10.0	7.0	5.1	4.7

* 1 AU is equal to the average distance between the Sun and the Earth.

Using a complete sentence **describe the relationship** between the distance from the sun and the average orbital speed of the nine planets.

____

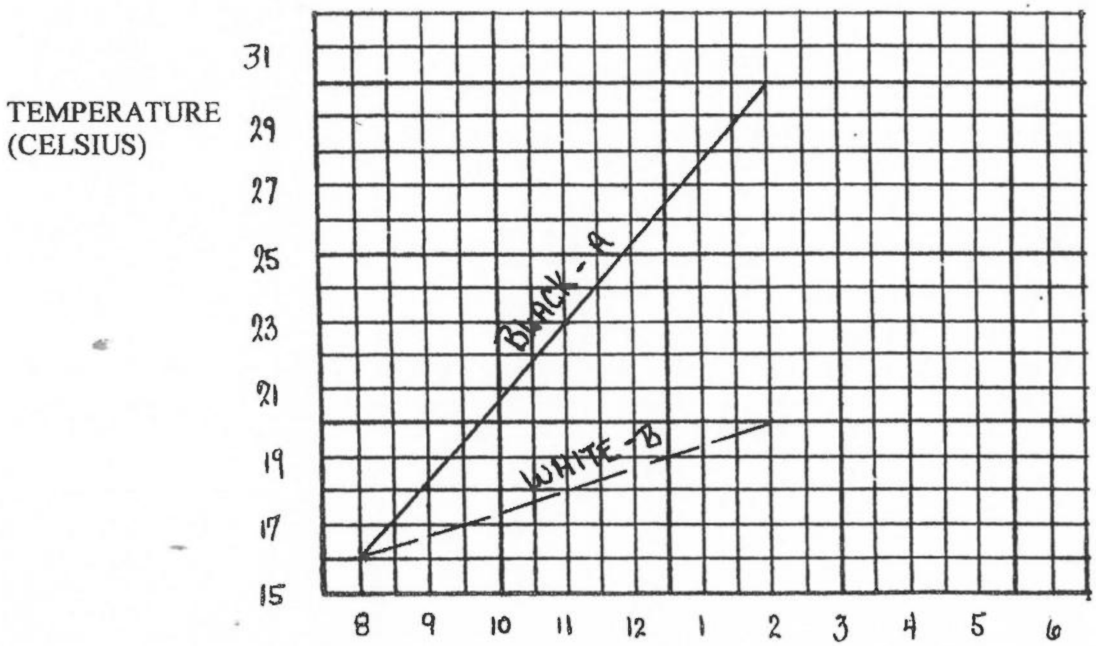
____

What **kind of relationship** is this and how does the graph show this relationship? ______

____

GRAPH 9

THE FOLLOWING GRAPH SHOWS THE TEMPERATURE CHANGE INSIDE TWO PARKED CARS SITTING IN THE SUN. GRAPH A WAS FOR A CAR WITH A BLACK INTERIOR, AND GRAPH B FOR A CAR WITH A WHITE INTERIOR.



1) How many degrees did the temperature rise inside the car with the black interior? ___________

2) How many degrees did the temperature rise inside the car with the white interior? ___________

3) By looking at the graphs, which car showed the greatest RATE of temperature change? ______

How did you tell?____

4) For graph A, calculate the rate of change (in degrees per hour) in temperature from 11 am to 2 pm. (Show formula and work).

5) For graph B, calculate the rate of change (in degrees per hour) in temperature from 11 am to 2 pm. (Show formula and work).

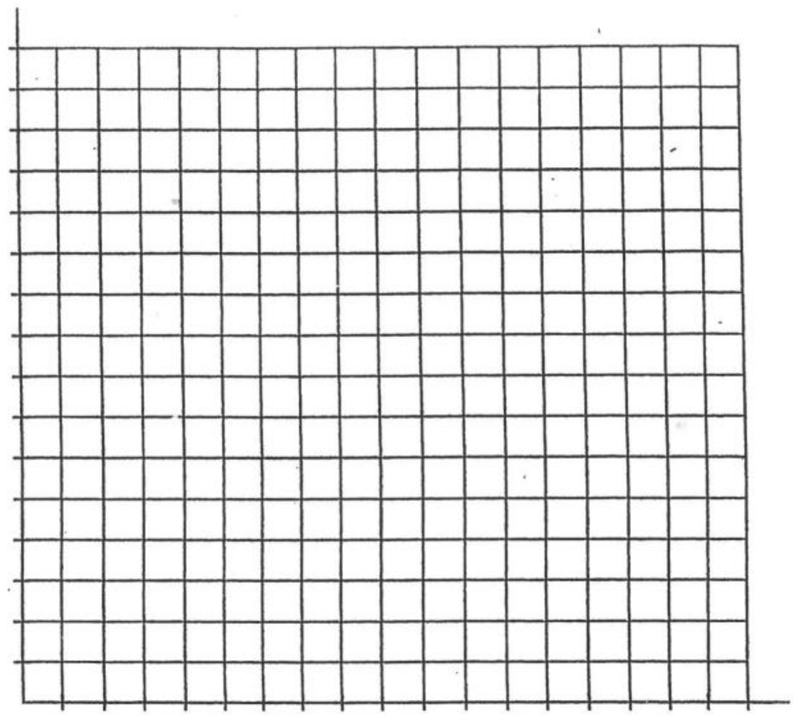
6) Based on the graphs, predict (extrapolate) what the temperature would most likely be at:

3 pm in the black car_______________

4 pm in the white car_______________

Stormy Sunspots *(continued)*

Line Graph



Analyze and Conclude

Write your answers on a separate sheet of paper.

1. **Graphing** Based on your graph, which years had the highest average Sunspot Number? The lowest average Sunspot Number?
2. **Interpreting Data** How often does the cycle of maximum and minimum activity repeat?
3. **Interpreting Data** When was the most recent maximum sunspot activity? The most recent minimum sunspot activity?
4. **Inferring** Compare your sunspot graph with the magnetic storms graph in your textbook. What relationship can you infer between periods of high sunspot activity and magnetic storms? Explain.
5. **Communicating** Suppose you are an engineer working for an electric power company. Write a brief summary of your analysis of sunspot data. Explain the relationship between sunspot number and electrical disturbances on Earth.

More to Explore

Using the pattern of sunspot activity you found, predict the number of peaks you would expect in the next 30 years. Around which years would you expect the peaks to occur?

Skills Lab

ɔrmy Sunspots

ɔlem

ɪre magnetic storms on Earth related to
ot activity?

ls Focus

ing, interpreting data

:erials

ɔh paper
r

:edure

ɪe the data in the table of Annual Sunspot ɹmbers to make a line graph of sunspot :ti\ ɛtween 1972 and 2002.

n the graph, label the *x*-axis "Year." Use a ale with 2-year intervals, from 1972 to 2002.

ıbel the *y*-axis "Sunspot Number." Use a ale of 0 through 160 in intervals of 10.

·aph a point for the Sunspot Number for ıch year.

ɔmplete your graph by drawing lines to ınnect the points.

ılyze and Conclude

·aphing Based on your graph, which years ıd the highest Sunspot Number? The low- t Sunspot Number?

terpreting Data How often does the cycle maximum and minimum activity repeat?

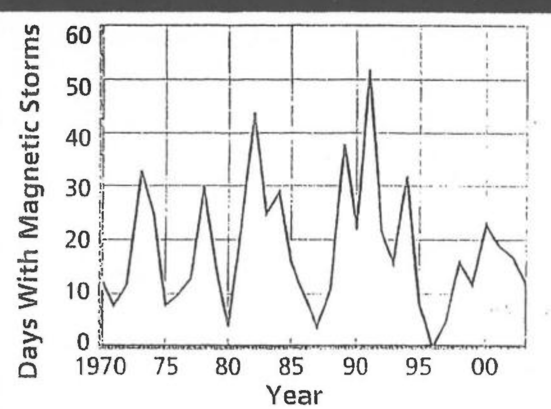
terpreting Data When was the most recent aximum sunspot activity? The most recent inimum sunspot activity?

ferring Compare your sunspot graph with e· ·netic storms graph. What relationship n y ıfer between periods of high sun- ot activity and magnetic storms? Explain.

Annual Sunspot Numbers

Year	Sunspot Number	Year	Sunspot Number
1972	68.9	1988	100.2
1974	34.5	1990	142.6
1976	12.6	1992	94.3
1978	92.5	1994	29.9
1980	154.6	1996	8.6
1982	115.9	1998	64.3
1984	45.9	2000	119.6
1986	13.4	2002	104.0

Magnetic Storm Days

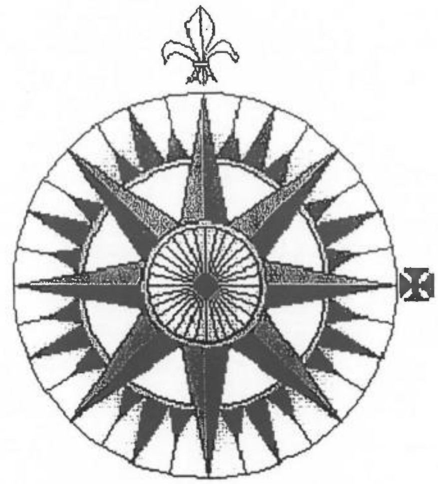


5. **Communicating** Suppose you are an engineer working for an electric power company. Write a brief summary of your analysis of sunspot data. Explain the relationship between sunspot number and electrical disturbances on Earth.

More to Explore

Using the pattern of sunspot activity you found, predict the number of peaks you would expect in the next 30 years. Around which years would you expect the peaks to occur?

Sailing Around the World



Question: How can we use heavenly bodies like the Sun and Polaris to help us locate ourselves on Earth?

Specific Objectives:

1. To use latitude and longitude to define locations on a map.
2. To use heavenly bodies like the Sun and Polaris to determine latitude and longitude.

Directions: Locate each of the following stops described below. Plot the location, number it, and then connect it to the next location to show your path as you sail around the world in your 70 foot mahogany sloop. Don't forget to get your passport stamped at each location- write the country name in the box at the right at each stop. Bon voyage!

Location 1: Here we go on our trip sailing around the world. Using the map, find Long Island and plot us (40°N, 73°W).

Stop 2: Stop on a Caribbean Island and get sugar for your tea and lemonade. Get your passport stamped (at right) to show which country you picked. Write the coordinates (lat., long.) to the nearest degree.

Latitude: ____________, Longitude: ____________

Stop 3: Head in a southeasterly direction to 37°S, 15°E, make a left, and head toward the cape. Hopefully while you are in port you will be able to pick up some diamonds.

Stop 4: Continue to 33°S, 46°E. Then head northeast and pick up some ink for your art class when you reach port at 20°N, 73°E.

Stop 5: While you are in the neighborhood, you might as well go kangaroo hunting. Sail over to 20°S, 115°E.

Stop 6: Be careful as you travel between the islands while heading northeast. Go to 7°S, 128°E. Then turn to port (left when you face the bow or front of the ship) and sail along to 3°S, 125°E to make your 6th stop on your trip. Make sure you have plenty of water before you set off to complete the last half of your journey.

Stop 7: Sail around the Philippines (9°N, 127°E) and then over to Taiwan (stop 7) to buy some shirts. You will find your port of call at 21°N, 122°E.

Stop 8: Stop off to buy a camera. The altitude of Polaris is 33°N, longitude is 140°E.

Stop 9: Head east and take a break at 19°N, 156°W. Take a side trip to see the lava flows. Do a little surfing, eat some pineapple, and dance up a storm with the locals.

Stop 10: Cruise into L.A. (33°N, 120°W). Do a little sight-seeing in Beverly Hills, do some window shopping on Rodeo Drive, and walk on the stars in the sidewalk in Hollywood.

Stop 11: Head south to 17°N, 100°W. Leave the boat docked while you take a side trip to the Aztec ruins.

Stop 12: Take the short cut through the Isthmus at 9°N, 80°W. Buy a hat. Say 'adios' to the Pacific.

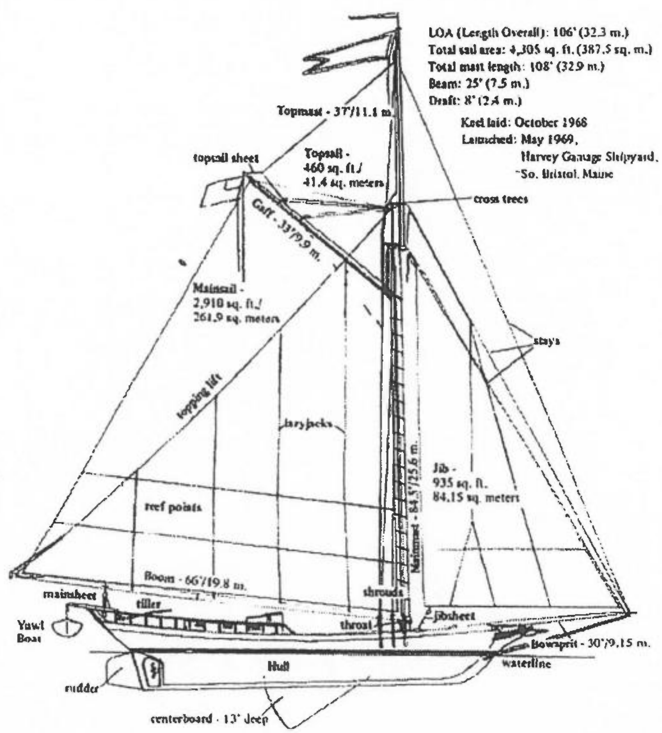
Stop 13: Head to 20°N, 86°W. Say 'Hola' to some of the best scuba diving around. Before you get prune-ish, head back out to sea.

Stop 14: Go to 25°N, 83°W. Take a rest at Jimmy Buffet's and join the Parrot Heads singing The Volcano Song. "I don't know, I don't know, I don't know where I'm a gonna go when the volcano blows!"

Stop 15: Sail on up to where the altitude of Polaris is 38° and your chronometer tells you that it is noon at Greenwich, while local time is 7 a.m. Write the coordinates of your stop (latitude, longitude) to the nearest degree. Visit the Smithsonian to see the Hope Diamond, then head on home.

Latitude: ______________, Longitude: ________________

End: Don't forget to draw in the last leg of our trip that shows you returned to Long Island.



Conclusion: prove your understanding of the specific objective # 2- use examples from the lab to show your application of your knowledge.

NAME______________________________PERIOD__________DATE___________

LAB PARTNERS______________________________ **LAB # 7**

LOCATING POSITIONS ON THE EARTH USING LATITUDE AND LONGITUDE

INTRODUCTION:
Locating any position on the earth's surface requires a system of curved reference lines. Two coordinates are necessary to accurately locate a position on the earth's surface.

MATERIALS: World map
Globe
Pencil with eraser

APPROXIMATE TIME: 2 periods

OBJECTIVES:
1. You will be determining positions on the earth using the coordinate system of latitude and longitude.

PROCEDURES:
1. Answer questions 1 and 2 in Part I.
2. Using the coordinates of latitude and longitude provided in Part II, plot these on the attached world map.
3. Find letters I-P on the world map and determine the latitude and longitude for each location.
4. In Part 4, find the cities listed and determine their latitude and longitude by using the world globe.
5. Answer lab questions 1-5 in Part 5.

PART I

1a. From what reference line on the earth is latitude measured? ______________

1b. What is the latitude of this line?______________

2a. From what reference line on the earth is longitude measured? ______________

2b. What is the longitude of this line?______________

2c. Through what city does this line pass?______________

PART 2

On the enclosed world map, place a letter at the following coordinates.

A. 10°N, 50°E

B. 30°N, 10°E

C. 40°S, 20°E

D. 80°S, 100°E

E. 60°N, 135°W

F. 80°N, 120°W

G. 70°S, 115°W

H. 75°S, 75°W

PART 3

On the enclosed world map, find the following points and determine their latitude and longitude.

	LATITUDE	LONGITUDE
I		
J		
K		
L		
M		
N		
O		
P		

PART 4

is the latitude and longitude of the following cities? (Use globe)

CITY	LATITUDE	LONGITUDE
San Francisco		
New York City		
Mexico City		
Paris		
Moscow		
Tokyo		
Sydney		
Cape Town		
Buenos Aires		
Baghdad		

PART 5

QUESTIONS

1. What is the latitude of the North Pole? _______________

2. Explain why any two lines used to determine latitude never can touch each other.

____

3. You are on a boat which is crossing the Prime Meridian. The altitude of Polaris is 50 degrees. Explain how you know the boat's location is 50 degrees North latitude and 0 degrees longitude.

____

____

4. Explain why the distance between two meridians at the North Pole is 0 miles.

____

5. What is the maximum number of degrees of longitude possible? ___________

PART 6

PROBLEM SOLVING

(Answer these questions in complete Sentences)

1. Is it possible for a city to be located at 115 degrees South Latitude and 25 degrees West Longitude? Explain.

____

____

2. What city is located at the following coordinates?
   40 degrees South Latitude
   80 degrees East Longitude

____

____

3. Would you travel farther if you drove 2 degrees east from Bismark, North Dakota, or from Austin, Texas? Explain.

____

____

4. What is the approximate latitude and longitude of Sachem South/North?

____

5. There is an old phrase "Digging a hole through the Earth's center would bring you out in China." If you could drill a hole from Long Island straight through the Earth's core, where would you in fact come out?

____

____

PART 7

LATITUDE/LONGITUDE IN NEW YORK STATE

Using the map on page 3 of your Earth Science Reference Tables entitled "Generalized Bedrock Geology og New York State," answer the questions below.

1. What city is located at the following coordinates?

LATITUDE	LONGITUDE	LOCATION
40°45'N	74°W	
43° 15'N	77°37'W	

2. Give the latitude and longitude of the following locations:

LOCATION	LATITUDE	LONGITUDE
ELMIRA		
MASSENA		

Name________________________________Period______________Date______

Lab Partners ____LAB #4

EARTH SCIENCE, MATH, AND YOU

PART I
ROUNDING OFF

When performing calculations, answers frequently come out uneven, with many decimal places. In this course, unless otherwise directed, you are expected to round off all answers to the nearest tenth. For example:

97.268 would be rounded to 97.3 139.42 would be rounded to 139.4

Round off the following numbers to the nearest tenth.

1) 10.76 _______________ 4) 1.549 _______________

2) 1369.07 _______________ 5) 0.09 _______________

3) 0.134 _______________ 6) 10.02 _______________

PART II
DIVISION

The mathematical procedure of division can be written many ways. For example, the problem of 4 divided by 5 can be written any of the following ways:

A) $4 \div 5$ B) 4/5 C) $\frac{4}{5}$ D) $5\overline{)4}$

When performing division on a calculator, the keystrokes should follow the method in example A above.

Solve the following division problems, rounding off all answers to the nearest tenth.

7) $75\overline{)105}$ _______________ 9) $\frac{20}{65}$ _______________

8) 36 / 7 _______________ 10) $\frac{10000}{77000}$ _______________

11) Measure your height in ***meters***, rounding off to the nearest tenth.

Your height ____________________

Tyrannosaurus Rex was 6 meters high. How many times higher was Tyrannosaurus Rex than you ? (Show your work below)

Answer _______________________

PART III
PERCENT DEVIATION

Using the equation for percent deviation on page 1 of the reference tables, solve the following problems.

12) A student is weighed in the nurse's office and is told that he weighs 150 lbs. He tells the nurse the scale is wrong, that he actually weighs 132 lbs. Calculate the percentage deviation. Round off your answer to the nearest tenth and **show all work.**

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

13) Based on the skeleton of Triceratops, a paleontologist determines that its eggs were 55 cm wide. An earth science teacher (from Sachem of course !) discovers an actual triceratops egg on one of his collecting trips, and it measures 72 cm wide. Calculate the percentage deviation. Round off your answer to the nearest tenth and **show all work.**

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

PART IV
SOLVING EQUATIONS

The equation A = B/C consists of three variables. Given a value for any two of the variables, you should be able to solve for the value of the third. For example, if B = 6 and C = 2, then you would calculate A =3. Or, if A = 12 and C = 2, then you would calculate that B = 24.

The hip height of a dinosaur can be calculated from the length of its footprint. Hip height is defined as the straight line distance from where the leg connects to the hip to the floor. The formula relating these variables is:

Hip Height (H) = 4.5 x footprint length (FL)

Solve the following problems, rounding off to the nearest tenth and **showing all work**.

14) Velociraptors had a footprint length of 0.2 meters. Calculate their hip height.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ____________________

15) Brachiosaurs had a footprint length of .56 meters. Calculate their hip height.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ____________________

16) Measure your hip height in meters. ____________________

Based on the measurement above, calculate your footprint length in meters.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ____________________

17) Measure your actual footprint length. ____________________

Using your calculated footprint length from question 16 and your actual footprint length from above, calculate your percent deviation.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ____________________

18) Diagram I is the sketch of a Dilophosaur print from Dinosaur State Park in Connecticut, actual size. Calculate its hip height.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ____________________

1?) Diagram II is the sketch of a Grallator print from New Jersey, actual size. Calculate (ip height.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ______________________

PART V
RATE OF CHANGE

Using the equation for rate of change on page 16 of the reference tables, solve the following problems. All answers should be rounded off to the nearest tenth, and show all work.

20) At birth (0 years), a Maiasaur was .2 meters long. At the age of 11 years it was 7.5 meters long. Calculate its rate of growth in meters per year.

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ______________________

The data table below shows the air temperatures recorded both inside and outside a greenhouse on a sunny day.

Time	Outside Temperature	Inside Temperature
6 am	10 C	13 C
8 am	11 C	14 C
10 am	12 C	16 C
12 noon	15 C	20 C
2 pm	19 C	25 C
4 pm	17 C	24 C
6 pm	15 C	23 C

21) Based on the data table above, calculate the rate of temperature change outside the greenhouse from 6 am to 12 noon.

a. **State Equation:**
b. **Substitute data into equation:**
c. **Solve equation**
d. **Show answer with correct units**

Answer ______________________________

22) Based on the data table above, calculate the rate of temperature change inside the greenhouse from 2 pm to 6 pm.

a. **State Equation:**
b. **Substitute data into equation:**
c. **Solve equation**
d. **Show answer with correct units**

Answer ______________________________

DIAGRAM I

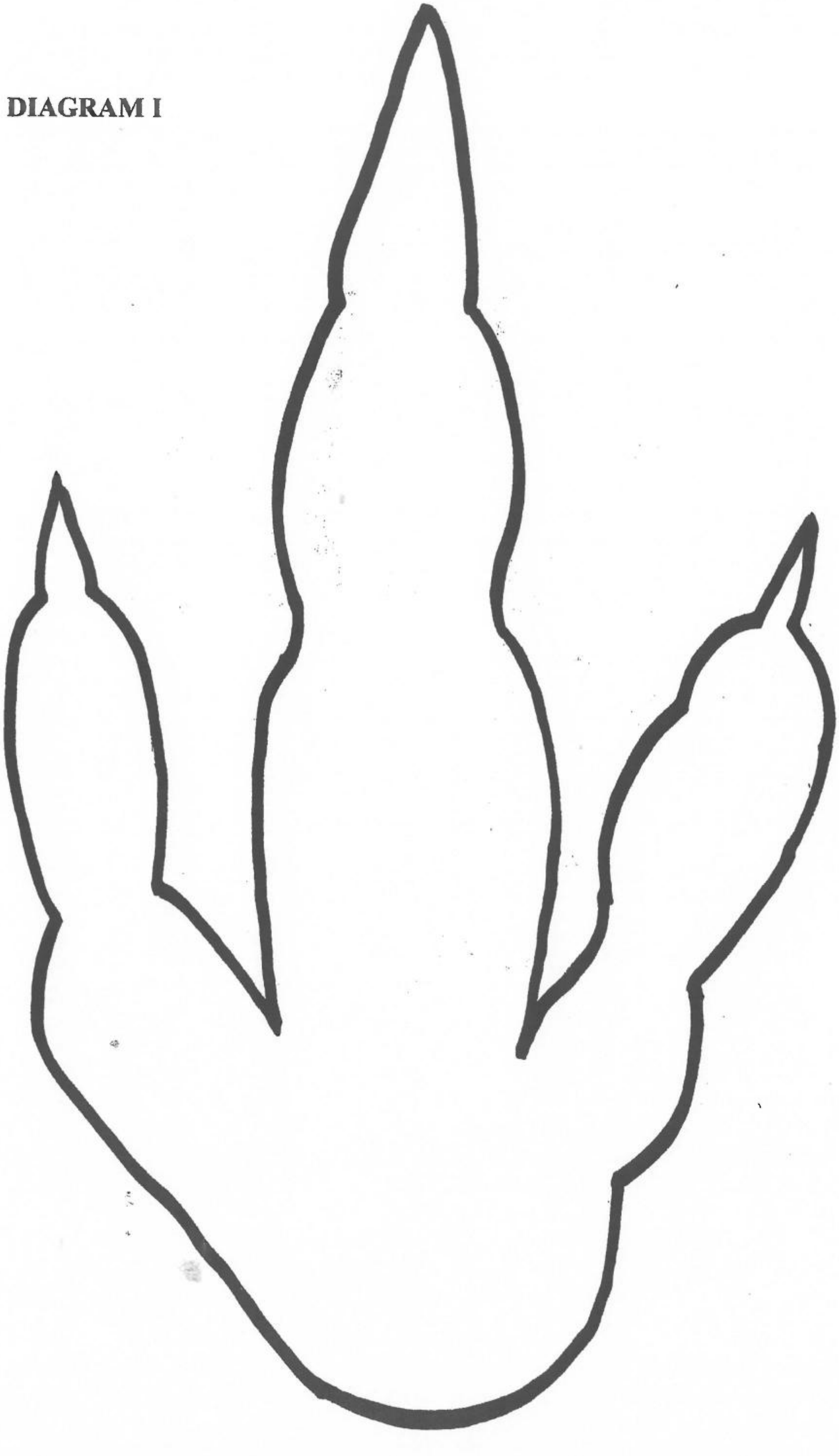


DIAGRAM II

PART VI
SOLVING PROPORTIONS

Proportions are used to compare the measurements or dimensions of real objects to those of models or sketches. They usually take the form below:

$$\frac{A}{B} = \frac{C}{D}$$

A and B represent the actual object, while C and D the model. Given three measurements, the fourth is solved for by cross - multiplication and then dividing to solve the equation:

A x D = C x B

23) Measure your height in meters and record your weight in pounds. If a toy company were to make an action figure of you and it weighed 2 pounds, how tall should it be made?

Your height ________________ Your weight __________________________

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ________________________

24) The space shuttle is 75 meters long and has a wing span of 43 meters. If a model were made that was .6 meters long, what should the wing span be ?

a. State Equation:
b. Substitute data into equation:
c. Solve equation
d. Show answer with correct units

Answer ________________________

OPTIONAL: Given scale models of dinosaurs or other objects given to you by your teacher, calculate the actual dimensions of the objects. Show work on back.

NAME______________________________ PERIOD__________ DATE______

LAB PARTNERS______________________________ LAB # 12

ROUNDNESS AND SMOOTHNESS OF THE EARTH

INTRODUCTION

Pictures taken of the Earth from space shows that the Earth appears to be perfectly round and smooth. However, from our viewpoint, the Earth appears to have a highly irregular surface. Satellite measurements of the Earth reveal that the Earth's polar diameter is slightly less than the equatorial diameter.

OBJECTIVES

By the end of this lab you will be able to:

1. Calculate the ratio of the equatorial diameter to the polar diameter of both the Earth and a model of the Earth.
2. Calculate how high or deep a feature on the Earth's surface would be if drawn to scale on a model of the Earth.
3. Attempt to actually draw the features to scale on your model of the Earth.
4. Draw conclusions about the roundness and smoothness of the Earth.

APPROXIMATE TIME: 2 Periods

MATERIALS

- Globe or other model of the Earth
- pencil compass
- white paper
- calculator
- pencil
- ruler
- relief map (optional)

PROCEDURES

<u>PART I - ROUNDNESS</u>

1. Using the following data, calculate the ratio of the equatorial diameter to the polar diameter of the Earth. (Show work below).

<u>THE REAL EARTH</u>

Polar diameter	12,730 km.
Equatorial diameter	12,750 km.

Ratio = ______________
(round to 3 decimal places)

THIS RATIO IS AN INDEX OF THE ROUNDNESS OF THE EARTH.

If the Earth were perfectly round, what would be the ratio of the diameters?

Ratio = ____________________

Is the real Earth ratio close to the ratio for a perfect sphere?

____

2. Now measure the polar and equatorial diameters of the globe. Measure as exactly as you can. (Round off the nearest tenth of a cm).

Polar diameter of globe = ____________________

Equatorial diameter of globe = ______________

3. Using your measurements calculate the roundness ratio of the globe. (Show work below).

Ratio = ____________________
(Round to 3 decimal places)

PART II - SMOOTHNESS

4. On the white paper use your ruler and compass to draw a circle that measures 20 cm. in diameter. Center the circle as much as possible in the middle of the paper.

5. Calculate the scale size of the Earth features listed in the data table to your 20 cm. circle. Show all work in the spaces provided at the end of the lab.

6. Draw the Earth features to scale on the 20 cm. diameter circle that you drew in procedure # 4. Label each feature.

NOTE: Some of the features may be difficult if not impossible to draw on the 20 cm. circle.

termine the size of the Earth features listed in the data table ow. Calculate the scale size in cm. by using proportions.

GIVEN: Earth diameter in km. 12,740
Scale Earth diameter in cm. 20

EARTH FEATURE	ACTUAL SIZE (KM)	SCALE SIZE (CM)
1. Thickness of Earth's crust	30	
2. Orbit of communication Satellite	19,000	
3. Sears Tower (Chicago)	.4	
4. Deepest Mine Tunnel	8	
5. Height of Mt. Everest	9	
6. Thickness of Earth's Atmosphere	120	
7. Depth down to the Earth's Outer Core	2,900	
8. Thickness of Earth's Hydrosphere	4	
9. Depth of the Marianas Trench	11	
10. Orbit of Trios Weather Satellite	750	

QUESTIONS: Answer all questions in complete sentences.

1. Which do you think is actually rounder, the Earth or the globe? Support your answer with data from this investigation.

____

____

2. Which do you think is actually smoother, the Earth or the model you drew? Support your answer with data from this investigation.

____

____

3. The moon and some of the planets in our solar system such as Mars have many large features on their surfaces. Why then do they <u>appear</u> to be so round and smooth?

____

____

4. List all of the features that could not be drawn on your 20 cm model of the Earth.

____

PROBLEM SOLVING:

Using a classroom wall relief map of the world, calculate what the actual height of Mt. Everest would be based on its height relative to the map size.

Given: Earth's Circumference 40,074 Km.

Calculations for the size of the Earth's features to scale.
Show all work and formula!

1.	2.	3.
4.	5.	6.
	8.	9.
10.		

Using a Topographic Map

Pre-Lab Discussion

When was the last time you used a map? Perhaps you used a road map to help plan a trip. You may have looked at a world map to locate a country for a school assignment. Did you ever use a map mounted in a mall to find a certain store? Maps provide a variety of information. They can show not only where something is but what it looks like. That's what topographic maps do. They show the shape of the land by providing a three-dimensional view of Earth's surface. With a little practice, you can read a topographic map and picture the landscape as if you were flying over it in a plane.

Imagine that your class is completing a three-day outdoor education program. You've learned about the plants and animals that live near your town of Mountain View. You've learned about the landforms in the area and how to read them on a topographic map. As a final exercise, the program leader has arranged a treasure hunt. She will fly a plane over the area and drop a bright red canister attached to a bright red parachute. Inside the canister are all kinds of gift certificates for the class. In this investigation, you will use clues and interpret a topographic map to find the canister. To do so, you need to know that each degree of latitude and longitude is divided into units called minutes. One degree is 60 minutes. The number of minutes for a given latitude is listed right after the number of degrees. The symbol for minutes is an apostrophe. The map in Observations shows examples of latitude and longitude using minutes.

1. Explain what a contour line is.

____

2. What kind of information do contour lines provide?

____

____

3. How would you write the latitude of a point that is half way between 35° N and 36° N? Use degrees and minutes.

____

Problem

How can you use a topographic map to pinpoint a location?

Materials *(per group)*

metric ruler

pencil

Name ______________________________ Date _____________________ Class ____________

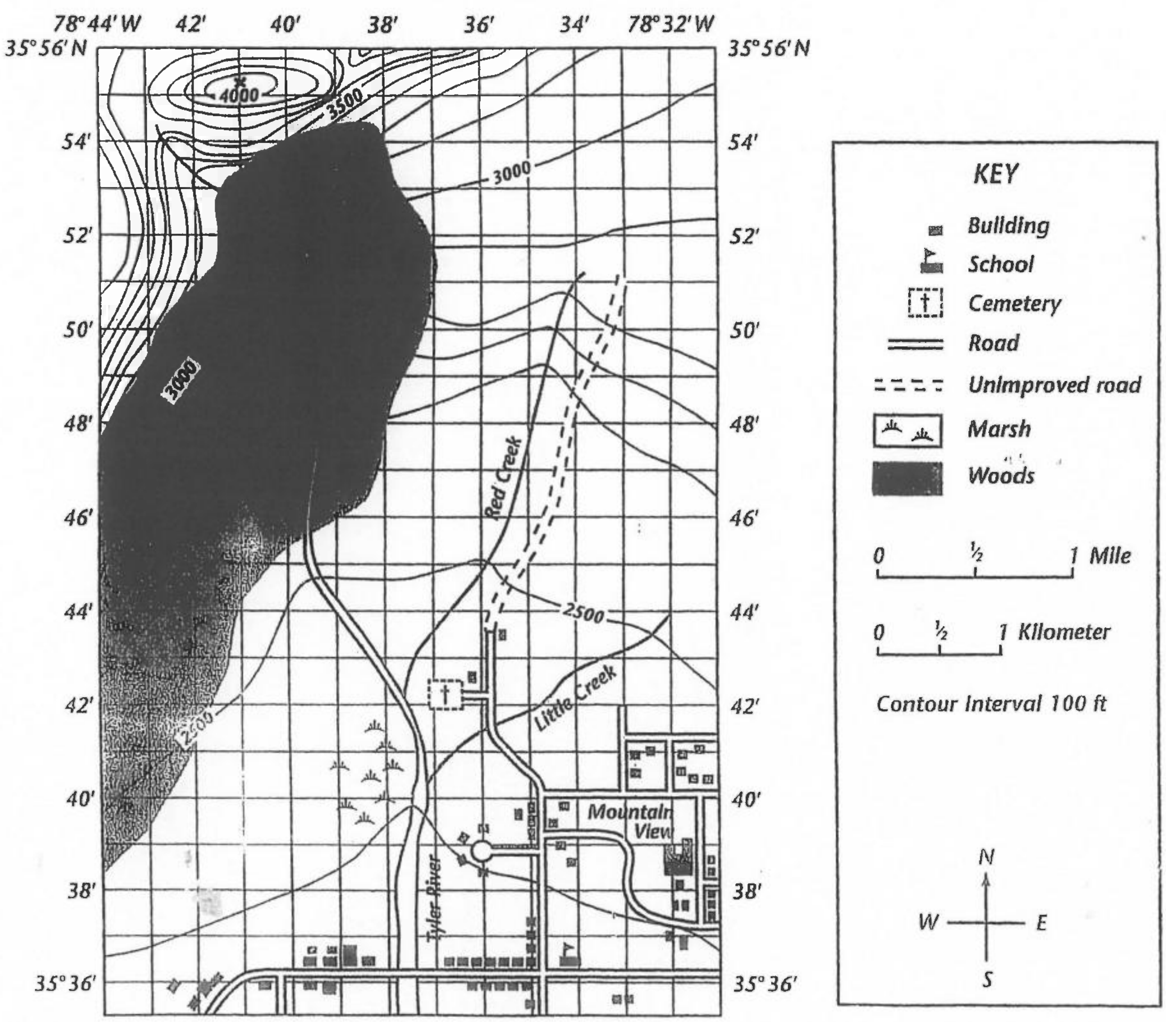
Using a Topographic Map *(continued)*

Procedure

The Program Leader has sent the following radio message from her plane: "Attention outdoor ed. students . . . heading northwest . . . over crossroads and school . . . marsh on my left . . . following river . . . over woods now . . . cliff approaching . . . turning northeast . . . crossing river . . . winds are calm . . . treetops . . . CANISTER AWAY!"

1. Use the message and the topographic map in Observations to determine where the pilot started sending the message.
2. Trace on the map the probable path taken by the pilot.
3. On the map, shade in an area where you would concentrate your search for the canister.

Observations



Analyze and Conclude

1. What are the latitude and longitude of the highest elevation on the map?

2. In which direction does the Tyler River flow? How do you know?

3. What clues in the pilot's radio message tell you where to start looking for the canister? What other clues might the pilot have given?

4. What are the latitude and longitude of the most likely place to find the canister? Give a reason for your answer.

5. How far will you have to travel to reach the drop site? Assume that you will travel in a straight line.

Critical Thinking and Applications

1. Look at the area where the canister probably came down. What problems might you have retrieving the canister?

Name _______________ Date _______________ Class _______________

Stormy Sunspots

During which years were electrical disturbances on Earth most common? In this lab, you will consider the relationship between sunspot activity and magnetic storms on Earth.

Problem

How are magnetic storms on Earth related to sunspot activity?

Skills Focus

graphing, interpreting data

Materials

graph paper   ruler

Procedure

1. Use the data in the table to plot a line graph of sunspot activity between 1972 and 2002. Use the next page or graph paper.
2. On the graph, label the x-axis "Year." Use a scale with 2-year intervals, from 1972 to 2002.
3. Label the y-axis "Sunspot Number." Use a scale of 0 through 160 in intervals of 10.
4. Graph a point for the Sunspot Number for each year.
5. Complete your graph by drawing lines to connect the points.

Sunspots

Year	Sunspot Number	Year	Sunspot Number
1972	68.9	1988	100.2
1974	34.5	1990	142.6
1976	12.6	1992	94.3
1978	92.5	1994	29.9
1980	154.6	1996	8.6
1982	115.9	1998	64.3
1984	45.9	2000	119.6
1986	13.4	2002	104.0

NAME__________________________________PERIOD_______DATE____________

LAB PARTNERS____________________________________ **LAB #9**

INTERPRETING A SIMPLIFIED TOPOGRAPHIC MAP OF BEAR MOUNTAIN

INTRODUCTION
In previous lab investigations and classwork you have studied how to locate positions on the earth's surface and how to construct a contour map from a three dimensional model. In this lab exercise you will interpret and analyze an actual topographic map.

OBJECTIVES
Using a topographic map of Bear Mountain you will:

1-Determine contour interval, elevations, and gradient
2-Determine direction of stream flow
3-Construct two profiles between points on the map

APPROXIMATE TIME: 1-2 periods

MATERIALS:
graph paper
ruler
Earth Science Reference Tables

PROCEDURES

1.Answer lab questions 1-11 by referring to the attached topographic map of Bear Mountain.

2.For question 12, calculate the gradient between the two points listed. You will need the Earth Science Reference Tables and a ruler.

3.Construct a profile along lines A-B and C-D using the graph paper provided.

1. What is the contour interval of this map? ___________________

2. What is the highest elevation of White Mountain? _________________

3. What is the symbol used for the very highest point on the mountains? ______________

4. What is the direction of water flow of Rapid Brook? _______________

   How can you tell? ____

5. Where on the map is the gradient steepest? __________________________________

6. What is the elevation of the mine? __________________

7. How deep is the depression, which is, located northeast of Bear Mountain Peak? ___________

8. Using the scale find the length of the railroad tunnel through Bear Mountain. ____________

9. What is the elevation of the center of the town of Dixon? __________________

10. Give the latitude and the longitude in degrees and minutes of White Mountain Peak.

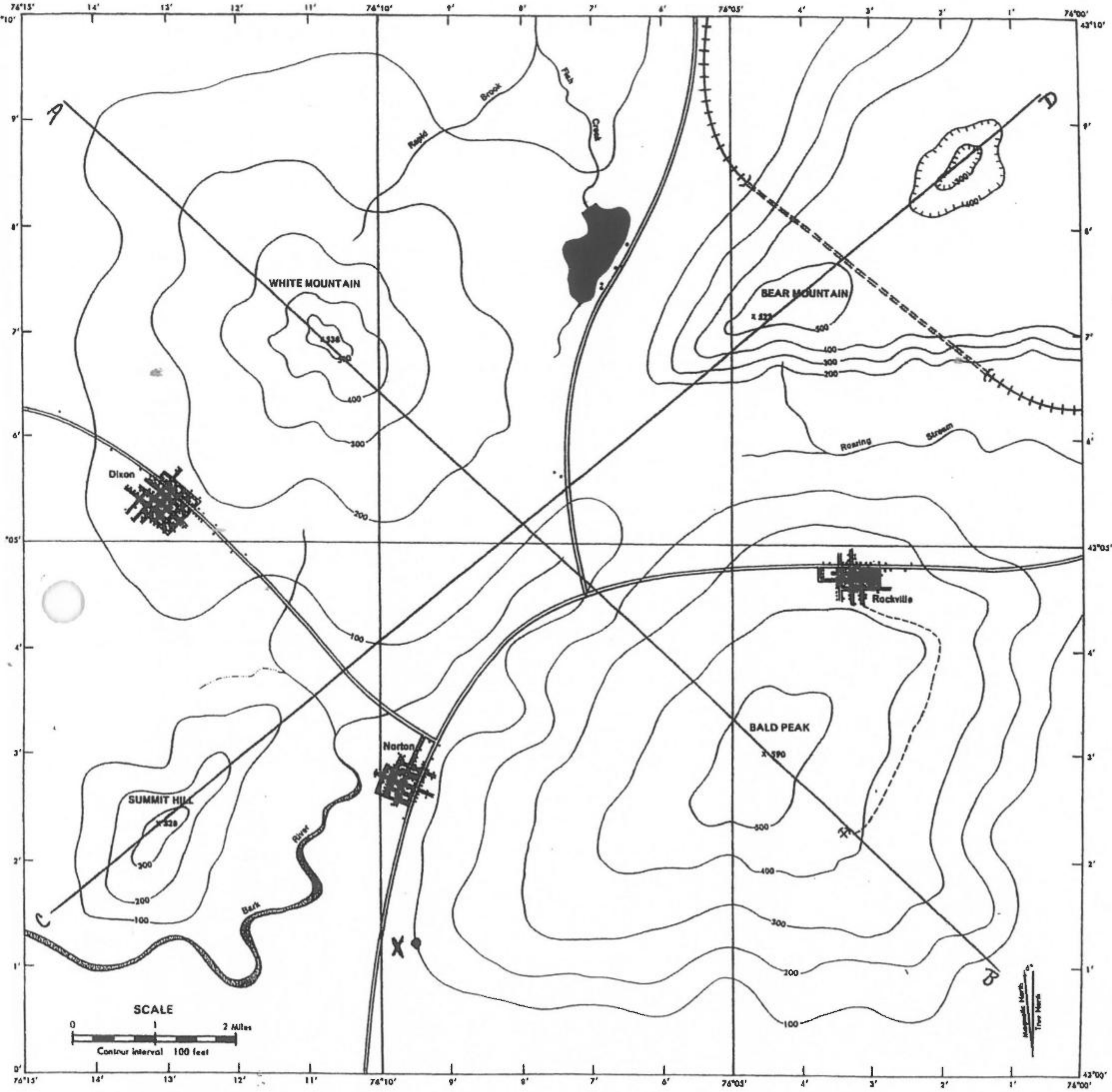
    ___________________________ ______________________

11. Intermittent streams are represented by the symbol ... — ... — ... — ...

    An intermittent stream is one in which the water does not flow all year long, but perhaps only during melting of snow and ice or during very heavy rainfalls. Is there an intermittent stream on this topographic map? If so, describe where.

    _________ ____

12. Calculate the gradient between the top of Bald Peak to the dot next to Point X. Show the formula, your calculations and be sure to include the correct units in your answer.



KEY

Tunnel ==============

Mine

Train Tracks +++++++++++++

NAME: ______________________________ PERIOD: ________DATE:_____

LAB PARTNERS: ____ LAB # 10

INTERPRETING TOPOGRAPHIC MAPS

Introduction: Extremely accurate topographic maps have been made of every part of New York State and the United States. These maps provide detailed information about the land which can be used for many purposes including hydrographic studies, man's impact on the environment, historical vs. current land data, and examination of striking geologic landform features,

Approximate Time: 2 periods

Materials: Topographic Map of West Ithaca, New York
Topographic Map of Brandon, Vermont
Topographic Map of Bray, California

PART A: ITHACA WEST, NEW YORK

USING THE TOPOGRAPHIC MAP OF ITHACA WEST, NEW YORK ANSWER THE FOLLOWING QUESTIONS.

1. What is the contour interval of this map? ______________________________
2. In what part of the map is the gradient the steepest? ____________________

   How can you tell? ____
3. In which direction is Williams Brook Flowing? ___________________________

   How can you tell? _____________________________________
4. What feature is found directly south of Ithaca Municipal Airport? ______________
5. What dos this tell you about the gradient of the area just south of the airport? _______

   ____
6. In what direction is the Delaware Lackawanna Railroad from the city of Ithaca? _____
7. What is the highest possible elevation of the X just north of Catskill Turnpike? ______

8. What is the distance in kilometers along Coyglen road? ______________________

9. Calculate the gradient between from the school at the western end of Catskill Turnpike to the X at the center of the Municipal Airport. (Show formula and all work).

10. Using evidence from the map explain why Ithaca is built where it is. ____________

____

____

11. Draw a profile along Line A-B on the graph paper provided.

PART B: BRANDON, VERMONT

USING THE TOPOGRAPHIC MAP OF BRANDON, VERMONT ANSWER THE FOLLOWING QUESTIONS.

12. What is the contour interval of this map? ______________________________

13. Which side of Hawk Hill is the steepest? ______________________________

14. Calculate the gradient between points A and B. (Show formula and all work).

15. Construct a profile from point C to Point D.

PART C: BRAY, CALIFORNIA

USING THE TOPOGRAPHIC MAP OF BRAY, CALIFORNIA ANSWER THE FOLLOWING QUESTIONS.

16. What is the contour interval of this map? ______________________________

17. Determine the straight line distance between the BM (benchmark) on the tops of Orr Mountain and Cedar Mountain.

    ____

18. Describe the land just to the northwest of Orr Mountain. ______________________________

    ____

18. Calculate the gradient between the benchmark on top of Cedar Mountain to point A. (Show formula and all work).

19. What could have formed the two mountain peaks shown in this topographic map?

    ____

    ____

20. From the map suggest two occupations that might be found in this area. Support Your answer.

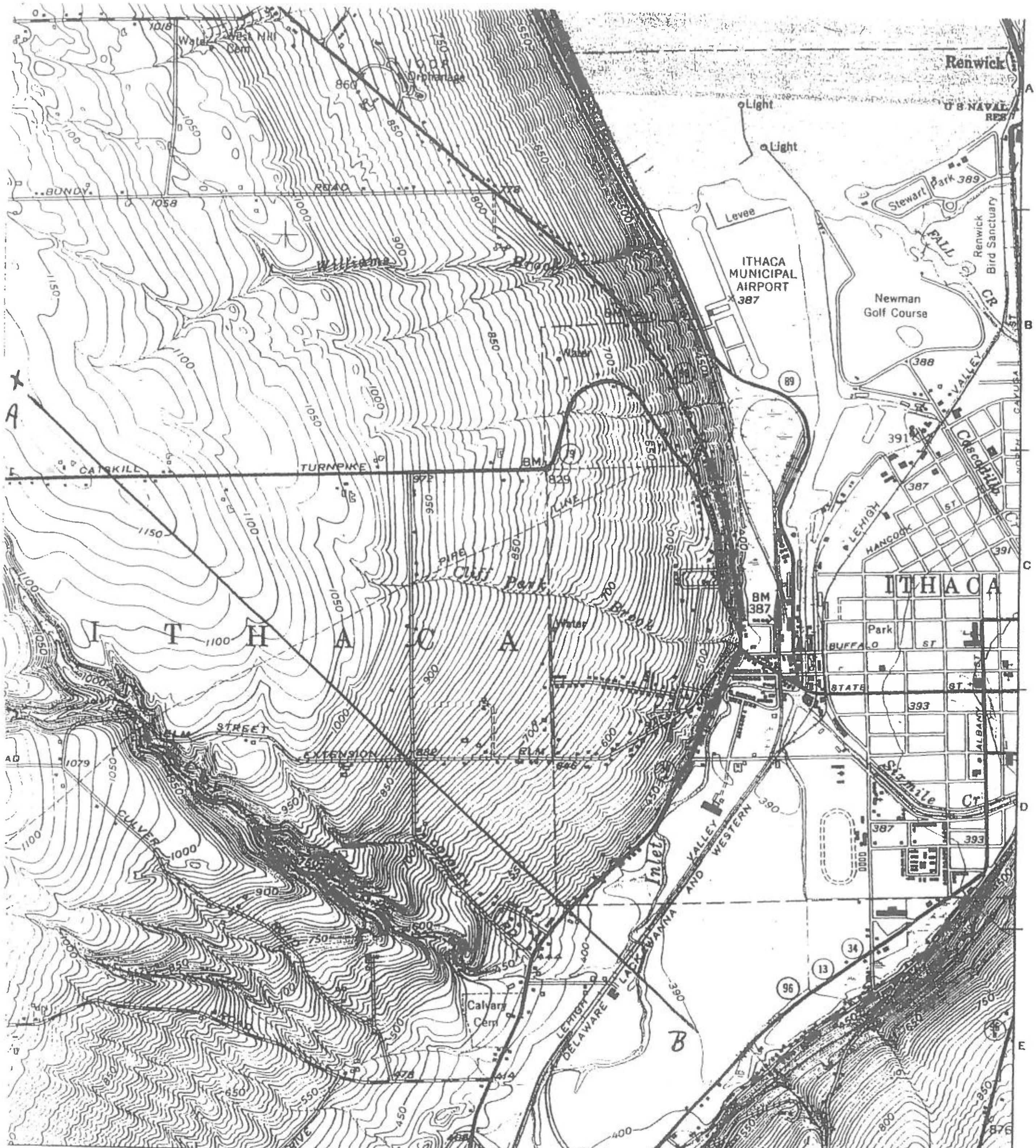
    1. ______________________________

       ____

    2. ______________________________

       ____

4,



ITHACA WEST, NEW YORK Major physiographic features of this map inset include a delta, and a stream in a glacial trough. This southern New York section of the Appalachian Plateau has an average 1100-foot relief pattern.

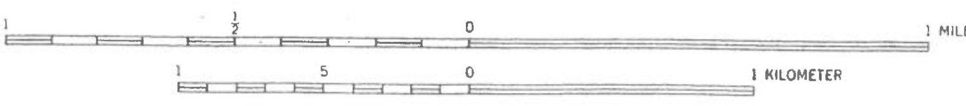
1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

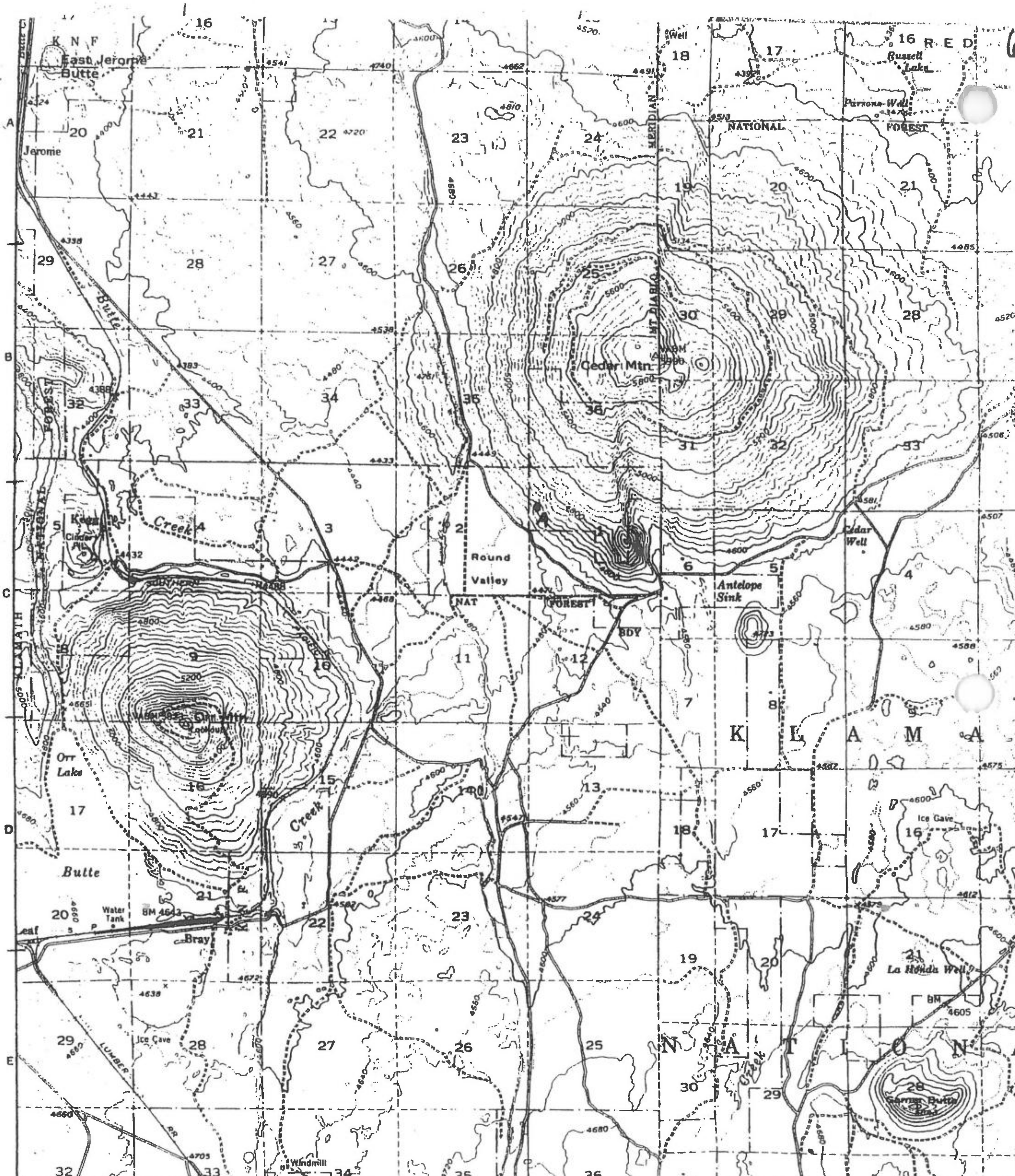
Scale 1:24,000
Contour Interval
Latitude 42° 25′ N to 42° 28′ N
Longitude 76° 30′ W to 76° 33′ W

BRANDON, VERMONT

Scale 1:24,000
Contour Interval
Latitude 43° 45′ N to 43° 48′ N
Longitude 73° 1′ W to 73° 04′ W

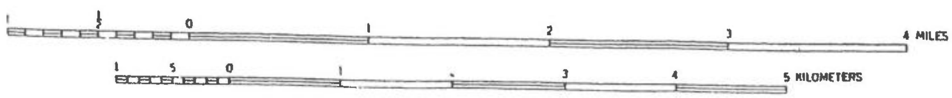


69



BRAY, CALIFORNIA

Scale 1:62,500
Contour Interval
Latitude 41° 38′ N to 41° 45′ N
Longitude 121° 51′ W to 122° W



Mapping GeoLab Make a Map Profile

A map profile, which is also called a topographic profile, is a side view of a geographic or geologic feature constructed from a topographic map. You will construct and analyze a profile of the Grand Tetons, a mountain range in Wyoming that formed when enormous blocks of rocks were faulted along their eastern flanks, causing the blocks to tilt to the west.

PREPARATION

Question

How do you construct a map profile?

Safety Procedures

Materials

metric ruler
sharp pencil
graph paper

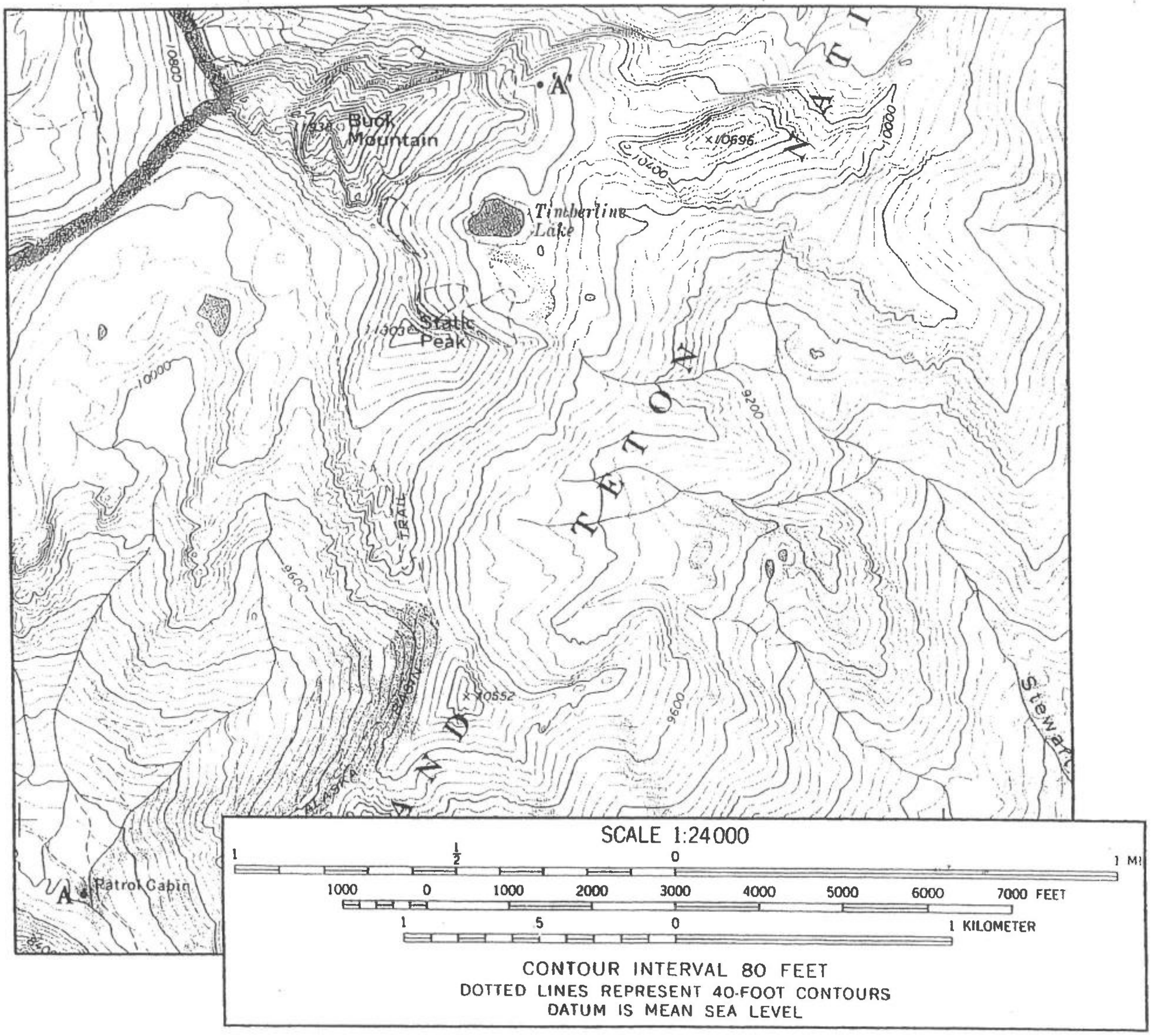
PROCEDURE

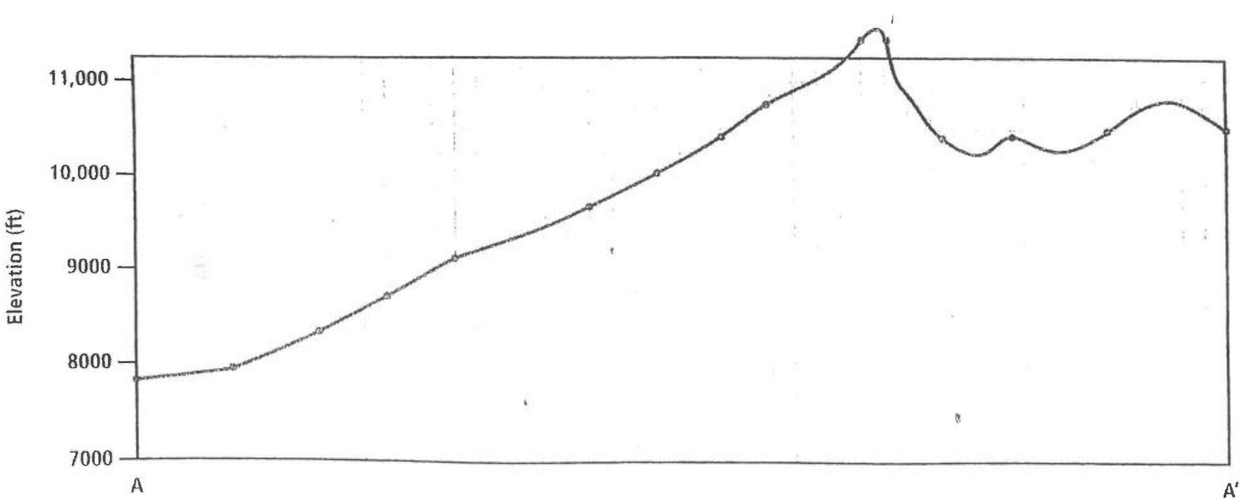
Contour lines are lines on a map that connect points of equal elevation. Locate the index contour lines on the map on the next page. Index contour lines are the ones in a darker color.

1. Read and complete the lab safety form.
2. On the graph paper, make a grid like the one shown on the facing page.
3. Place the edge of a paper strip along the profile line AA' and mark where each major contour line intersects the strip.
4. Label each intersection point with the correct elevation.
5. Transfer the points from the paper strip to the profile grid.
6. Connect the points with a smooth line to construct a profile of the mountain range along line AA'.
7. Label the major geographic features on your profile.

Name Class Date

Mapping GeoLab Making a Map Profile





Name

Mapping GeoLab

Make a Map Profile

ANALYZE AND CONCLUDE

1. **Interpret Data** Describe how the topographic profile changes with distance from point A.

2. **Interpret Data** What is the elevation of the highest point on the topographic profile? The lowest point?

3. **Interpret Data** What is the average elevation shown in the profile?

4. **Interpret Data** Calculate the total relief shown in the profile.

5. **Interpret Data** Is your topographic profile an accurate model of the topography along line AA'? Explain.

6. **Analyze** What determined the scale of this topographic profile?

7. **Predict** What would happen to your topographic profile if the horizontal scale was marked in 20-ft intervals?

Earth's Interior

Name__________________________

Date Per

Purpose: To determine the thickness of the various layers of the earth, using a scale drawing.

Materials: Metric ruler, pencil

Procedure:

1. Examine figure 2-1a on Practice Sheet 2-1. It is a *scale* drawing of a cross-sectional slice of the earth.

   What are the four major layers or shells that make up the structure of the earth?

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________

2. Examine Scale A on Practice Sheet 2-1. The total length of the scale represents a distance of 2000 kilometers.

   a. What is the length of the scale line in centimeters?

   ____

   b. What distance in kilometers does each centimeter represent?

   ____

   c. A line 3 cm long would represent a distance of how many kilometers?

   ____

   d. A millimeter (mm) is 0.1 cm. What distance in kilometers would a length of 1 mm on the scale represent?

   ____

   e. What distance in kilometers would a line 22.7 cm in length on the scale represent?

   ____

3. On Practice Sheet 2-1, using your ruler, measure in centimeters the thickness of the mantle layer. Record this value on the Practice Sheet and in the correct space in Table 2-1. *INCLUDE UNITS!!!*

Table 2-1

Earth Layer	Practice Sheet	Actual Thickness
Mantle		
Outer Core		
Inner Core		

4. Using Scale A, convert the thickness of the mantle in *centimeters* to its thickness in *kilometers*. Record this value both on the Practice Sheet and in Table 2-1.
5. Repeat Procedures 3 and 4 to determine the thickness in kilometers of the outer core layer and the inner core layer. Record values on the Practice Sheet and in Table 2-1.
6. Check the thickness of each layer with page 10 of the ESRT. Record those values in Table 2-2. *INCLUDE UNITS!!!*

Table 2-2

Earth Layer	Approximate Thickness
Mantle	
Outer Core	
Inner Core	

What is the approximate total distance in kilometers from the surface to the center of the earth?

____

7. Using Scale B, determine the approximate radius of the earth in miles. Determine its diameter.

   a. radius = ______________________________

   b. diameter = ______________________________

8. If 1 mile = 1.6 = 1.6 km, what is the approximate diameter of the earth in kilometers?

   ____

9. Examine Figure 2-1b on the Practice Sheet. It is a cross-sectional drawing of a small part of the upper layer of the earth. This layer is called the crust.

   a. Under what parts of the earth or the oceans is the crust thickest?

   ____

   b. What layer of the earth supports the crust?

   ____

10. Using Scale C, determine the thickness in kilometers of the thickest and thinnest sections of the earth's crust in Fig. 2-1b.

   a. Thickest = ______________________________

   b. Thinnest = ______________________________

11. Convert the above values to miles.

   c. Thickest = ______________________________

   d. Thinnest = ______________________________

12. According to page 10 in your ESRT what is the density of each layer of the earth? Record this data in Table 2-3.

Table 2-3

Earth Layer		Density
Crust	Continental	
	Oceanic	
Mantle		
Outer Core		
Inner Core		

GO BACK AND MAKE SURE THAT YOU INCLUDED THE CORRECT UNITS FOR ALL DATA!!!

PRACTICE SHEET 2-1

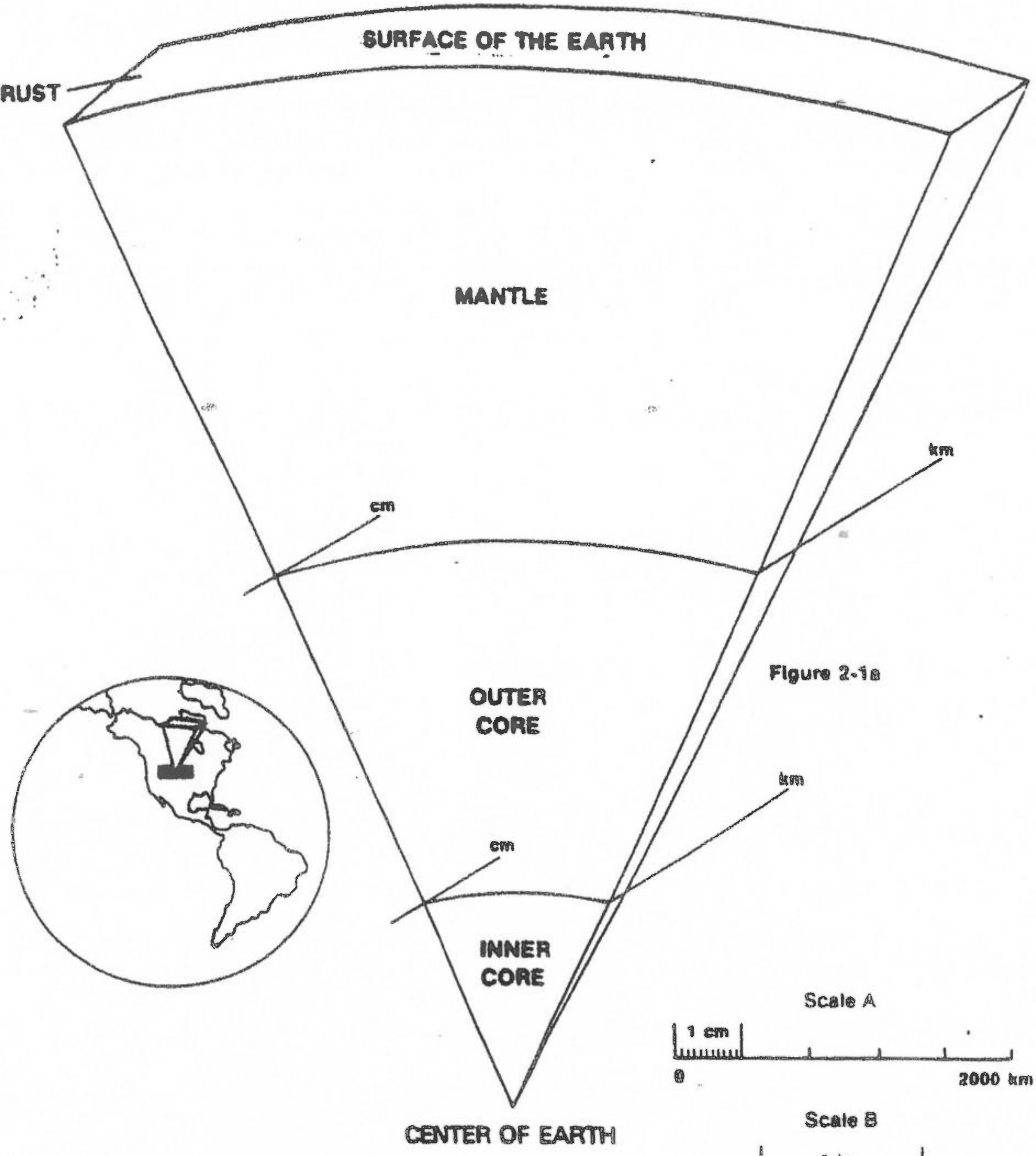
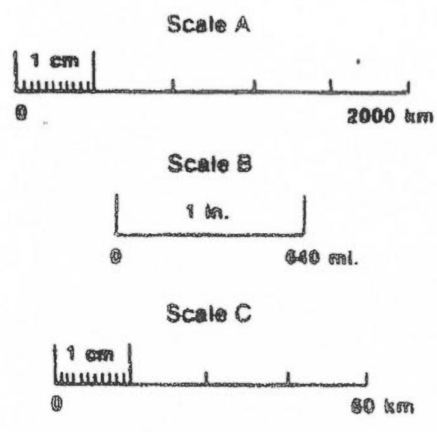


Figure 2-1a



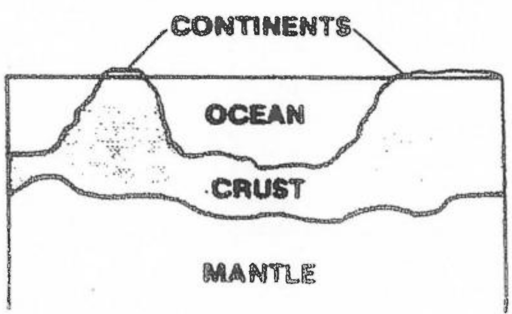


Figure 2-1b

NAME ______________________________ *DATE* ______________

INSTRUCTOR ________________ *PERIOD* ____ *PARTNER* ______________

UNIT 4: Plate Tectonics and Earth's Interior

LAB 4-6: PROPERTIES OF EARTH'S INTERIOR

INTRODUCTION: Earth is inferred to be divided into three major parts: the **crust** on the surface; the **mantle** below the crust and the metallic **core**. The deep parts of Earth are studied *indirectly* by interpreting seismic waves, and the measurement of heat flow, gravity and magnetism. Laboratory studies and computational simulations of conditions at depth have also provided glimpses of the minerals that could exist in Earth's interior.

OBJECTIVE: Using pressure and density data, you will infer the location of interfaces between Earth's interior zones. You will see how seismic data was used to find the location of the boundary between the crust and the mantle (Mohorovičić Discontinuity or MOHO).

VOCABULARY:

lithosphere:

asthenosphere:

MOHO:

refraction:

mantle:

discontinuity:

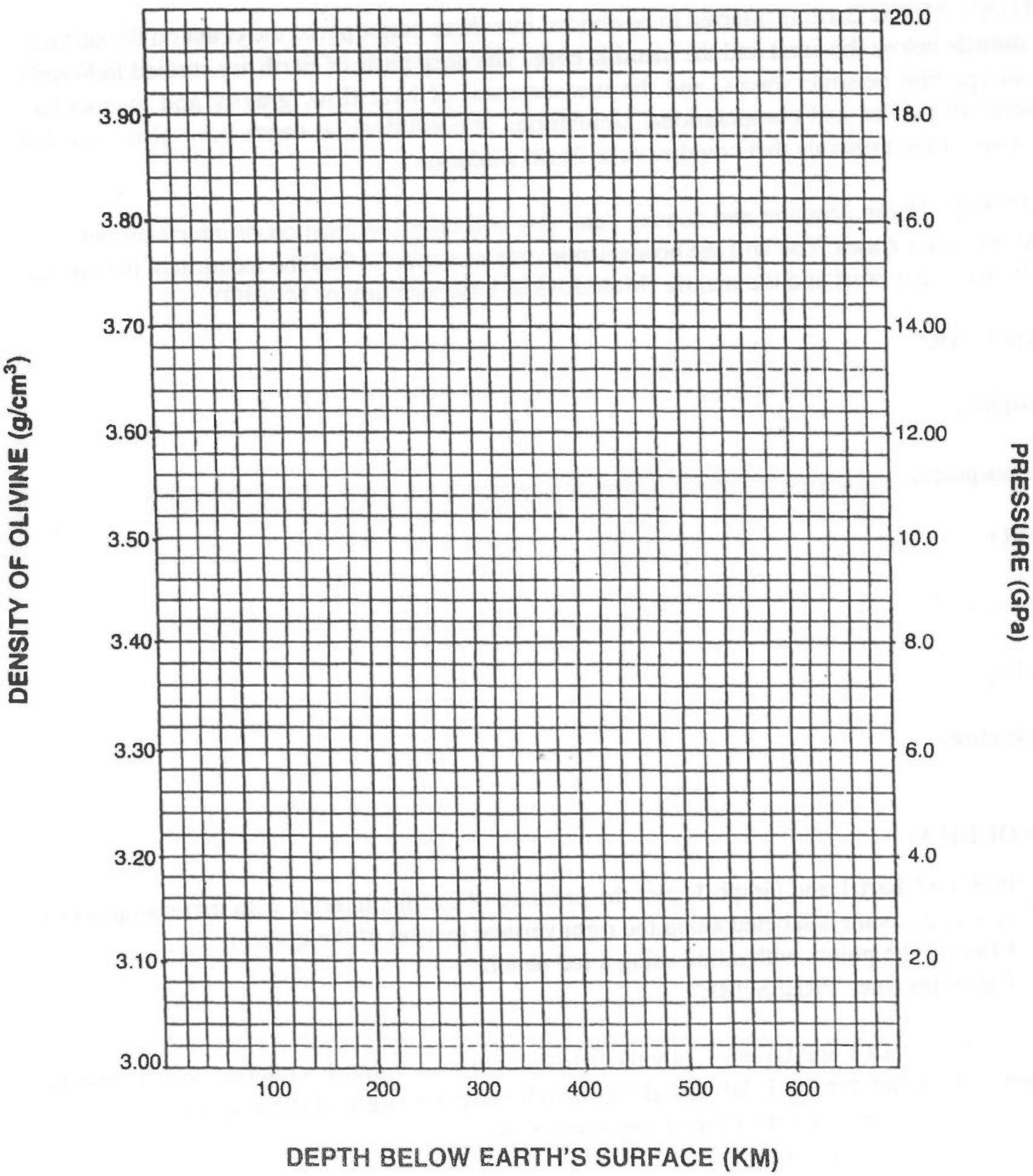
PROCEDURE A:

1. Using Data Chart 1 and Graph 1, plot the pressure of Earth's interior with increasing depth. (Note that pressure is labeled along the right vertical margin of the graph.)
   a) Connect the points with a line using a red pencil.
   b) Label this line "PRESSURE".

2. Using Data Chart 1 and Graph 1, plot the density of olivine in Earth's interior with increasing depth. (Note that density is labeled along the left vertical margin of the graph.)
   a) Connect the points with a line using a blue pencil.
   b) Label this line "DENSITY OF OLIVINE".

3. On Graph 1, identify the location of olivine's sudden change in density. Draw an arrow to this portion of the graph line and label it "ULTZ" (Upper Limit Transition Zone).
4. On Graph 2, draw arrows to the four discontinuities that can be inferred from the line for density.
5. At each discontinuity on Graph 2, draw a line straight down to the horizontal axis (depth in km).
6. On Graph 2, label the discontinuity within the upper mantle that you identified in Procedure 3. Label this ULTZ for Upper Limit Transition Zone.

GRAPH 1: Properties of the Mineral Olivine with Increasing Depth



7. On Graph 2 discontinuities show the boundaries between Earth's interior zones. Label these interior zones on the graph. They are (in order of increasing depth) the upper mantle, lower mantle, outer core and inner core.

DATA CHART 1: "Properties of the Mineral Olivine with Increasing Depth"

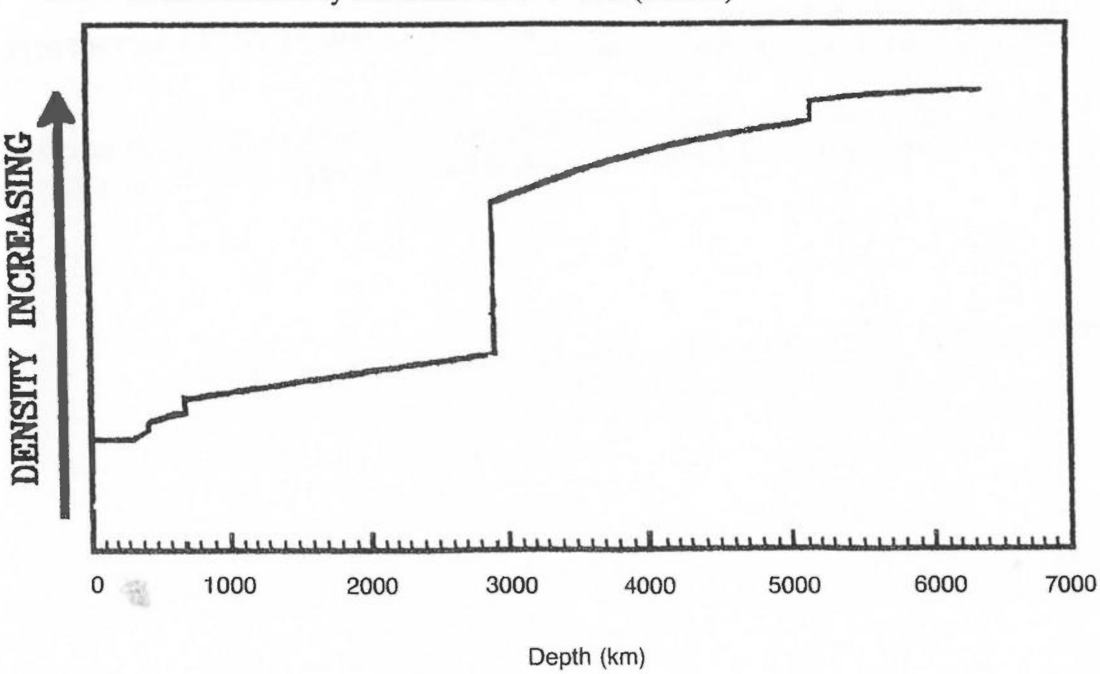
cc = cubic centimeters (cm^3)
GPa = gigapascal (one billion pascals which is equivalent to 10 thousand atmospheres)
Data compiled by the Center for High Pressure Research, State University of New York at Stony Brook (Dr. Yue Meng)

DEPTH (in Km)	PRESSURE (in GPa)	DENSITY (in g/cc)
20	0.5	3.37
50	1.5	3.40
100	3.1	3.43
150	4.7	3.47
170	5.4	3.48
200	6.4	3.51
250	8.1	3.54
280	9.2	3.57

DEPTH (in Km)	PRESSURE (in GPa)	DENSITY (in g/cc)
300	9.9	3.58
350	11.6	3.62
380	12.7	3.63
390	13.1	3.64
400	13.4	3.86
420	14.2	3.87
450	15.3	3.89
500	17.2	3.92

GRAPH 2: Variations in Density of Earth's Interior

Based on the Preliminary Reference Earth Model (PREM)



4. According to Graph 3, what change in arrivals of P and S-waves occurs at distances from the earthquake greater than 200 kilometers?

5. On the diagram, compare the lengths of the paths through Earth's interior of the 1st arrival S-wave and the 2nd arrival S-wave.

6. Considering your answer to Question 5 and your Report Sheet, how is it possible that the 1st arrival S-wave reached the earthquake recording station before the 2nd arrival S-wave?

7. What caused the refraction of the 1st arrival S-wave?

8. According to the Report Sheet and the diagram, what is a possible reason for the different rates of the 1st and 2nd arrival S-waves in the crust?

NOTE: COMPLETE QUESTION 9 AFTER COMPLETING THE ACTIVITY WITH PENNIES AS DIRECTED BY YOUR INSTRUCTOR.

9. What is the comparison between the changing patterns of pennies and the sudden change in olivine's atomic pattern as density changed with increasing depth in Earth's interior?

CONCLUSION: How can seismic waves be used to infer the presence of the Mohorovičić Discontinuity?

Name ______________________ Date ______________ Class ____________

Investigating the Speed of Earthquake Waves

Pre-Lab Discussion

An earthquake produces waves that travel away from the earthquake's epicenter, like ripples on a pond when you throw in a pebble. An earthquake produces three types of waves, primary (P waves), secondary (S waves), and surface waves. Seismologists track how far and how fast P and S waves travel to find the epicenter of the quake.

In this investigation, you will construct a travel-time graph for P and S waves. You will use the graph to answer some questions about earthquakes.

1. What causes an earthquake?

____

____

2. What is the epicenter of an earthquake?

____

____

Problem

How can you use a graph of earthquake waves' travel distance and time to find an epicenter?

Materials *(per group)*

pen or pencil

Procedure

1. An earthquake produced P and S waves that were recorded by instruments at 20 stations. These waves are listed in the Data Table on the next page. The table shows the distance traveled and the travel time for each wave. Using these data, construct a graph showing the relationship between the distance traveled by P and S waves and their travel times. Label the curves *P wave* or *S wave*.
2. Use your graph to answer the questions.

[illegible] Skills

Investigating the Speed of Earthquake Waves

[illegible]

[illegible] earthquakes [illegible] the Earth's [illegible] Earth's surface [illegible]

[illegible] you will use the graph to answer some questions about earthquakes.

1. What causes an earthquake?

2. [illegible]

Problem

How can you use a graph of earthquake waves [illegible] to [illegible] an epicenter?

Materials

[illegible]

Procedure

1. [illegible] earthquake waves [illegible] earthquake [illegible] These waves are listed in the Data Table on the [illegible] the distance traveled [illegible] P waves and S waves and their travel times. [illegible]

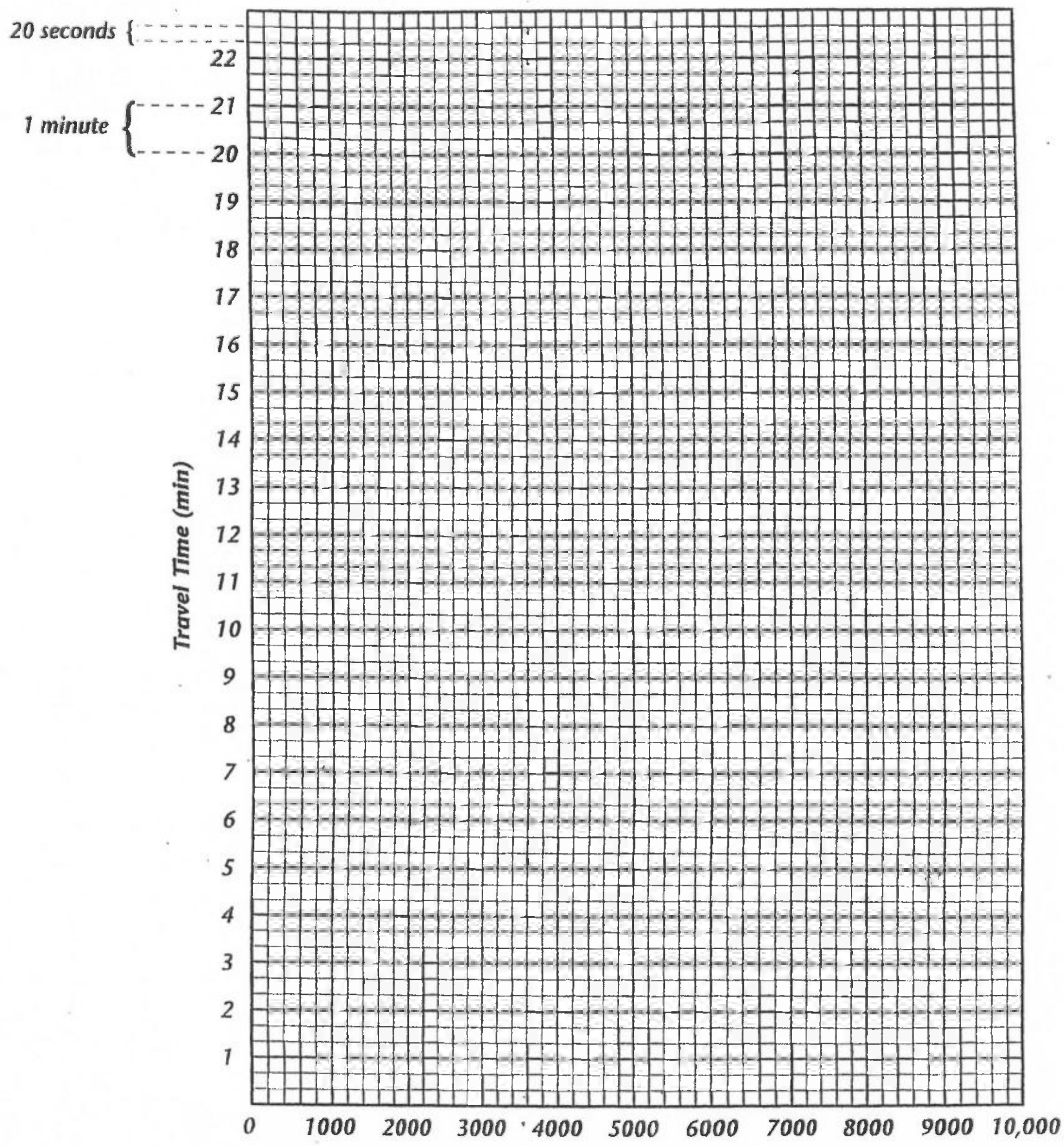
2. [illegible]

Wave Type	Distance Traveled from Epicenter (km)	Travel Time	
		(min)	(s)
P	1600	3	20
P	6500	9	50
P	5400	8	40
P	2000	4	00
P	9600	12	40
P	700	1	30
P	7000	10	20
P	3400	6	10
P	8800	12	00
P	4000	7	00
S	2200	8	00
S	4000	12	40
S	5200	15	20
S	1700	6	30
S	6000	17	00
S	1100	4	20
S	7400	19	40
S	8200	21	00
S	500	2	10
S	9000	22	10

Investigating the Speed of Earthquake Waves *(continued)*

Observations

Earthquake S Wave and P Wave Travel-Time Graph



Analyze and Conclude

1. If an earthquake occurred near you, would P waves or S waves reach you first? Explain your answer.

____

____

2. How long would it take a P wave to travel 8000 km from an earthquake epicenter? How long would it take an S wave to travel the same distance?

____

3. Approximately how far is an observer from an earthquake epicenter if he or she observed a P wave 8 min after the earthquake?

____

4. How could you tell which of two observers was farther from an earthquake epicenter by comparing the arrival times of P and S waves for the two locations?

____

____

Critical Thinking and Applications

1. How far from an earthquake epicenter is an observer who measured a difference of 8 min 40 s in the arrival times of P and S waves?

____

2. If a curve for surface waves were added to the graph, where would it appear? Explain.

____

3. States along the West Coast, such as California and Washington, have much earthquake and volcanic activity. What does this activity indicate about the underlying rock structure of this part of the country?

____

____

More to Explore

Tie a piece of colorful yarn to a coil near the middle of a spring toy. Move the spring to create a P wave. Then move the spring to create an S wave. Which wave travels faster? Which kind of wave produces the most overall motion of the yarn? Which wave would cause more damage as a seismic wave?

____

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Name ____________________ Date ______________ Class __________

Mapping Earthquakes and Volcanoes

Problem

Is there a pattern in the locations of earthquakes and volcanoes?

Materials

outline world map showing longitude and latitude

4 pencils of different colors

Procedure

1. Use the information in the data table on the next page to mark the location of each earthquake on the world map that follows the data table. Use one of the colored pencils to draw a letter E inside a circle at each earthquake location.
2. Use a pencil of a second color to mark the locations of the volcanoes on the world map. Indicate each volcano with the letter V inside a circle.
3. Use a third pencil to lightly shade the areas in which earthquakes are found.
4. Use a fourth colored pencil to lightly shade the areas in which volcanoes are found.

Analyze and Conclude

Write your answers on a separate sheet of paper.

1. How are earthquakes distributed on the map? Are they scattered evenly or concentrated in zones?
2. How are volcanoes distributed? Are they scattered evenly or concentrated in zones?
3. From your data, what can you infer about the relationship between earthquakes and volcanoes?
4. Suppose you added the locations of additional earthquakes and volcanoes to your map. Would the overall pattern of earthquakes and volcanoes change? Explain in writing why you think the pattern would or would not change.

Name ______________________ Date ________________ Class ____________

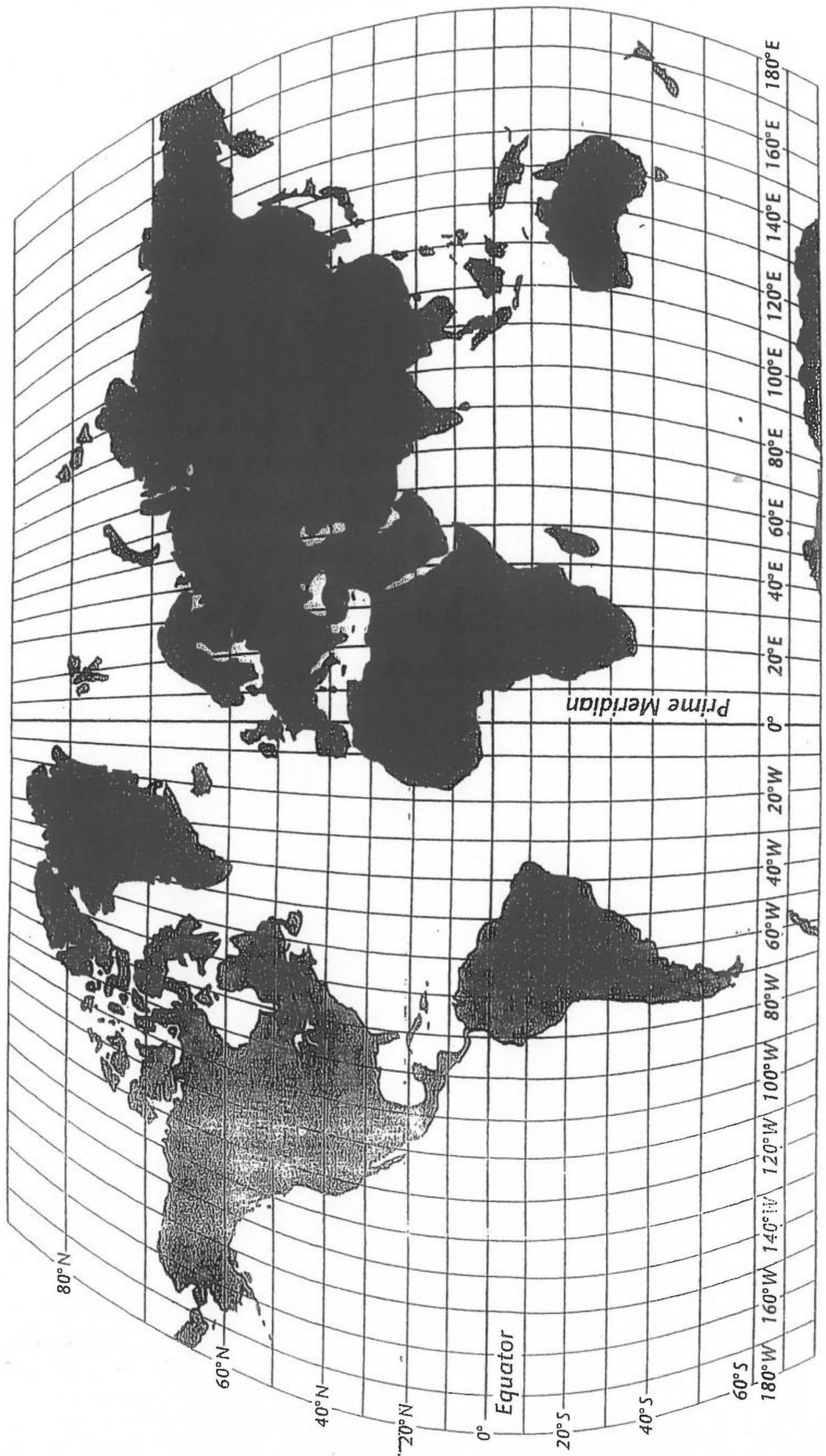
Volcanoes ▪ *Skills Lab*

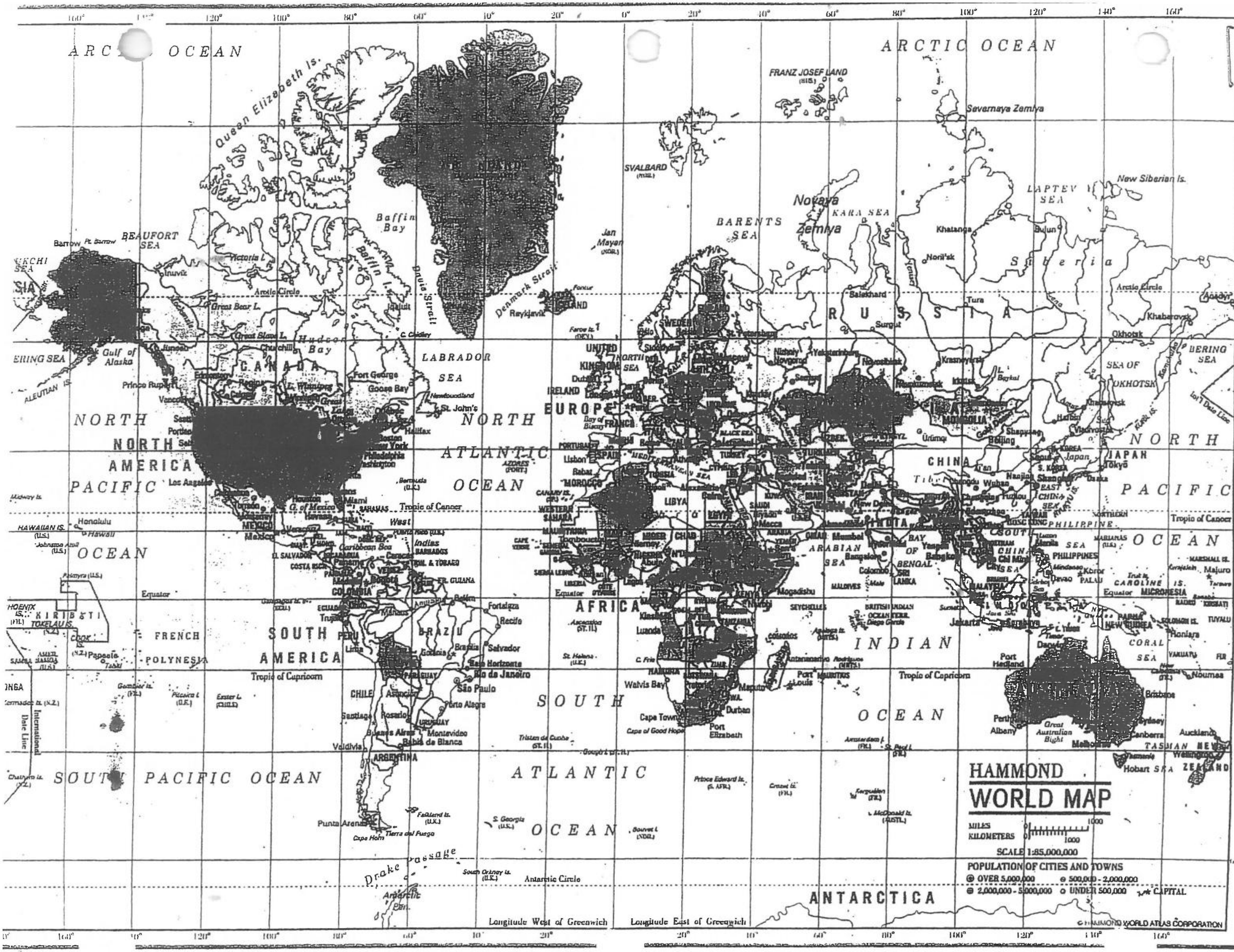
Earthquakes		Volcanoes	
Longitude	**Latitude**	**Longitude**	**Latitude**
120° W	40° N	150° W	60° N
110° E	5° S	70° W	35° S
77° W	4° S	120° W	45° N
88° E	23° N	61° W	15° N
121° E	14° S	105° W	20° N
34° E	7° N	75° W	0°
74° W	44° N	122° W	40° N
70° W	30° S	30° E	40° N
10° E	45° N	60° E	30° N
85° W	13° N	160° E	55° N
125° E	23° N	37° E	3° S
30° E	35° N	145° E	40° N
140° E	35° N	120° E	10° S
12° E	46° N	14° E	41° N
75° E	28° N	105° E	5° S
150° W	61° N	35° E	15° N
68° W	47° S	70° W	30° S
175° E	41° S	175° E	39° S
121° E	17° N	123° E	38° N

More to Explore

On a map of the United States, locate active volcanoes and areas of earthquake activity. Determine the distance from your home to the nearest active volcano.

Mapping Earthquakes and Volcanoes *(continued)*




ARCTIC OCEAN
Queen Elizabeth Is.
FRANZ JOSEF LAND
Severnaya Zemlya
SVALBARD
New Siberian Is.
LAPTEV SEA
Novaya Zemlya
KARA SEA
BARENTS SEA
Baffin Bay
BEAUFORT SEA
Barrow
Jan Mayen
Victoria I.
Baffin I.
Davis Strait
Denmark Strait
Inuvik
Arctic Circle
Great Bear L.
Reykjavik
Khatanga
Noril'sk
Siberia
Salekhard
Tura
Surgut
RUSSIA
Khabarovsk
Great Slave L.
Hudson Bay
Churchill
Juneau
Gulf of Alaska
BERING SEA
ALEUTIAN IS.
Prince Rupert
CANADA
Edmonton
Regina
L. Winnipeg
Fort George
Goose Bay
LABRADOR SEA
Newfoundland
St. John's
Halifax
Boston
New York
Philadelphia
Washington
UNITED KINGDOM
NORTH SEA
IRELAND
Dublin
London
EUROPE
Bay of Biscay
FRANCE
PORTUGAL
SPAIN
Lisbon
Rabat
MOROCCO
Krasnoyarsk
Irkutsk
MONGOLIA
Okhotsk
SEA OF OKHOTSK
BERING SEA
Vladivostok
JAPAN
Tokyo
Beijing
Shanghai
CHINA
Tibet
Wuhan
Nanjing
N. KOREA
S. KOREA
EAST CHINA SEA
NORTH PACIFIC
NORTH ATLANTIC OCEAN
NORTH AMERICA
PACIFIC OCEAN
Los Angeles
Houston
G. of Mexico
Havana
Miami
BAHAMAS
Tropic of Cancer
West Indies
Caribbean Sea
Mexico
AZORES (PORT.)
Bermuda (U.K.)
CANARY IS.
WESTERN SAHARA
MAURITANIA
LIBYA
CHAD
NIGER
SAUDI ARABIA
Mecca
ARABIAN SEA
Mumbai
INDIA
BAY OF BENGAL
SRI LANKA
Colombo
Bangkok
SOUTH CHINA SEA
PHILIPPINES
Manila
Honolulu
Hawaii
Midway Is.
HAWAIIAN IS.
Johnston Atoll
EL SALVADOR
COSTA RICA
Panama
Caracas
TRIN. & TOBAGO
FR. GUIANA
Bogota
COLOMBIA
ECUADOR
Equator
Fortaleza
Recife
AFRICA
Ascension (ST. H.)
Luanda
Kinshasa
KENYA
Nairobi
Mogadishu
SEYCHELLES
MALDIVES
BRITISH INDIAN OCEAN TERR.
COMOROS
Jakarta
PAPUA NEW GUINEA
SOLOMON IS.
TUVALU
KIRIBATI
FRENCH POLYNESIA
SOUTH AMERICA
PERU
Lima
BRAZIL
Salvador
Belo Horizonte
Rio de Janeiro
São Paulo
PARAGUAY
Tropic of Capricorn
St. Helena (U.K.)
NAMIBIA
Walvis Bay
Maputo
Port Louis
MAURITIUS
INDIAN OCEAN
Tropic of Capricorn
Port Hedland
AUSTRALIA
CORAL SEA
Nouméa
Brisbane
Sydney
Canberra
Melbourne
Perth
Albany
Great Australian Bight
Auckland
Wellington
NEW ZEALAND
TASMAN SEA
Hobart
Pitcairn I.
Easter I. (CHILE)
CHILE
Asunción
Porto Alegre
Santiago
Rosario
URUGUAY
Buenos Aires
Montevideo
Bahía Blanca
Valdivia
ARGENTINA
SOUTH ATLANTIC OCEAN
Cape Town
Cape of Good Hope
Durban
Port Elizabeth
Tristan da Cunha (ST. H.)
Prince Edward Is. (S. AFR.)
Crozet Is. (FR.)
Kerguelen (FR.)
McDonald Is. (AUSTL.)
Amsterdam I. (FR.)
St. Paul I. (FR.)
SOUTH PACIFIC OCEAN
Chatham Is. (N.Z.)
International Date Line
Falkland Is. (U.K.)
Punta Arenas
Tierra del Fuego
Cape Horn
S. Georgia (U.K.)
Bouvet I. (NOR.)
Drake Passage
South Orkney Is. (U.K.)
Antarctic Circle
Antarctic Pen.
ANTARCTICA
Longitude West of Greenwich
Longitude East of Greenwich
HAMMOND
WORLD MAP
MILES
KILOMETERS
1000
SCALE 1:85,000,000
POPULATION OF CITIES AND TOWNS
OVER 5,000,000
500,000 - 2,000,000
2,000,000 - 5,000,000
UNDER 500,000
CAPITAL
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Name _______________ Class _______ Date _______

Use with Section 20.1

Plate Tectonics of North America

Changes in the positions and shapes of Earth's continents and oceans can be explained by the theory of plate tectonics. This theory states that Earth's crust and rigid upper mantle are divided into roughly a dozen slabs, called plates. Tectonic plates move slowly over Earth's surface. Interactions among tectonic plates account for most earthquakes, volcanoes, and mountain ranges.

PREPARATION

PROBLEM

How can the theory of plate tectonics be used to analyze some of the tectonic features of North America?

OBJECTIVES

- **Identify** the major plates associated with North America and their movements.
- **Describe** the locations and orientations of major mountain chains of North America.
- **Explain** how geologic evidence supports the theory of plate tectonics.
- **Predict** how future tectonic processes might affect the North American continent.

MATERIALS

red, blue, and orange markers

PROCEDURE

1. Use a blue marker to draw a line on map B that traces the deep-sea trenches off of the western coasts of the Americas.
2. Using a red marker and map A as a reference, draw lines on map B to mark the edges of the tectonic plates shown. Indicate with arrows their directions of movements.
3. Locate the Mid-Atlantic Ridge on map B and color it orange.
4. Study maps B and C. Answer questions 1–5 in Analyze.
5. An active tectonic plate has a leading edge and a trailing edge. On map B, label the leading and trailing edges of the North American Plate.
6. Look at the map legend for map D. What do the dashed lines in the gulf between the Baja Peninsula and the mainland indicate?

____

____

7. Plate boundaries are convergent, divergent, or transform. Identify each boundary that is associated with the North American Plate. Label them on map B. Answer questions 6 and 7 in Analyze.

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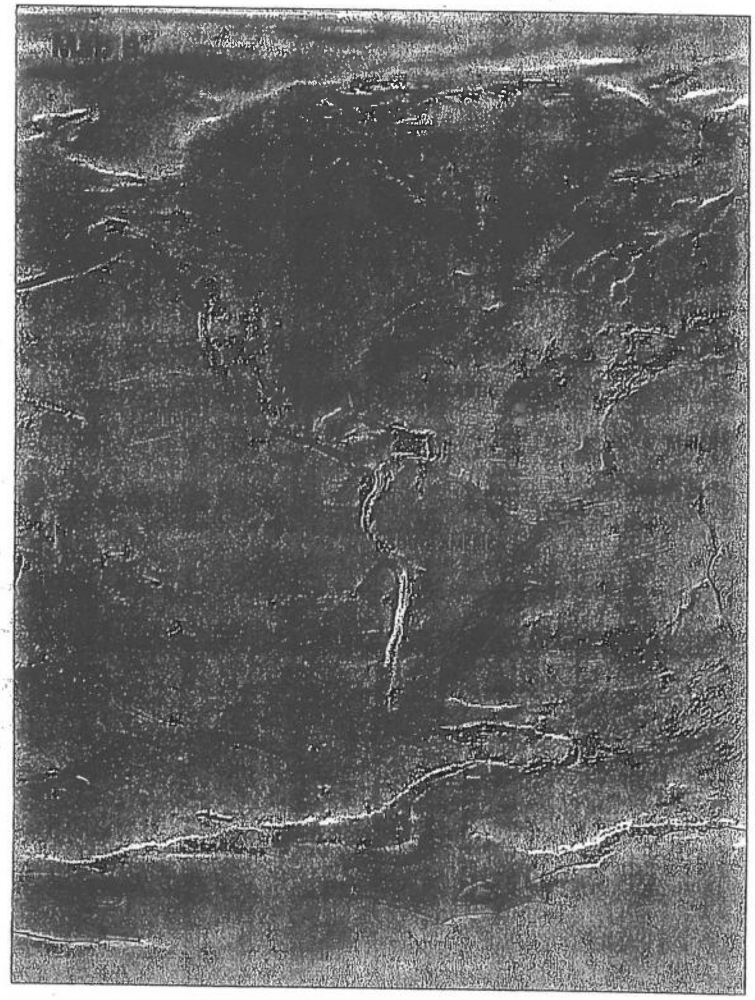
____

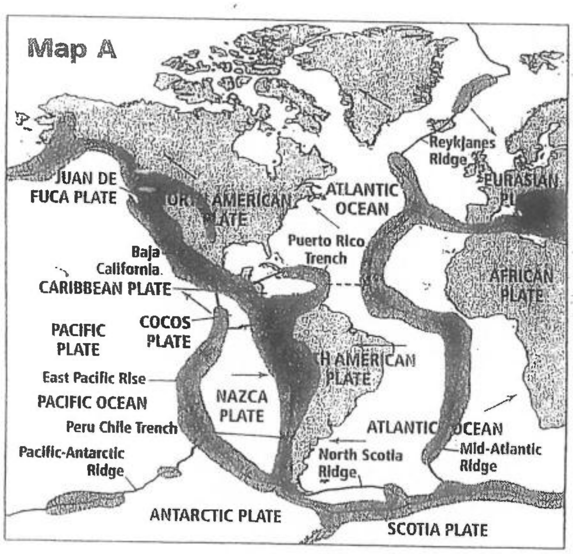
____

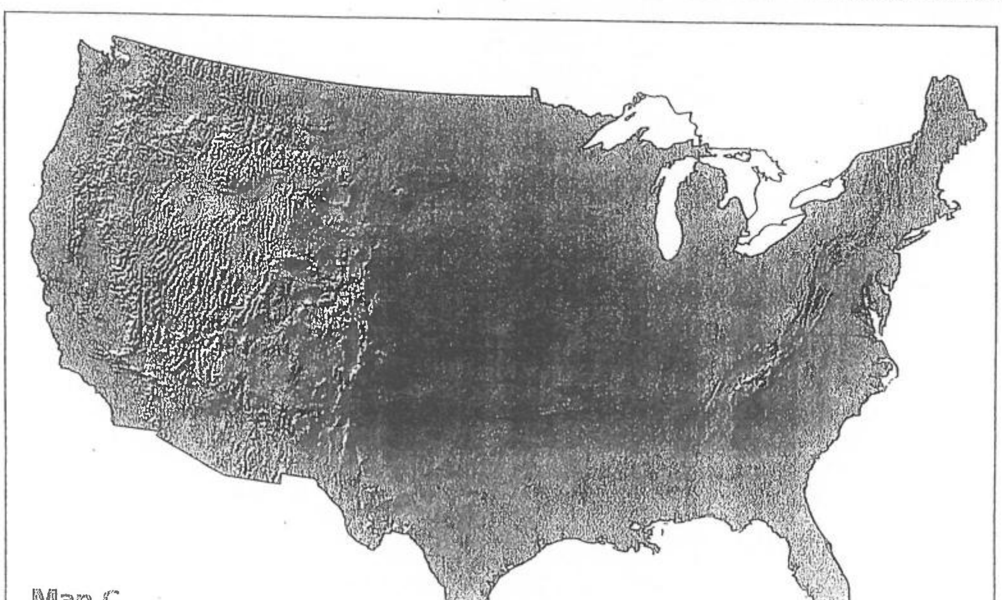
Name Class Date

LAB 20.1 INVESTIGATION

DATA AND OBSERVATIONS



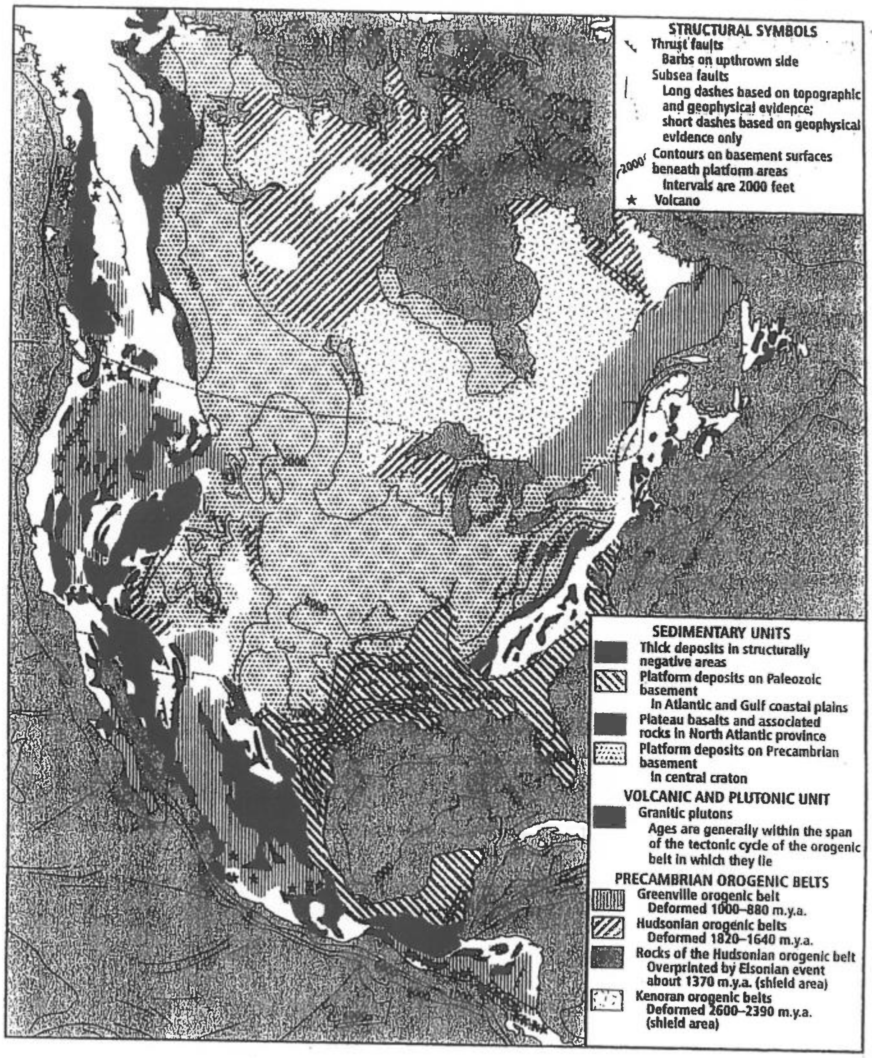




Name _______________ Class _______________

DATA AND OBSERVATIONS, *continued*

Map D



ANALYZE

1. List two features shown on map B that formed or are forming as a result of plate motion.

____

____

2. In what direction is the North American Plate moving?

____

3. Use map C to describe the locations and orientation of the major mountain systems of North America.

____

____

____

ANALYZE, *continued*

4. How does the theory of plate tectonics explain your answer to question 3?

5. From what direction were the forces that resulted in the formation of the Appalachian Mountains in the eastern United States?

6. Locate Baja, California, on maps A, B, and D. List all of the tectonic features and events that are associated with this area.

7. If the Pacific Plate continues to move along the San Andreas Fault, what might happen to Baja, California?

CONCLUDE AND APPLY

1. With your group, use the information in maps A–D and what you know about the theory of plate tectonics to briefly describe the tectonic processes that have affected North America.

Name _______________ Class _______ Date _______

Use With Section 18

Analyzing Volcanic-Disaster Risk

On May 18, 1980, an earthquake shook Mount St. Helens. A bulge on the side of the mountain and the area surrounding it slid away in a gigantic avalanche, releasing pressure and triggering a major pumice and ash eruption of the volcano. Debris filled 62 km^2 of a valley; a lateral blast damaged 650 km^2 of recreation, timber, and private lands; and volcanic mud flows deposited an estimated 0.15 km^3 of material in the nearby river. Nearly five dozen people died in the eruption. There was over $1 billion in damage.

PREPARATION

PROBLEM

What is the probability that a volcano will erupt in any given year? What does that imply for the cost of insuring people against volcanic disasters?

OBJECTIVES

- **Assess** the probability of a volcanic disaster.
- **Investigate** the feasibility of an insurance policy against volcanic disaster.

MATERIALS

Tables 1 and 2
calculator

PROCEDURE

Mount St. Helens is a volcano in the Cascade Range, which extends from California to British Columbia. Table 2 contains data for the eruption histories of the Cascade Range volcanoes. With these data, you could estimate the annual probability that a particular volcano will erupt.

$$\text{annual probability} = \frac{\text{number of eruptions}}{\text{years}}$$

For example, based on the Holocene data, the probability that Lassen Peak will erupt in any given year is (3 eruptions)/(10 000 years), or 3/10 000. From Table 1, you can see that this value lies between the annual probabilities that an individual human will die by homicide or die of AIDS.

Only huge eruptions left records before the Holocene. Smaller eruptions in the Pleistocene are poorly documented in the rock record. To calculate eruption probabilities for which there are no Pleistocene data, use the 10 000-year Holocene baseline.

Use the formula above and the data in Table 2 to answer the questions in Analyze.

Name Class Date

DATA AND OBSERVATIONS

Table 1

Event	[illegible]
Experience car theft	1/100
Experience house fire	1/200
Die from heart disease	1/280
Die of cancer	1/500
Die in a car wreck	1/6000
Die by homicide	1/10 000
Die of AIDS	1/11 000
Die of tuberculosis	1/200 000
Win a state lottery	1/1 million
Die from lightning	1/1.4 million
Die from a flood or tornado	1/2 million
Die in a hurricane	1/6 million
Die in a commercial plane crash	1/1 million to 1/10 million

Table 2

		[illegible]	[illegible]			
Feature	State	Huge	Huge	Large	Medium	Small
Mount Baker	WA				1	3
Glacier Peak	WA			2		7
Mount Rainier	WA	1			1	10
Mount St. Helens	WA				7	
Mount Adams	WA					4
Mount Hood	OR					3
Mount Jefferson	OR	1				
Three Sisters	OR			2		2
Newberry Caldera	OR			1	3	
Crater Lake	OR		1	2		
Medicine Lake	CA				8	8
Mount Shasta	CA	1		2		10
Lassen Peak	CA	4		1		2
Total		7	1	10	20	49

Note: Huge eruptions = >10 km^3 of ejecta; large = 1–10 km^3; medium = 0.1–1 km^3; small = <0.1 km^3.
The periods of the eruptions are late Pleistocene (10 000 years to 100 000 years ago) or Holocene (<10 000 years ago).

ANALYZE

1. Based on the Holocene data, what is the probability that Medicine Lake will erupt this year?

2. What is the probability that Medicine Lake will have a medium-size eruption this year?

3. What is the annual probability that Mount Jefferson will erupt?

4. During the last 10 000 years, how many eruptions have occurred in the Cascade Range?

5. What is the annual probability that one of the Cascade Range volcanoes will erupt?

6. What is the annual probability that a small eruption will occur in the Cascade Range? Multiply this by $100 million to obtain the contribution of small eruptions to the annual cost of Cascade volcanic disasters.

7. What is the annual probability that a medium-size eruption will occur in the Cascade Range? Multiply this by $1 billion to obtain the contribution of medium-size eruptions to the annual cost of Cascade volcanic disasters.

8. Calculate the annual probability for large Cascade eruptions. If a large Cascade eruption costs $10 billion, what is the contribution of large eruptions to the annual cost of Cascade volcanic disasters?

9. Using both Pleistocene and Holocene data, what is the annual probability that a huge eruption will occur? Calculate the contribution of huge eruptions to the annual cost of Cascade volcanic disasters if the cost of a huge eruption is $100 billion.

10. What is the total cost per year of Cascade eruptions? If inflation and land development drove the cost per eruption up by a factor of 100, what would the annual cost be?

Name Class Date

CONCLUDE AND APPLY

1. Think of two reasons why your estimates of the probabilities might predict three times fewer volcanic eruptions than the actual number that will occur during the twenty-first century.

2. If there were three times as many volcanoes as predicted, what would the total annual cost be? Use the value that you obtained for question 10. If this cost is distributed evenly among 2 million policyholders, what would the insurance premium be?

3. Suppose that 10 percent of the inhabitants in the Cascade Range owned 90 percent of the property, and that the cost of the insurance premium would prohibit the other 90 percent from becoming policyholders. Divide 90 percent of the cost by 10 percent of 2 million people to find out what the annual insurance premium would be.

4. Explain why insurance companies rarely insure against volcanic-disaster damage, even though volcanic disasters do not occur very often.

LAB

Use with Section 17.3

Earthquakes and Subduction Zones

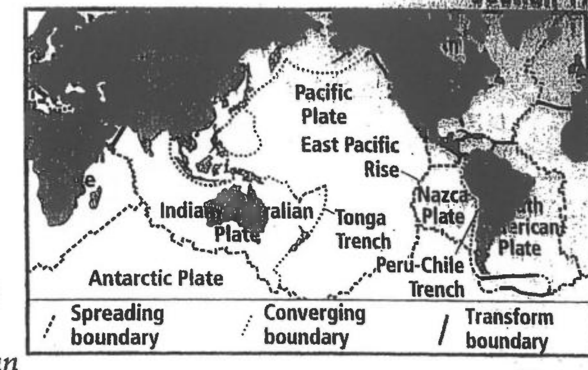


Figure 1

The density of the rock that makes up a subducting plate is one of the factors that determines how the plate behaves. The greater the density, the faster the plate subducts into the mantle and the steeper the angle of subduction. Older crust is cooler and therefore denser than younger crust, so it subducts faster and at a steeper angle along a subduction zone.

Most earthquakes occur at tectonic plate boundaries. An earthquake can be classified by the depth of its focus. Deep-focus earthquakes have foci at more than 300 km, shallow-focus earthquakes have a focus at less than 70 km, and intermediate-focus earthquakes have foci between 70 km and 300 km.

PREPARATION

OBJECTIVES

- **State** a hypothesis about the relative ages of the crust at two convergent boundaries.
- **Use** earthquake data to **construct** profiles of two convergent boundaries.
- **Compare** the behavior of two subducting plates.

HYPOTHESIS

Consider Figure 1. The East Pacific Rise is an ocean ridge, running north-south at about 110°W, where the Pacific Plate meets the Nazca Plate. Material from this divergent boundary flows westward across the Pacific Plate or eastward across the Nazca Plate. The west-flowing material runs into the Australian Plate at the Tonga Trench, which is north of New Zealand at about 175°W. East-flowing material meets the South American Plate at the Peru-Chile Trench, at about 65°W. Assume that the seafloor spreads at the same rate both west and east of the East Pacific Rise. Form a hypothesis about the relative ages of the East Pacific Rise material at the two convergent boundaries: the Tonga Trench and the Peru-Chile Trench.

____

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MATERIALS

calculator

PROCEDURE

1. Table 1 shows earthquake data from the region associated with the Peru-Chile Trench. Plot these data on a graph, using a dot to represent each data point.
2. Plot the earthquake data from the region associated with the Tonga Trench on a second graph.
3. Draw a best-fit line for the Peru-Chile Trench data. A best-fit line is a smooth line that shows the trend of the data; the line does not have to pass through the data points.
4. Draw a best-fit line for the Tonga Trench data.

Name Class Date

DATA AND OBSERVATIONS

Longitude	[illegible]	[illegible]	[illegible]
61.7	540	173.8	35
62.3	480	173.8	50
63.8	345	173.8	60
65.2	285	173.9	60
65.5	290	174.1	30
66.2	230	174.6	40
66.3	215	174.7	35
66.4	235	174.8	35
66.5	220	174.9	40
66.7	210	174.9	50
66.7	200	175.1	40
66.9	175	175.4	250
67.1	230	175.7	205
67.3	185	175.7	260
67.5	180	175.8	115
67.5	170	175.9	190
67.7	120	176.0	160
67.9	140	176.0	220
68.1	145	176.2	270
68.1	130	176.8	340
68.2	160	177.0	380
68.3	130	177.0	350
68.3	110	177.4	420
68.4	120	177.7	560
68.5	140	177.7	580
68.6	180	177.7	465
68.6	125	177.8	460
69.1	95	177.9	565
69.2	35	178.0	520
69.3	60	178.1	510
69.5	75	178.2	595
69.7	50	178.2	550
69.8	30	178.3	540
69.8	55	178.5	505
70.8	35	178.6	615
		178.7	600
		178.8	590
		178.8	580
		179.1	675
		179.2	670

Name Class Date

DATA AND OBSERVATIONS, *continued*

ANALYZE

1. How far is the Tonga Trench from the East Pacific Rise? Note that one degree longitude equals about 100 km. If the seafloor spreads at 3 cm/year, how long would it take material on the plate to travel this distance?

2. What is the depth of the deepest earthquake in the Tonga data set? Estimate the rate of descent of the East Pacific Rise material at the Tonga Trench in centimeters per year.

ANALYZE, *continued*

3. Estimate the rate of descent of East Pacific Rise material into the Peru-Chile Trench in centimeters per year.

4. The best-fit line on the Peru-Chile graph is an estimate of the location of the boundary between the Nazca Plate and the South American Plate. Indicate on the graph which plate is which. Add an arrow to show the direction of motion of the Nazca Plate.

5. The best-fit line on the Tonga graph is an estimate of the location of the boundary between the Pacific Plate and the Australian Plate. Indicate on the graph which plate is which. Add an arrow to show the direction of motion of the Pacific Plate.

CHECK YOUR HYPOTHESIS

Was your **hypothesis** supported by your data? Why or why not?

CONCLUDE AND APPLY

1. Compare your two graphs. Which has the steeper profile? Which do you think has the denser material? The older material? Explain your answer.

2. Summarize your observations, including a statement about the validity of your hypothesis.

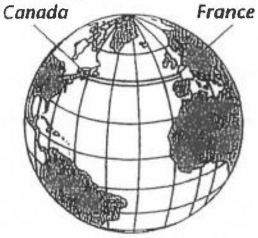
Name ______________________ Date ______________ Class ____________

Ocean Zones • *Skills Lab*

The Shape of the Ocean Floor

Problem

Imagine you are an oceanographer traveling across the Atlantic along the 45° N latitude line marked on the map. You are gathering data on the depth of the ocean between Nova Scotia, Canada, and Soulac, France. How can you use data to determine the shape of the ocean floor?



Skills Focus

graphing, predicting, inferring

Materials

pencil

graph paper

Procedure

1. Draw the axes of a graph. Label the horizontal axis *Longitude.* Mark from 65° W to 0° from left to right. Label the vertical axis *Ocean Depth.* Mark 0 meters at the top of the vertical axis to represent sea level. Mark –5,000 meters at the bottom to represent the depth of 5,000 meters below sea level. Mark depths at equal intervals along the vertical axis.
2. Examine the data in the table. The numbers in the Longitude column give the ship's location at 19 points in the Atlantic Ocean. Location 1 is Nova Scotia, and Location 19 is Soulac. The numbers in the Ocean Depth column give the depth measurements recorded at each location. Plot each measurement on your graph. Remember that the depths are represented on your graph as numbers below 0, or sea level.
3. Connect the points you have plotted with a line to create a profile of the ocean floor.

Ocean Depth Sonar Data

Longitude	Ocean Depth (m)
1. 64° W	0
2. 60° W	91
3. 55° W	132
4. 50° W	73
5. 48° W	3,512
6. 45° W	4,024
7. 40° W	3,805
8. 35° W	4,171
9. 33° W	3,439
10. 30° W	3,073
11. 28° W	1,756
12. 27° W	2,195
13. 25° W	3,146
14. 20° W	4,244
15. 15° W	4,610
16. 10° W	4,976
17. 05° W	4,317
18. 04° W	146
19. 01° W	0

Analyze and Conclude

1. On your graph, identify and label the continental shelf and continental slope.
2. Label the abyssal plain on your graph. How would you expect the ocean floor to look there?

   ____

   ____

   ____

   ____

3. Label the mid-ocean ridge on your graph. Describe the process that is occurring there.

   ____

   ____

   ____

   ____

   ____

4. What might the feature at 10° W be? Explain.

   ____

   ____

   ____

   ____

5. **Think About It** Imagine you are traveling along the ocean floor from Nova Scotia, Canada, to Soulac, France. Describe the features you would see along your journey.

   ____

   ____

   ____

More to Explore

Use the depth measurements in the table to calculate the average depth of the Atlantic Ocean between Nova Scotia and France.

The Ocean Floor

You might be surprised to find that the ocean floor is not sandy plain. If you could take a submarine voyage along the floor, what would you see? **If you could travel along the floor, you would see the continental shelf, the contir slope, the abyssal plain, and the mid-ocean ridge.** Trac journey in Figure 2.

Shallow Water As you leave the harbor, your subn first passes over a section of the ocean floor calle **continental shelf.** This gently sloping, shallow area c ocean floor extends outward from the edge of a continen depth of about 130 meters, the slope of the ocean floo steeper. This incline beyond the edge of the continental sl called the **continental slope.**

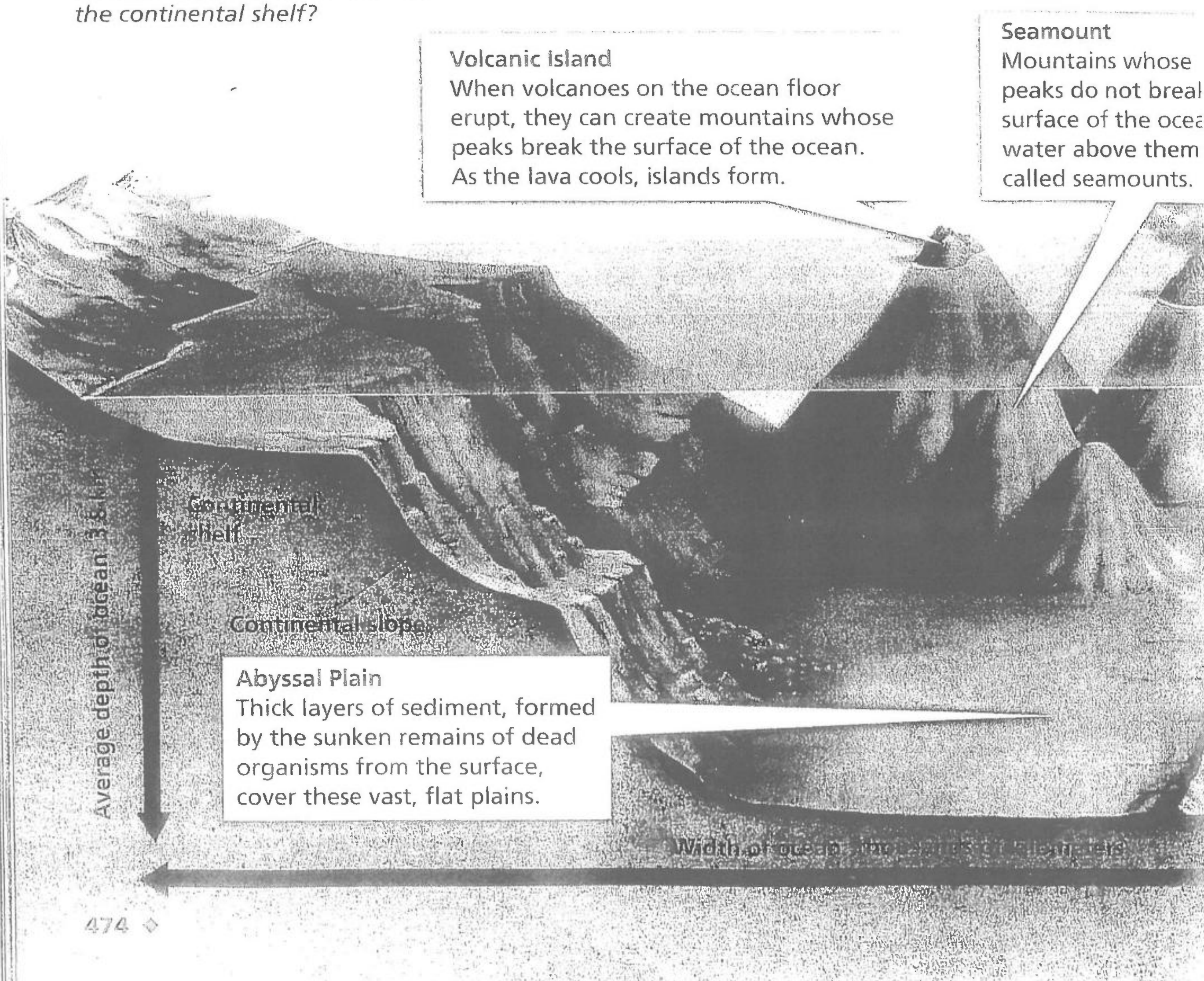
Open Ocean As you follow the ocean floor, it slopes g ally toward the deep ocean. Soon, you encounter mour tall enough to break the ocean's surface, forming islands. mountains, called seamounts, are completely underwater.

FIGURE 2

The Ocean Floor

The floor of the ocean has mountains, slopes, and other features. To show the major features of the ocean floor, thousands of kilometers have been "squeezed" into one illustration.

Interpreting Diagrams *Which is steeper, the continental slope or the continental shelf?*



Next you cross a broad area covered with thick layers of mu(d and) silt. This smooth, nearly flat region of the ocean floor is ca(lle)d the **abyssal plain** (uh BIHS ul). After gliding over the abyssal plain for many kilometers, you see a mountain range ahead. The **mid-ocean ridge** is made up of a range of mountains that winds through the oceans, much as the line of stitches winds around a baseball.

Deepest Depths You cross the ocean floor from the mid-ocean ridge toward the abyssal plain. Soon your submarine's lights reveal a dark gash in the ocean floor ahead of you. As you pass over it, you look down into a canyon in the ocean floor called a **trench.** The trench is so deep you cannot see the bottom.

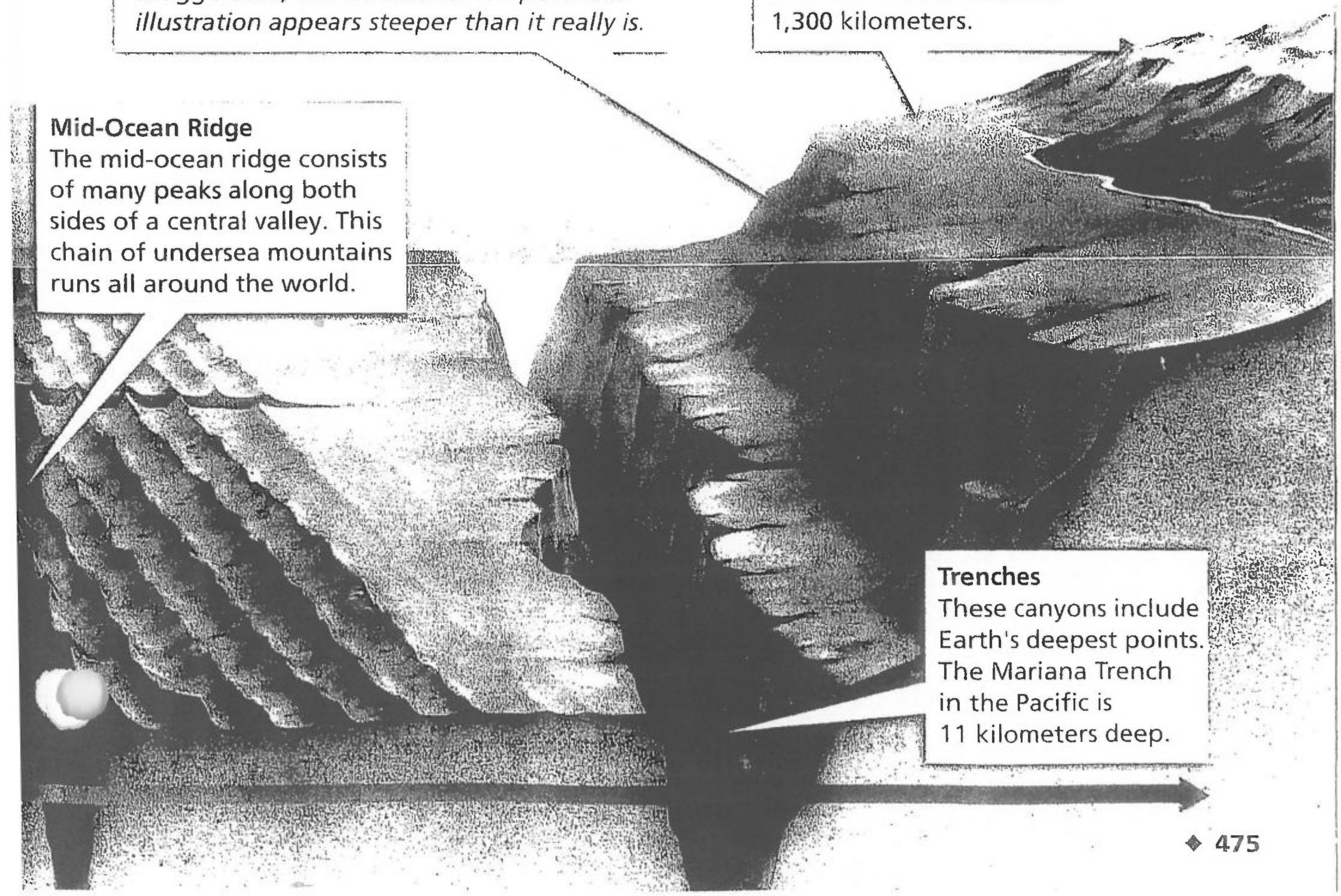
Then your submarine slowly climbs the continental slope. You cross the continental shelf on this side of the ocean and maneuver the submarine into harbor.

Discovery Channel School

Ocean Zones

Video Preview
▶ Video Field Trip
Video Assessment

Reading Checkpoint **Which ocean-floor feature makes up the deepest parts of the ocean?**



Name Class Date

Use with Section 15.2

Ocean Surface Temperatures

Ocean water has distinct chemical and physical properties, such as level of salinity, temperature, and the ability to absorb light. Because the oceans constantly intermix, these properties can vary from day to day and from place to place. Scientists use satellite data to track changes in some of these properties. Ocean surface temperatures, for example, can be determined by using satellite imagery that detects differences in thermal energy. These data are then compiled into maps.

PREPARATION

PROBLEM

How do ocean surface temperatures vary from place to place?

OBJECTIVES

- **Interpret** a world map of ocean surface temperatures.
- **Compare** the surface temperatures of different oceans.
- **Analyze** why ocean surface temperatures vary.

MATERIALS

globe

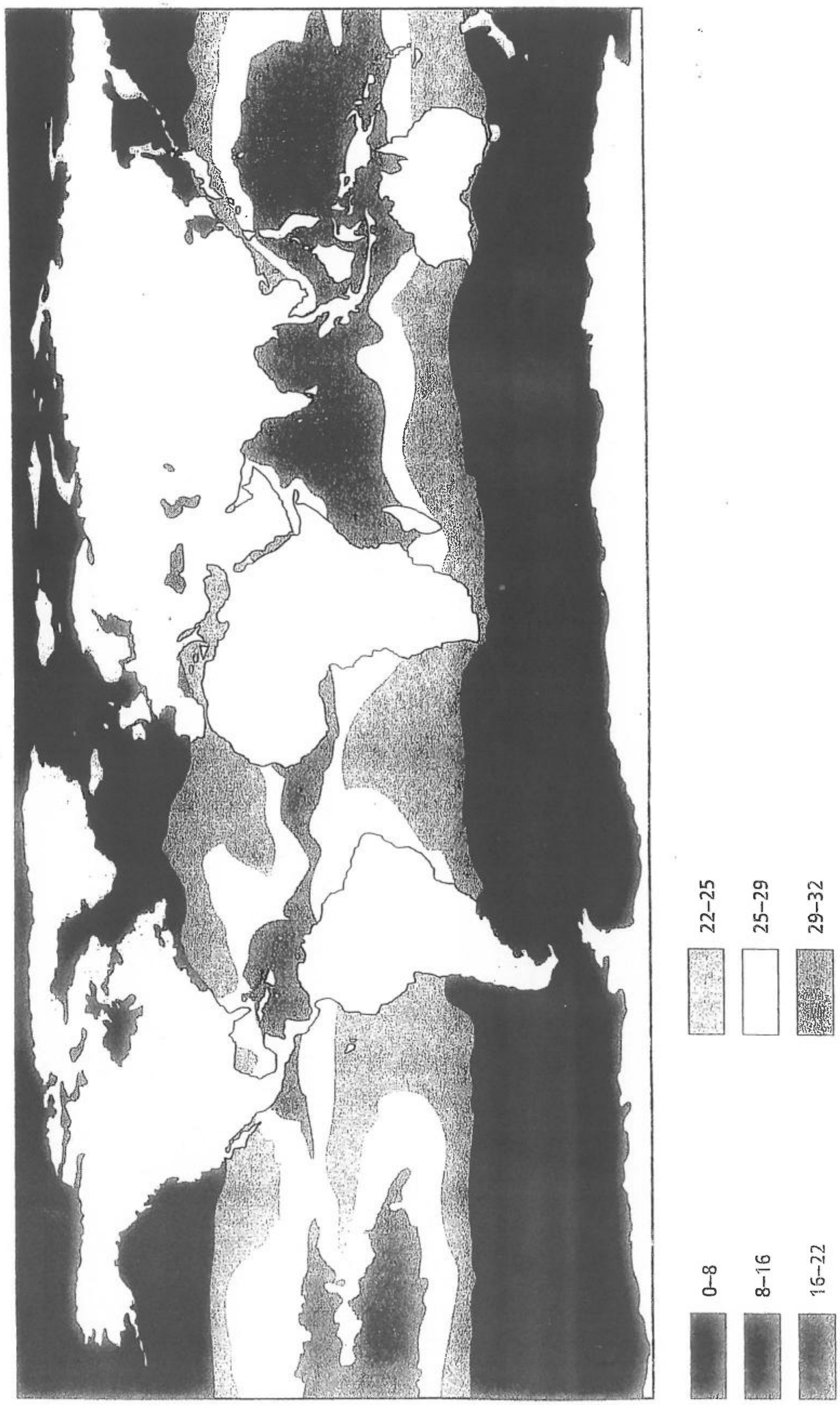
PROCEDURE

1. Study the map, which shows ocean surface temperatures in October 2000. Compare it to a globe.
2. Use the globe to label the oceans and the continents on the map. Add latitude and longitude coordinates to the map. Also label north, south, east, and west on the map.

Name Class Date

LAB 15.1 MAPPING

DATA AND OBSERVATIONS



Name ______________________ Class ______________________

ANALYZE

1. What is the range of ocean surface temperatures shown in the scale on the map?

2. Look for and describe patterns on the map. For example, which surface temperature or range of temperatures appears to be most common?

3. What is the surface temperature of the ocean nearest to the place you live? Convert this temperature to the Fahrenheit scale.

4. Describe how ocean surface temperatures change from the northern Pacific Ocean southward to Antarctica.

CONCLUDE AND APPLY

1. Where are the coldest surface temperatures found? Where are the warmest found? What accounts for these differences in temperature?

2. Global warming is an increase in global temperatures caused by increases in certain atmospheric gases. How might scientists use maps such as the one in this lab to analyze global warming? What might be some other uses of this map?

3. How might this map change if the satellite data were gathered in February? In July?

Name Class Date

Use with Section 11.2

Temperature Inversion

In some cities, the weather report often warns of high air-pollution levels. People are asked not to drive unless it is absolutely necessary, and open fires and barbecues are forbidden. A frequent reason for high levels of air pollution near the ground is a temperature inversion in the atmosphere. Although temperature and pressure in the overall troposphere decrease with height, the temperature inversion is an exception to this rule.

PREPARATION

PROBLEM

How can you detect a temperature inversion, and how does it trap pollution?

OBJECTIVES

- **Graph** temperature data for the atmosphere.
- **Describe** how a temperature inversion affects ground-level pollution.

MATERIALS

ruler
calculator

PROCEDURE

1. Use Box 1 to graph data sets A and B. The horizontal axis will be height and the vertical axis will be temperature. Label these axes.
2. Look at the data sets and choose suitable ranges and intervals for the axes. Mark the axes accordingly.
3. Plot data set A on your graph. Connect the points with a solid line. Plot data set B on the same graph but connect the points with a dashed line.
4. Indicate on your graph which line represents which data set. Give the graph a title.
5. When air is heated, it expands. As air expands, the number of molecules in a particular volume, for example, 1 m^3, decreases. So the mass of air molecules per cubic meter—or its density—decreases. Because of this relationship, if the pressure of the air remains unchanged, then its density is inversely proportional to its temperature, provided the temperature is expressed in kelvins (K). The Kelvin scale starts at absolute zero, which corresponds to -273.15°C. To convert a temperature in degrees Celsius to kelvins, you simply add 273.15. Convert the temperatures in the table into kelvins.
6. You can work out the density of air at a particular height from the temperature data if you know the density of air at ground level.

PROCEDURE, *continued*

Density is inversely proportional to absolute temperature; therefore, the density at height x is equal to the density at ground level times the absolute temperature (kelvins) at ground level divided by the absolute temperature at height x. Use this information to calculate the density at each height for both data sets. Assume that the air density at ground level in both data sets is 1 kg/m^3.

7. Use Box 2 to make a graph of density versus height similar to the first graph you made.

DATA AND OBSERVATIONS

Table

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0	20.0			20.0		
100	19.5			19.3		
200	18.7			18.8		
300	18.0			18.0		
400	17.5			19.0		
500	16.9			19.5		
600	16.0			19.4		
700	15.5			18.8		

Box 1

Name ______________________ Class __________ Date __________

Box 2

ANALYZE

1. For data set A, does the temperature increase or decrease as height increases? At what altitude does the temperature first change by 1°C?

2. At what point do the two plotted lines from data sets A and B intersect?

3. Describe the plotted data of set B above 300 m.

4. Which data set shows normal conditions and which shows a temperature inversion?

5. In the data set with the temperature inversion, use your graph in Box 2 to compare the density in two regions: 300–500 m and 500–700 m.

Name Class Date

CONCLUDE AND APPLY

1. Air pollutants tend to move from more dense regions toward less dense regions. What does this imply for the movement of air pollutants in the data set with the temperature inversion?

2. At what height would you expect to find the greatest concentration of air pollutants in the data set with the temperature inversion?

3. In your own words, summarize how temperature inversions increase air pollution at ground level.

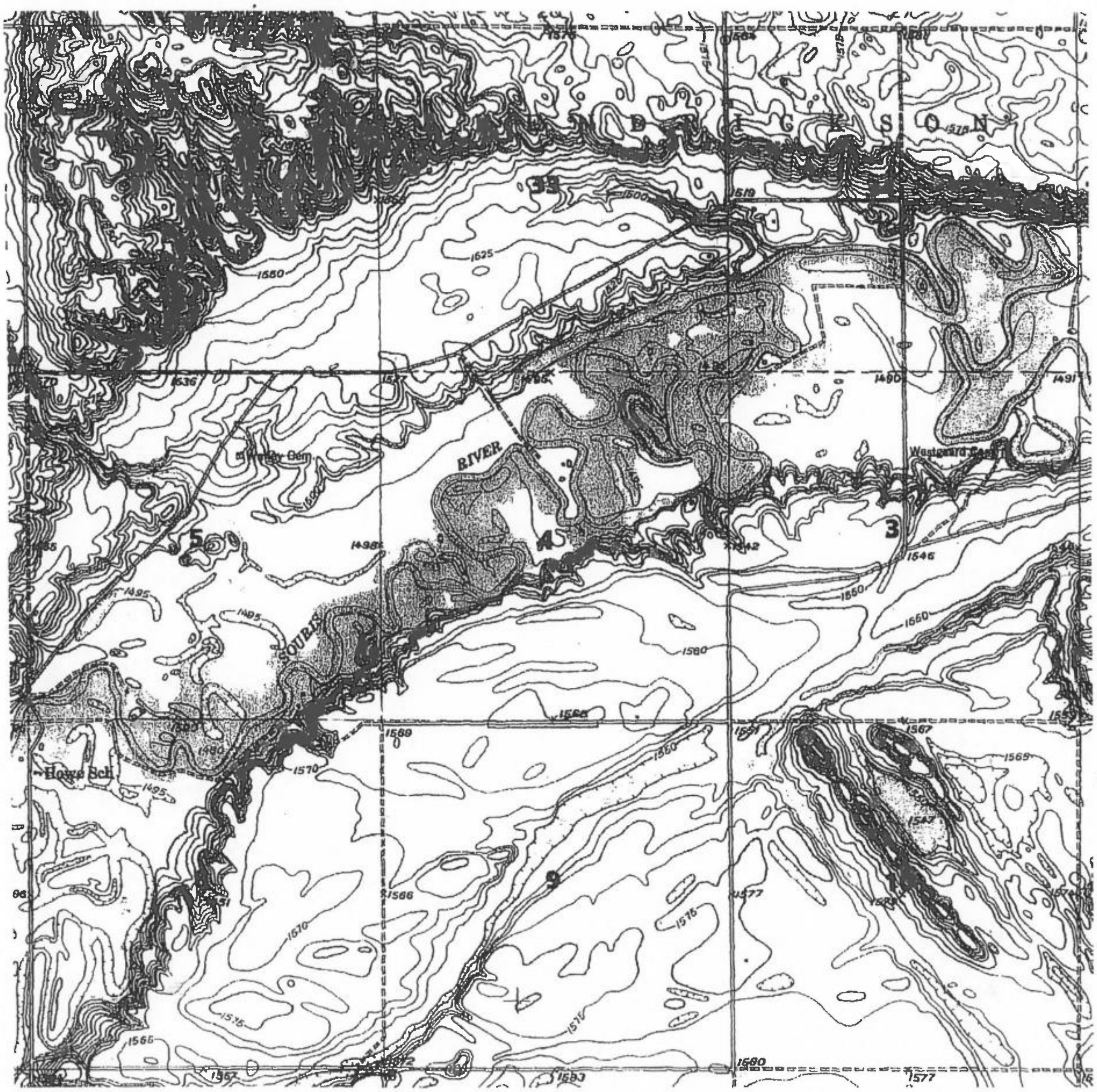
Name Class Date

LAB 9.2 MAPPING

Interpreting a River's Habits

Use with Section 9.2

All stream systems generally start from rain running off the land. A stream develops further, depending on the amount of available water, the slope of the land, and the underlying type of bedrock. Fast-moving streams follow a straighter path than do slow-moving streams, which tend to form meanders. Oxbow lakes often form from meandering streams and rivers. Below is a topographic map of the Souris River valley in north-central North Dakota. This area was under a continental glacier during the ice ages. The surface is largely covered with moraine deposits.



Contour interval: 5 feet
Scale: 1 inch = 2000 feet

2000 ft 4000 ft 6000 ft 8000 ft

Name Class Date

PREPARATION

PROBLEM

What can a topographic map tell about a river and its surroundings?

MATERIALS

ruler

OBJECTIVES

Use a topographic map to answer questions about a river and its valley.

PROCEDURE

1. The topographic map has a contour interval of 5 feet. The scale is 1 inch for 2000 feet. Study the map and answer questions 1–4 in the table.
2. The river drops about 2 feet in elevation across the map. Determine the gradient and answer questions 5–7.
3. Examine the floodplain of the river. Notice that the contour lines along the river run into one another. This indicates that natural levees occur and that at some places they are at least 5 feet high. Answer questions 8–10.
4. Notice that there are numerous elongated depressions in the floodplain. Answer question 11.
5. Examine the structures across the top of the map in sections 32, 33, and 34. Answer questions 12 and 13.

Name Class Date

DATA AND OBSERVATIONS

Table

Questions	[illegible]
1. What is the approximate difference between the lowest point and the highest elevation?	
2. What is the straight-line distance from where the river enters the map to where it leaves the map?	
3. What is the approximate length of the river's course that you can see on the map?	
4. What does the difference between the two distances in questions 2 and 3 tell you about the river's gradient?	
5. What is the river's gradient per 100 feet?	
6. What is the river's gradient per mile?	
7. Estimate the rate at which the river flows: very slowly, slowly, or rapidly.	
8. Approximately how wide is the floodplain of the river?	
9. What happened just east of Westgaard Cemetery in section 3?	
10. Has what you described in question 9 occurred anywhere else on the map? If so, where?	
11. What are the depressions in the floodplain called?	
12. Is there any evidence of erosion in sections 32, 33, and 34?	
13. Is there any evidence of other stream valleys?	

ANALYZE

1. How is a structure like the one identified in question 9 formed?

2. What do you suspect is the origin of the generally flat land between the present floodplain bluff and the steep bank in the northern third of section 33 and most of section 32?

CONCLUDE AND APPLY

1. From your interpretation of the topographic map, describe the Souris River's shape, flow rate, and amount of downcutting into the bedrock.

2. Describe the geography around the Souris River.

3. What do you think the overall rain pattern in this area might be: little rain, moderate, or heavy? Support your answer with an explanation.

Water Usage

According to the United States Geological Survey (USGS), the government agency that oversees United States water supplies, the United States has abundant freshwater resources. However, many existing sources of groundwater and surface water, such as wells, lakes, and reservoirs, are in danger of being overused, and drought is a problem in some areas. The economic and environmental health of the country—and of the entire planet—depends, in part, on maintaining a balance between water demand and water supply.

PREPARATION

PROBLEM

How has water usage changed in the United States since 1950?

OBJECTIVES

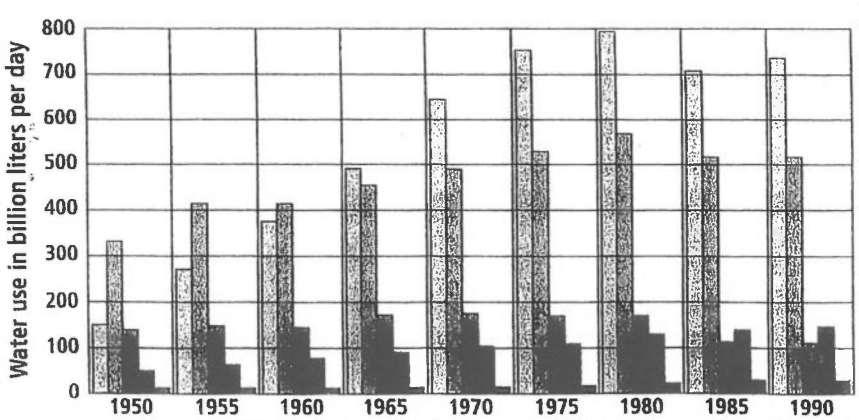
- **Analyze** changing trends in water usage over a 40-year period.
- **Determine** which categories use the most water per day.
- **Discuss** conservation methods that might decrease water use.

MATERIALS

calculator

PROCEDURE

1. Study the bar graph, based on data from the USGS. Look for patterns in water usage. Do certain categories consistently use more water than others? Have some categories increased their water use more quickly than others?
2. Create a data table based on the graph. Place the nine time periods across the top of the table. List the five categories on the left side of the table. In the rows, write the total amount of water used per day by each category for the years listed.
3. Calculate the total amount of water used per day by all categories for each year. Add this information to the data table.



Name Class Date

DATA AND OBSERVATIONS

Data Table

ANALYZE

1. Approximately how many billions of liters of water were used per day in the United States in 1990? How does this amount compare to total water usage in 1950?

2. Which category showed the greatest increase over the course of the 40 years shown in the graph? What might account for the increase?

3. Which category showed a decrease in water use over the course of 40 years? What might account for the decrease?

4. When did water usage peak in the United States for most categories? Which categories continued to show an increase? Make a hypothesis for the reasons behind the increase.

5. Which two categories consistently account for most water usage in the United States? How much water did these categories use in 1980?

6. Describe how water might be used for each category in the graph.

CONCLUDE AND APPLY

1. The 1990 population of the United States was about 252 million. Use the amount listed in the "Public supply" category for 1990 to calculate the average amount of water each United States citizen used daily.

2. In 1995, total United States water use was about 1520 billion L per day. Add this information to your data table. In your own words, describe the overall trend in water usage in the United States from 1950 to 1995.

3. Think of all the ways that you use water each day. Describe at least three things that you could do as an individual to decrease your daily water use. Identify two things that government or industry could do to decrease water use.

Name ________________ Class ________ Date ________

LAB 9.1

Use with Section 9.1

Analyzing Watersheds

A watershed is the land area whose water drains into a particular stream system. Any pollutants from the surface or in the groundwater will find their way into wells, surface streams, and lakes in a watershed. A watershed is also affected by any construction that disrupts its drainage pattern. You can gauge the health of a watershed by looking at condition indicators and vulnerability indicators. A condition indicator represents present conditions, such as contaminated sediments and groundwater that contains chemicals. Vulnerability indicators represent conditions that may adversely affect the watershed in the future, such as large human populations and the potential for agricultural runoff.

PREPARATION

PROBLEM

Determine the health of a watershed by analyzing indicators and establish goals to improve the health of the watershed.

OBJECTIVES

- **Examine** maps showing condition and vulnerability indicators.
- **Analyze** maps and establish a watershed health report.
- **Develop** a list of goals aimed at reversing damage and improving the health of the watershed.

MATERIALS

ruler
colored markers

PROCEDURE

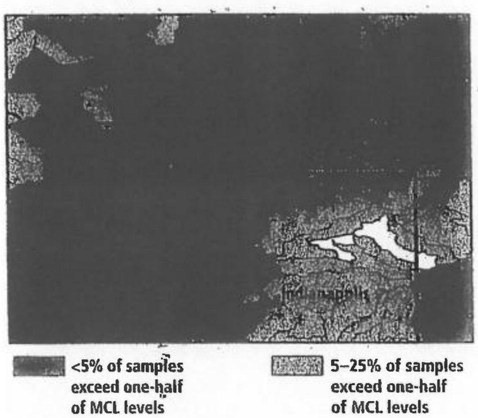


Figure 1. Chemicals from many different sources in the groundwater. Before the water is used, many of these chemicals will be filtered out or neutralized. (1997)

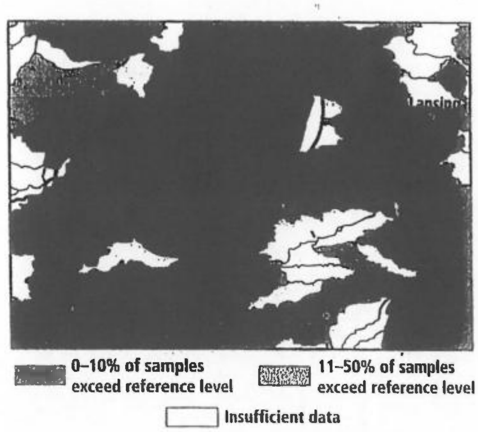


Figure 2. Copper, chromium, nickel, and zinc in the groundwater. Consumption of high concentrations of these chemicals causes illness or death. (1997)

Name Class Date

PROCEDURE, *continued*

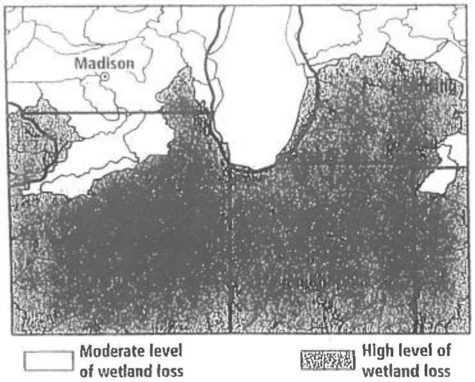


Figure 3. Wetlands lost because of human use. Wetlands make important contributions to the health of a watershed by purifying water, filtering runoff, abating floods, and decreasing erosion. (1997)

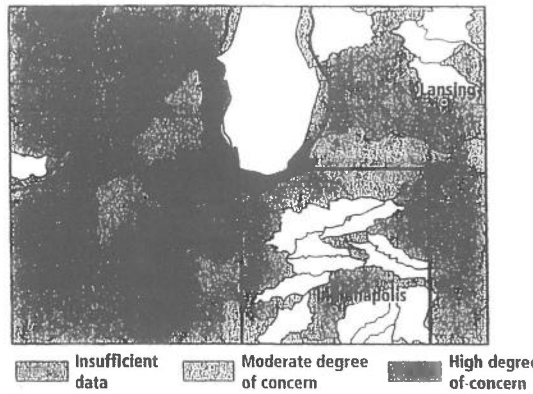


Figure 4. Chemicals found in bottom sediments. These chemicals can harm or kill bottom-dwelling organisms. They can also accumulate in organisms and move up the food chain to fish, shellfish, and humans. (1997)

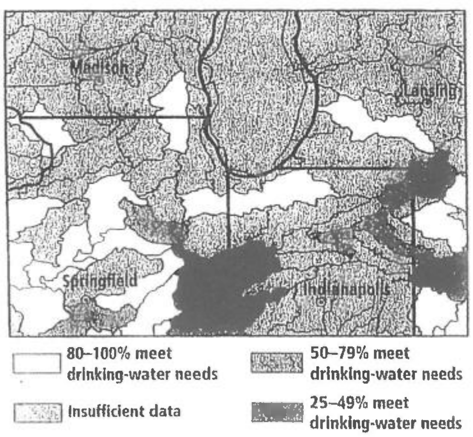


Figure 5. Watersheds that meet drinking-water needs of a human population. (1997)

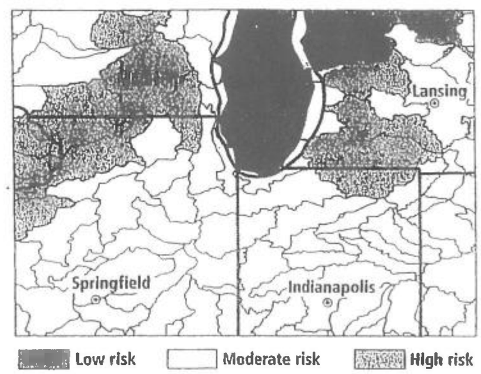


Figure 6. Fish advisories issued for the watershed. Advisories indicate the accumulation of toxic substances in fish and shellfish, making them unsafe for human consumption. (1997)

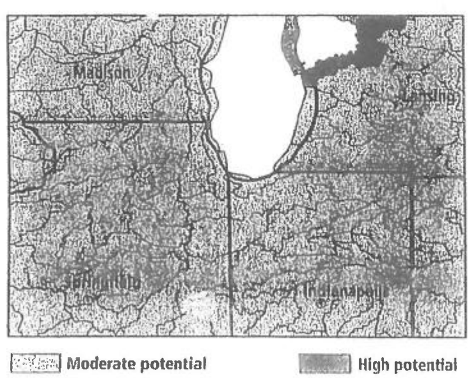


Figure 7. Pesticide runoff from farms. Watersheds with high scores are at greater risk of contamination of surface water by pesticides. (1997)

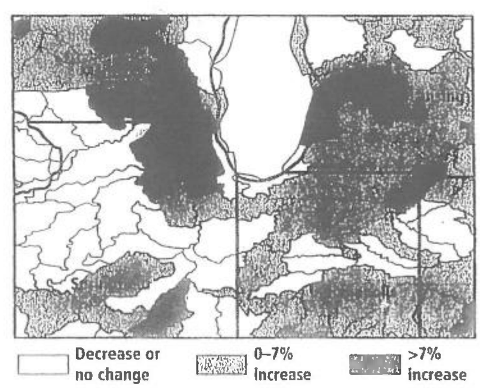


Figure 8. Growth of human population. Population increases can result in increased pollution of the water. (1997)

Name Class Date

LAB 9.1

PROCEDURE, *continued*

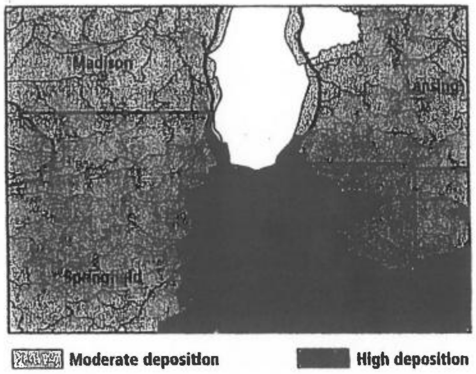


Figure 9. Atmospheric deposition of nitrogen. Nitrogen and phosphorus are nutrients that can cause algal and cyanobacterial blooms and other problems in surface water and groundwater. (1997)

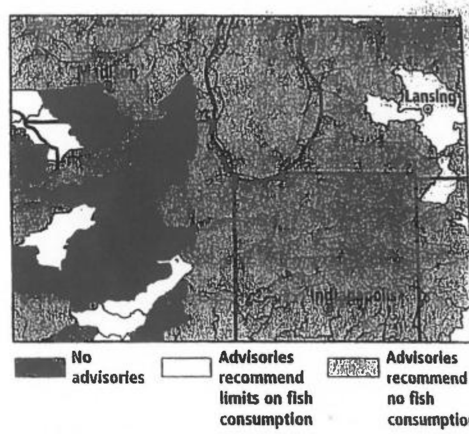


Figure 10. Nitrate risk from various sources, such as fertilizers, atmospheric deposition, and karst aquifers. (1997)

1. Examine the six condition indicators (Figures 1–6) and four vulnerability indicators (Figures 7–10). Each irregular area on the map represents a watershed.
2. Pick one watershed and draw around its perimeter on each map. This will be the watershed that you examine for each indicator.
3. Analyze each condition indicator. In Figure 11, draw a bar for each condition indicator to represent your interpretation of the map.
4. Analyze each vulnerability indicator. Draw a bar for each vulnerability indicator in Figure 12.

DATA AND OBSERVATIONS

Figure 11 Condition Indicators

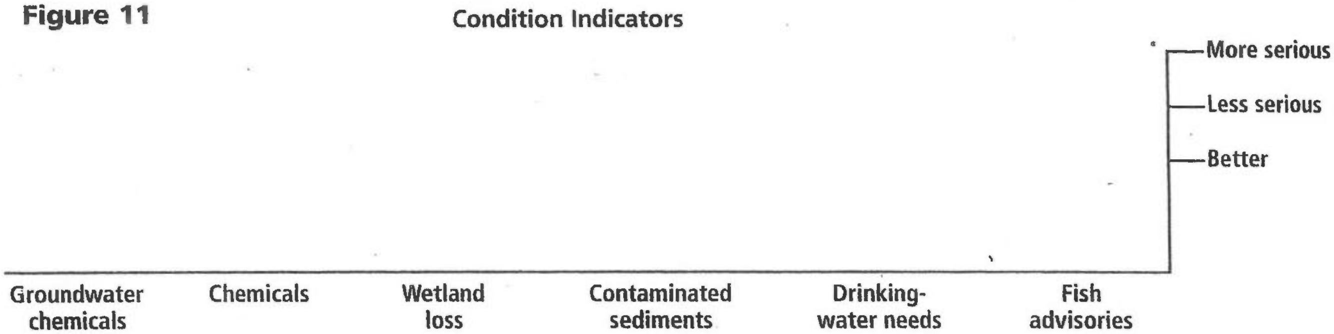
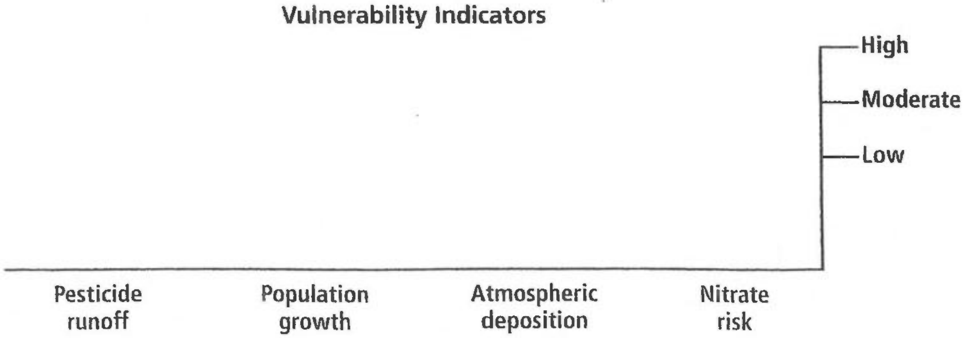


Figure 12. Vulnerability Indicators



Name _______________ Class _______ Date _______

ANALYZE

1. Write a short narrative describing the present condition of the watershed that you chose.

2. Describe the vulnerability of the watershed.

3. Are the watershed conditions similar to those of surrounding watersheds? Why do you suppose they are or are not?

CONCLUDE AND APPLY

1. Taking into consideration the many pressures on the watershed you chose, predict what will happen if conditions remain the same for the next 50 years.

2. What is your assessment of most of the watersheds that appear on the maps of condition and vulnerability indicators?

3. If you were the governor of the state in which these watersheds are located, what specific goals would you set up to improve the health of the citizens?

Name ____________________ Class ______ Date ______

LAB 7.2

Use with Section 7.3

Global Soils and Climate

Soil is one of our most important natural resources. Humans and other animals depend on plants, which usually grow in soil, for their food and shelter. Except for some mountainous terrain and extremely cold areas on Earth, soil is found everywhere. Soil formation depends on the weathering of bedrock. The type and amount of weathering is closely related to the local climate. Because soils form from different parent bedrock and undergo different climatic conditions, soils vary greatly from one place to another.

PREPARATION

PROBLEM
Are soil types influenced by precipitation and temperature?

OBJECTIVES
- **Use** maps to **compare** climate and soils in different regions.
- **Relate** regional soil types to temperature and rainfall.

MATERIALS
ruler

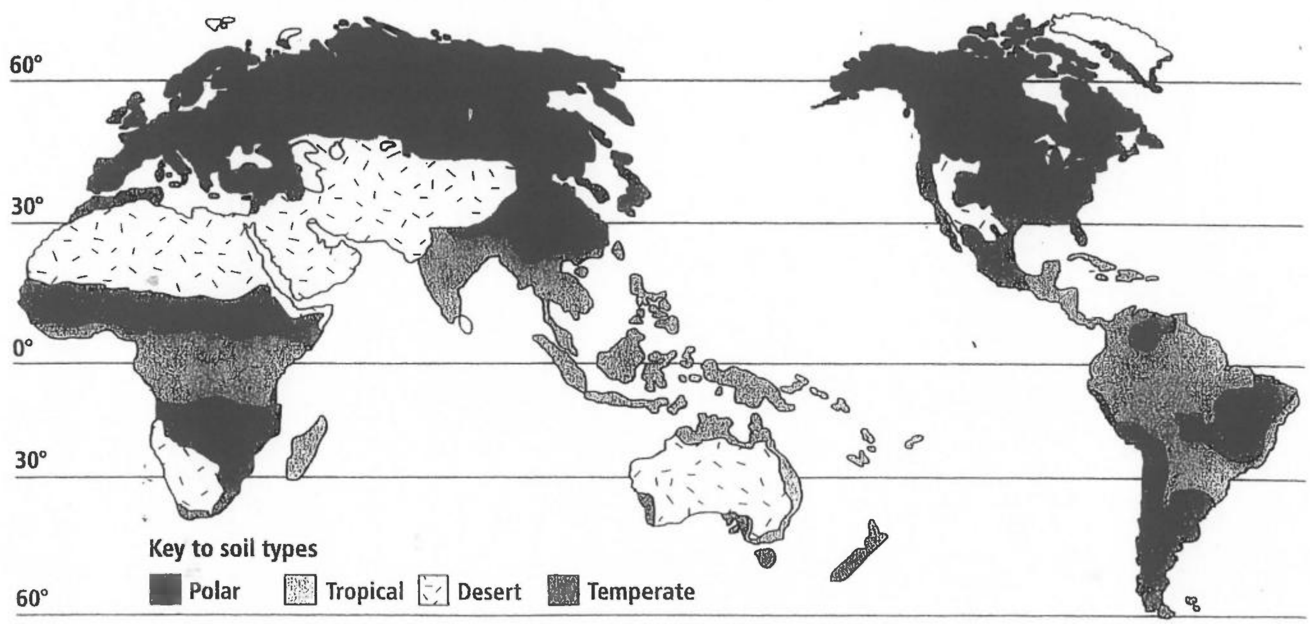


Figure 1

LAB 7.2 MAPPING

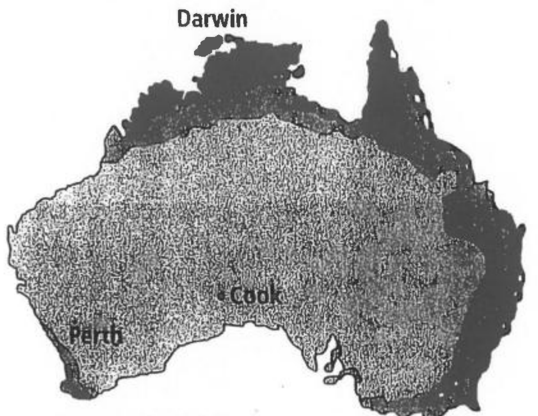


Figure 2

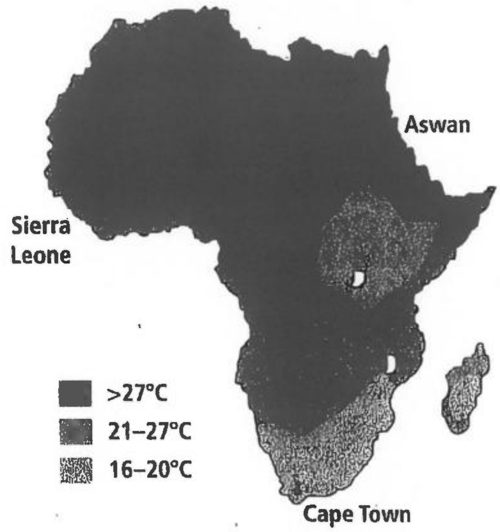


Figure 3

PROCEDURE

1. Examine Figure 1. The map covers roughly 70°N to 60°S latitude. Notice the key to the four soil types.
2. Estimate the range of latitudes for polar soils, and record your estimate in Table 1.
3. Estimate and record the range of latitudes for tropical soils.
4. Estimate and record the range of latitudes for temperate soils in the northern hemisphere.
5. Examine Figure 2, an annual rainfall map of Australia. In Table 2, record the range of rainfall for the cities of Perth, Cook, and Darwin.
6. Examine Figure 3, a typical temperature day during the summer in Africa. Record the range of temperatures in the cities of Sierra Leone, Aswan, and Cape Town.

Name ______________________ Class ________ Date ________

LAB 7-2

DATA AND OBSERVATIONS

Table 1

Soil Type	Range of Latitudes
Polar	
Tropical	
Northern temperate	

Table 2

City	Range of Rainfall
Perth	
Cook	
Darwin	
	Range of Temperature
Sierra Leone	
Aswan	
Cape Town	

ANALYZE

1. At what latitudes in the northern and southern hemispheres are desert soils found?

____

____

2. What might be the reason for polar soils reaching down to about 40°N in the United States, while in the rest of the world they stay up around 50°N?

____

____

3. Compare the rainfall pattern in Australia to the soil types found there.

____

____

____

____

____

Name ___ Class ___ Date ___

ANALYZE, *continued*

4. Compare the temperature map of Africa with the soil types found in that country.

CONCLUDE AND APPLY

1. Are the soil types found in different areas of Earth related to the climate of that area? Explain your answer.

2. Are the soil types more closely related to temperature or to rainfall?

3. If you had to predict the type of soil found in an area on Earth, what information would you seek?

Cool Climate Graphs

Problem

According to climate data, what is the best time of year to visit various cities to enjoy particular recreational activities?

Skills Focus

graphing, interpreting data

Materials

calculator

ruler

3 pieces of graph paper

black, blue, red, and green pencils

Climate Regions map in textbook

U.S. map with city names and latitude lines

Procedure

1. Work in groups of three. Each person should graph the data in your textbook for a different city, A, B, or C.
2. On graph paper, use a black pencil to label the axes as on the sample climate graph shown in your textbook. Title your climate graph City A, City B, or City C.
3. Use your green pencil to make a bar graph of the monthly average amount of precipitation. Place a star below the name of each month that has more than a trace of snow.
4. Use a red pencil to plot the average monthly maximum temperature. Make a dot for the temperature in the middle of each space for the month. When you have plotted data for all 12 months, connect the points with a smooth curved line.
5. Use a blue pencil to plot the average monthly minimum temperature for your city. Use the same procedure as in Step 4.
6. Calculate the total average annual precipitation for this city and include it in your observations. Do this by adding the average precipitation for each month.

Cool Climate Graphs *(continued)*

Analyze and Conclude

Write an answer for each question in the space provided. Use all three climate graphs, plus the graph for Washington, D.C., in your textbook to answer questions 1–4.

1. **Interpreting Data** Which of the four cities has the least change in average temperatures during the year?

   ____

2. **Interpreting Maps** Use the **Climate Regions** map in your textbook to help find the climate region in which each city is located.

   ____

   ____

3. **Applying Concepts** Which of the cities listed below matches each climate graph?

Colorado Springs, Colorado	latitude 39° N	____________
San Francisco, California	latitude 38° N	____________
Reno, Nevada	latitude 40° N	____________

4. **Inferring** The four cities are at approximately the same latitude. Why are their climate graphs so different?

   ____

   ____

5. **Graphing** What factors do you need to consider when setting up and numbering the left and right *y*-axes of a climate graph so that your data will fit on the graph?

   ____

   ____

   ____

6. **Communicating** Imagine that you are writing a travel brochure for one of the four cities. Write a description of the climate of the city and discuss the best time to visit to do a selected outdoor activity.

   ____

   ____

   ____

   ____

   ____

More to Explore

What type of climate does the area where you live have? Find out what outdoor recreational facilities your community has. How is each one particularly suited to the climate of your area?

Cool Climate Graphs

Problem

Based on climate data, what is the best time of year to visit various cities to enjoy particular recreational activities?

Skills Focus

graphing, interpreting data

Materials

- calculator
- ruler
- 3 pieces of graph paper
- black, blue, red, and green pencils
- climate map on pages 626–627
- U.S. map with city names and latitude lines

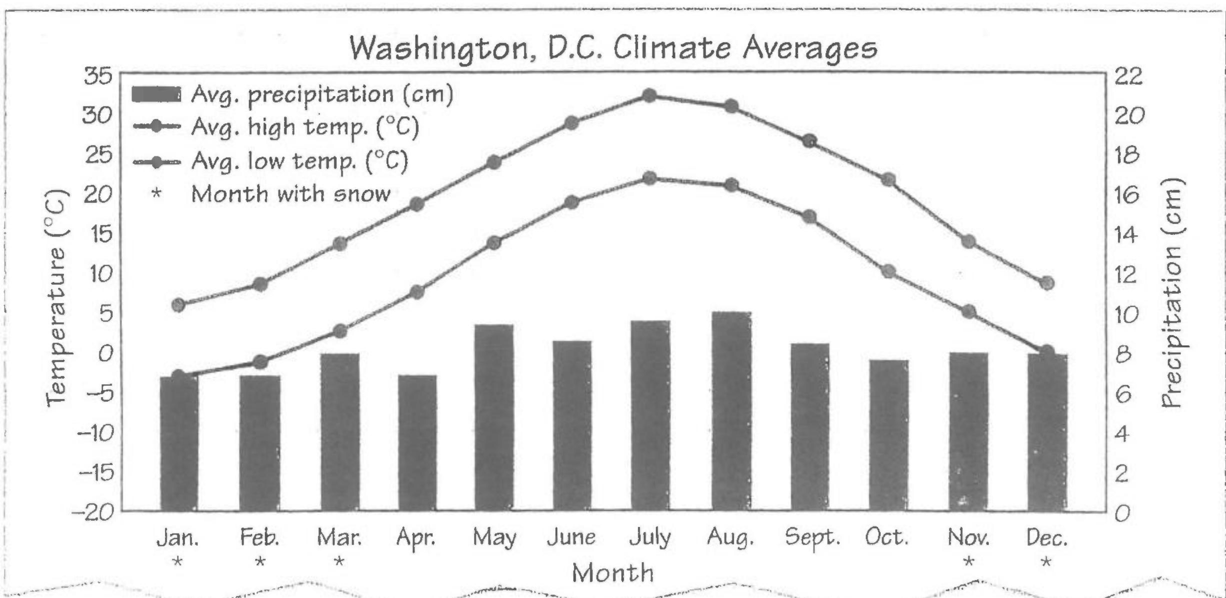
Procedure

1. Work in groups of three. Each person should graph the data for a different city, A, B, or C.
2. On graph paper, use a black pencil to label the axes as on the climate graph below. Title your climate graph City A, City B, or City C.
3. Use your green pencil to make a bar graph of the monthly average amount of precipitation. Place a star below the name of each month that has more than a trace of snow.
4. Use a red pencil to plot the average mont maximum temperature. Make a dot for tl temperature in the middle of each space the month. When you have plotted data all 12 months, connect the points into a smooth curved line.
5. Use a blue pencil to plot the average monthly minimum temperature for your c Use the same procedure as in Step 4.
6. Calculate the total average annual precipi tion for this city and include it in your obs vations. Do this by adding the average precipitation for each month.

Analyze and Conclude

Use all three climate graphs, plus the graph fo Washington, D.C., to answer these questions.

1. **Interpreting Data** Which of the four cities h the least change in average temperatures during the year?
2. **Interpreting Maps** Use the map on pages 626–627 to help find the climate region in which each city is located.



Climate Data

Washington, D.C.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average High Temp. (°C)	6	8	14	19	24	29	32	31	27	21	14	8
Average Low Temp. (°C)	–3	–2	3	8	14	19	22	21	17	10	5	0
Average Precipitation (cm)	6.9	6.9	8.1	6.9	9.4	8.6	9.7	9.9	8.4	7.6	7.9	7.9
Months With Snow	*	*	*	trace	—	—	—	—	—	trace	*	*
City A	**Jan.**	**Feb.**	**Mar.**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Average High Temp. (°C)	13	16	16	17	17	18	18	19	21	21	17	13
Average Low Temp. (°C)	8	9	9	10	11	12	12	13	13	13	11	8
Average Precipitation (cm)	10.4	7.6	7.9	3.3	0.8	0.5	0.3	0.3	0.8	3.3	8.1	7.9
Months With Snow	trace	trace	trace	—	—	—	—	—	—	—	—	trace
City B	**Jan.**	**Feb.**	**Mar.**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Average High Temp. (°C)	5	7	10	16	21	26	29	27	23	18	11	6
Average Low Temp. (°C)	–9	–7	–4	1	6	11	14	13	8	2	–4	–8
Average Precipitation (cm)	0.8	1.0	2.3	3.0	5.6	5.8	7.4	7.6	3.3	2.0	1.3	1.3
Months With Snow	*	*	*	*	*	—	—	—	trace	*	*	*
City C	**Jan.**	**Feb.**	**Mar.**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Average High Temp. (°C)	7	11	13	18	23	28	33	32	27	21	12	8
Average Low Temp. (°C)	–6	–4	–2	1	4	8	11	10	5	1	–3	–7
Average Precipitation (cm)	2.5	2.3	1.8	1.3	1.8	1	0.8	0.5	0.8	1	2	2.5
Months With Snow	*	*	*	*	*	trace	—	—	trace	trace	*	*

3. **Applying Concepts** Which of the cities below matches each climate graph?
   Colorado Springs, Colorado; latitude 39° N
   San Francisco, California; latitude 38° N
   Reno, Nevada; latitude 40° N
4. **Inferring** The four cities are at approximately the same latitude. Why are their climate graphs so different?
5. **Graphing** What factors do you need to consider when setting up and numbering the left and right *y*-axes of a climate graph so that your data will fit on the graph?
6. **Communicating** Imagine that you are writing a travel brochure for one of the four cities. Write a description of the climate of the city and discuss the best time to visit to do a selected outdoor activity.

More to Explore

What type of climate does the area where you live have? Find out what outdoor recreational opportunities your community has. How is each activity particularly suited to the climate of your area?

Investigating Differences in Climate

Pre-Lab Discussion

Many factors are responsible for the different types of climates. However, each factor falls into one of two major categories: those that affect the average yearly temperature of an area and those that affect the average yearly precipitation. The amount of available energy helps determine the temperature of a region.

One measure of energy is evapotranspiration—the total water loss from the land through evaporation and transpiration. In transpiration, the surface of leaves and other plant parts gives off moisture. In this investigation, you will use the ratio of average yearly precipitation (P) to average yearly potential evapotranspiration (E_p). This climate ratio, written as P/E_p, represents the average yearly moisture supply divided by the moisture demand, or need, at a certain location. Four different climates, based on P/E_p, are arid, semiarid, subhumid, and humid. The table below lists each climate and its ratio.

Climate Ratios

P/E_p	Climate
less than 0.4	arid
0.4–0.8	semiarid
0.8–1.2	subhumid
greater than 1.2	humid

In this investigation, you will study how the relationship between available energy and moisture affects climate.

1. What conditions produce a "dry" climate?

____

2. Why might a cool place with low rainfall be less dry than a hotter place that gets the same amount of rain?

____

____

____

Investigating Differences in Climate *(continued)*

Problem

How can you use the ratio between precipitation and potential evapotranspiration to map different climates?

Materials *(per group)*

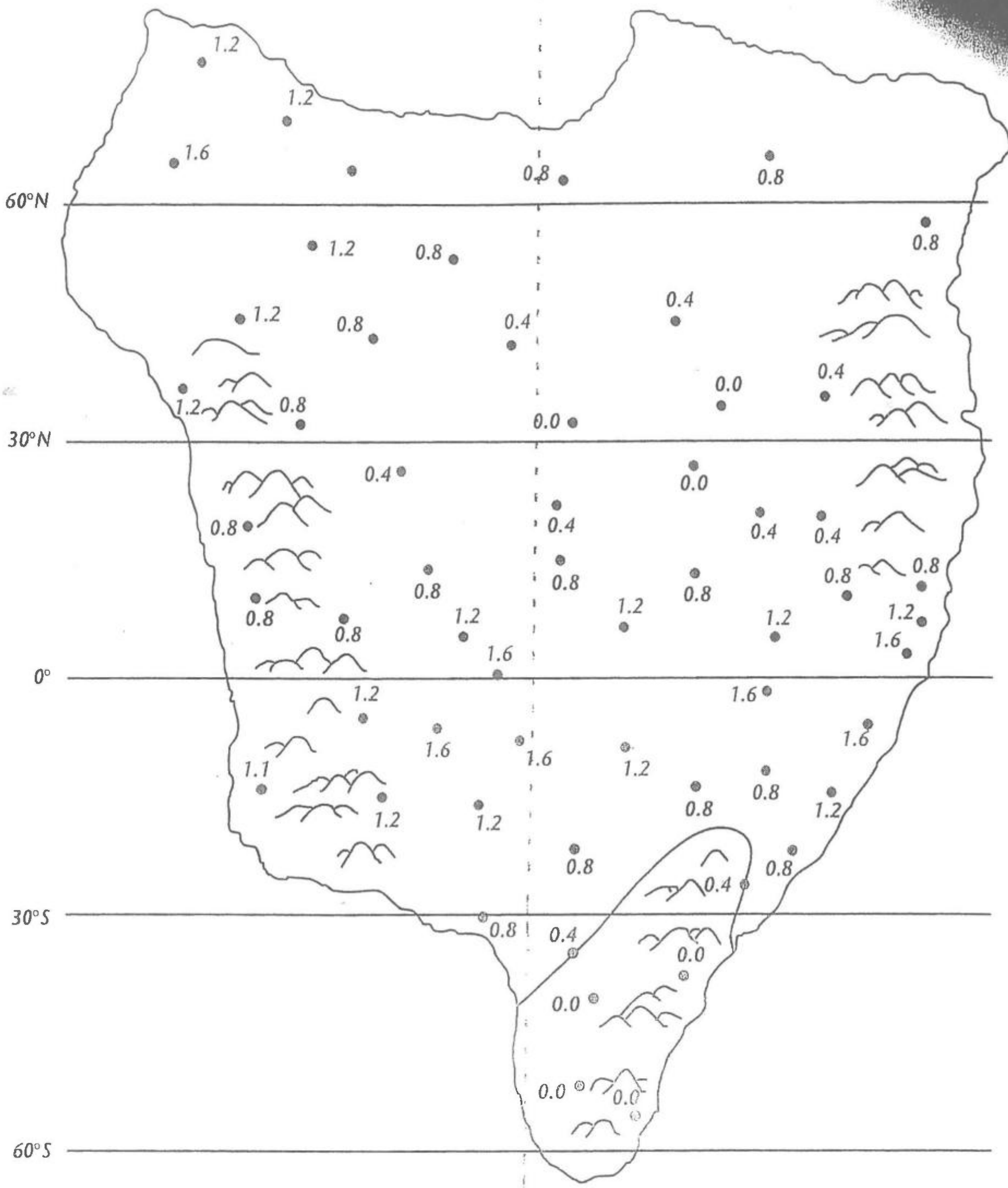
soft graphite pencil

colored pencils or crayons, four colors

Procedure

1. Carefully examine the map of Ert, an imaginary continent. The numbers at various locations are the climate ratios for those areas. Notice that Ert is very large, extending toward the poles beyond latitudes 60° N and 60° S. Notice also the extensive mountain range along the west coast, as well as two mountain ranges along the east coast.
2. Remember the following information when you are working on your map:
   - Climate ratios greater than 1.2 are usually in regions at or near the equator. These regions are generally humid.
   - Regions at or near latitudes 30° N and 30° S are generally arid, unless influenced by mountain ranges or other factors. Climate ratios of 0.4 or less are usually found in these regions.
   - Areas at or near latitudes 60° N and 60° S are generally moist but often have climate ratios that vary greatly because of the influence of global wind systems, large bodies of water, and mountain ranges.
   - The lines of two climate types cannot cross. They tend to run parallel to each other and do not form sharp edges or acute angles. Also, these lines must be continuous; that is, they must form closed loops or run off the edges of the continent.
3. Locate the regions on Ert that are most arid and most humid. Find the mountain ranges and lines of latitude.
4. Using a soft graphite pencil, lightly connect points with a 0.4 climate ratio. Notice that two regions have this climate ratio, one in each hemisphere. The 0.4 line in the Southern Hemisphere has been correctly drawn for you.
5. Lightly draw lines connecting points that have a 0.8 climate ratio. Then draw lines connecting points that have 0.0, 1.2, and 1.6 climate ratios.
6. Darken the contour lines and identify the areas as arid, semiarid, humid, or subhumid. For example, regions between lines 0.4 and 0.8 are semiarid. Make each type of region on your map a different color. Add a color key that identifies the climate.

Ert: A Continent



Investigating Differences in Climate *(continued)*

Observations

1. Describe the general locations of the regions of Ert that are most humid.

____

____

____

2. Describe the general locations of the regions of Ert that are most arid.

____

____

____

Analyze and Conclude

1. How can two regions with the same total yearly precipitation have different climate ratios?

____

____

____

2. How can two regions with the same total yearly temperature have different climate ratios?

____

____

____

3. What relationship exists between latitude and temperature patterns?

____

____

____

tical Thinking and Applications

Suppose the mountains on the west coast of Ert between 0° and 30° S did not exist. How would you expect the climate in those latitudes to be different, if it changed at all?

What areas on Ert would you expect to be the most heavily populated? Give a reason for your answer.

3. In which of the four climatic regions would you prefer to live? Give reasons for your answer.

4. How does the climate where you live affect the type of clothing people wear?

The types of plants or animals that are raised for food?

The recreational activities?

The amount of energy consumed?

Name Class Date

Mapping GeoLab Use a Topographic Map

Topographic maps show two-dimensional representations of Earth's surface. With these maps, you can determine the slope a hill, what direction streams flow, and where mines and other features are located. In this lab, you will use the topographic map on the following page to determine elevation for several routes and to create a profile showing elevation.

PREPARATION

Problem

How can you use a topographic map to interpret information about an area?

Materials

ruler

string

piece of paper

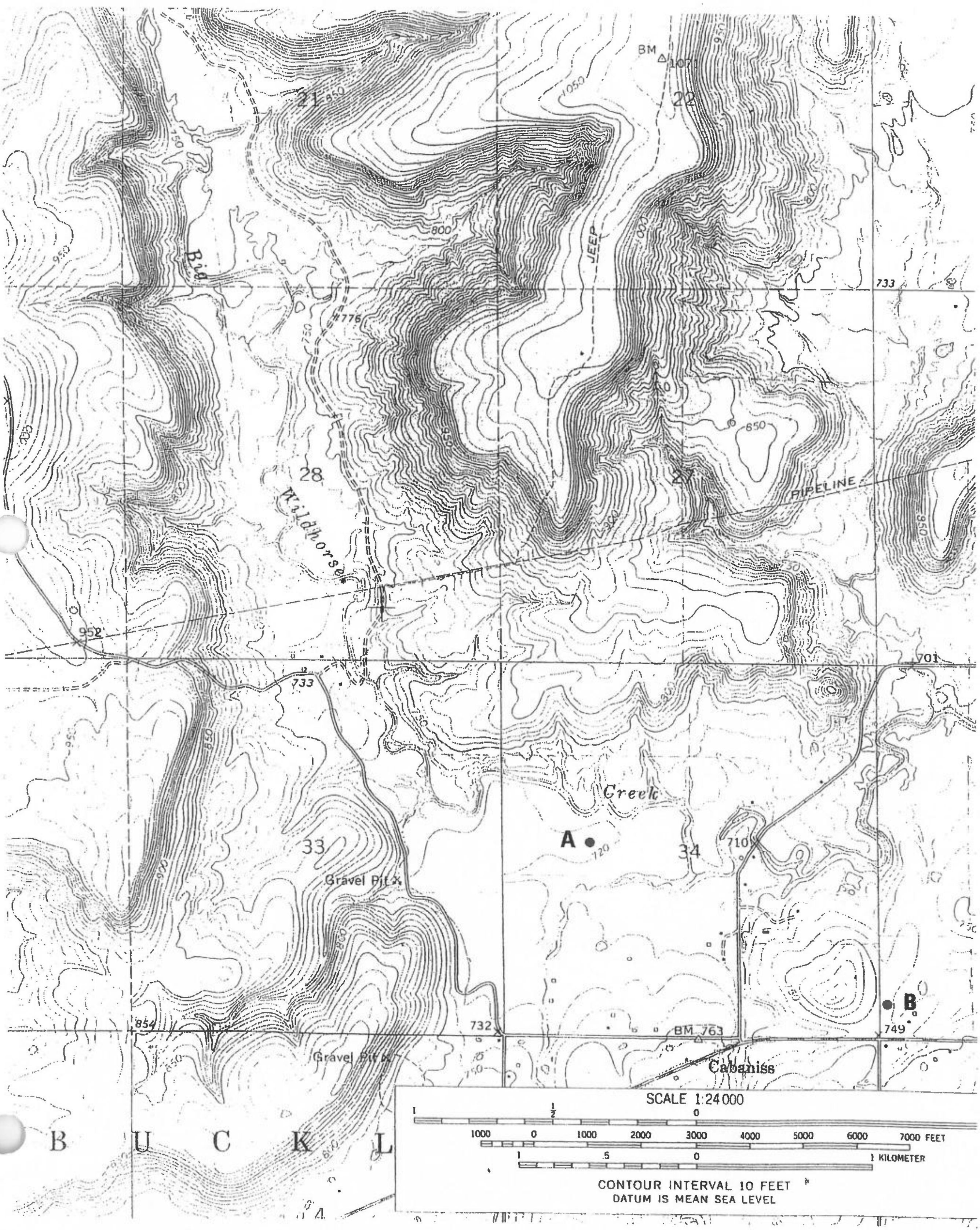
PROCEDURE

1. Read and complete the lab safety form.
2. Take a piece of paper and lay it on the map so that it intersects Point A and Point B.
3. On this piece of paper, draw a small line at each place where a contour line intersects the line from Point A to Point B. Also note the elevation at each hash mark and any rivers crossed.
4. Copy the table shown on this page into your science journal.
5. Now take your paper where you marked your lines and place it along the base of the table.
6. Mark a corresponding dot on the table for each elevation.
7. Connect the dots to create a topographic profile.
8. Use the map to answer the following questions. Be sure to check the map's scale.
9. Use the string to measure distances between two points that are not in a straight line. Lay the string along curves, and then measure the distance by laying the string along the ruler. Remember that elevations on United States Geological Survey (USGS) maps are given in feet.

	820
	810
	800
	790
	780
	770
	760
	750
	740
	730
	720
	710
	700

Name Class Date

Mapping GeoLab Use a Topographic Map



Mapping GeoLab Use a Topographic Map

ANALYZE AND CONCLUDE

1. What is the contour interval?

2. Identify what type of map scale the map utilizes..

3. Calculate the stream gradient of Big Wildhorse Creek from the Gravel Pit in Section 21 to where the creek crosses the road in Section 34.

4. What is the highest elevation of the jeep trail? If you followed the jeep trail from the highest point to where it intersects an unimproved road, what would be your change in elevation?

5. If you started at the bench mark (BM) on the jeep trail and hiked along the trail and the road to the Gravel Pit in Section 21, how far would you have hiked?

6. What is the straight-line distance between the two points in Question 4? What is the change in elevation?

7. Does Big Wildhorse Creek flow throughout year? Explain your answer.

8. What is the shortest distance along roads from the Gravel Pit in Section 21 to the secondary highway?

INQUITY EXTENSION

Make a Map Using what you have learned in this lab, create a torographic map of your hometown. For more information on topographic maps, visit glencoe.com.

LAB 1.1

Use with Section 1.2

Observing and Analyzing Stream Flow

One way that scientists learn about the world is by modeling natural phenomena and observing and describing what happens. For example, Earth scientists can model how flowing water moves soil by using a stream table, which is a large, shallow pan that is propped at an angle and partly filled with sand or other material (Figure 1). Water is allowed to flow from the higher end of the stream table down through the sand to the lower end of the table. By observing the water's path and its effects on the sand and by altering the rate of water flow, scientists can learn a great deal about stream development.

PREPARATION

PROBLEM

What conclusions can you draw about some of the processes represented in a stream table?

OBJECTIVES

- **Observe** a model of natural phenomena.
- **Communicate** observations clearly and accurately.
- **Choose** criteria to classify observed phenomena.

MATERIALS

pen or pencil
Figures 2–7 in lab manual

PROCEDURE

1. Examine Figures 2–7. They are diagrams of stream development as modeled on a stream table. The table shown is about 4 meters long and 1 meter wide. Before the modeling began, a mass of sand sloped gently and smoothly from the back of the table to about the halfway point on the table. The figures show the water's path and the transport and deposition of sand that occurred as water trickled from a spigot for 2 days.
2. Write a detailed description in the Analyze section on page 3 of what you observe in the figures.

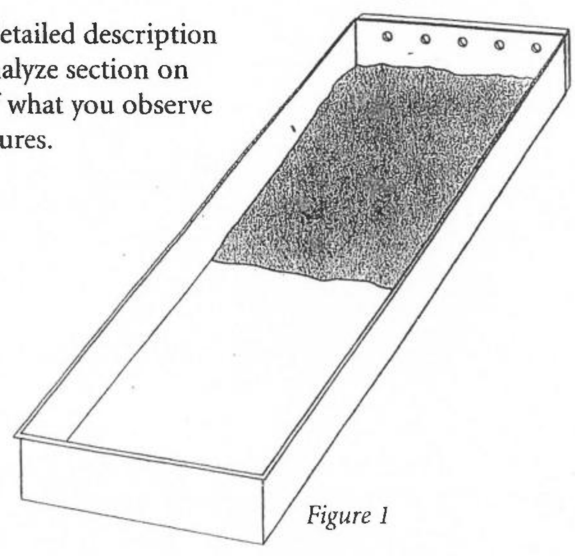


Figure 1

Name Class Date

INVESTIGATION

DATA AND OBSERVATIONS

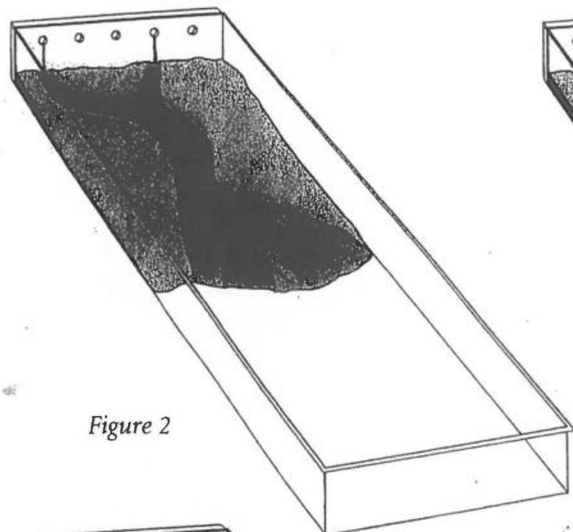


Figure 2

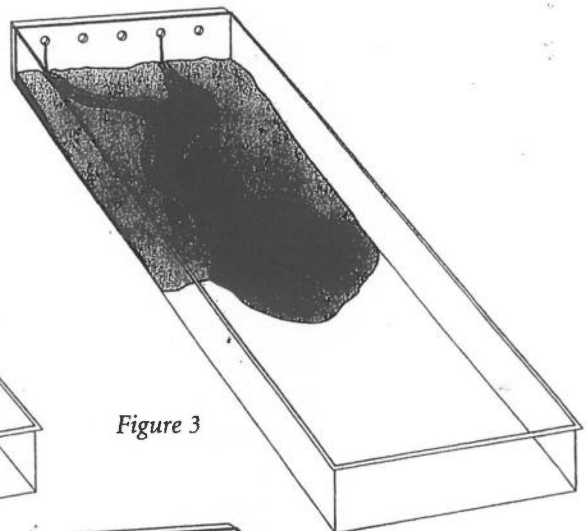


Figure 3

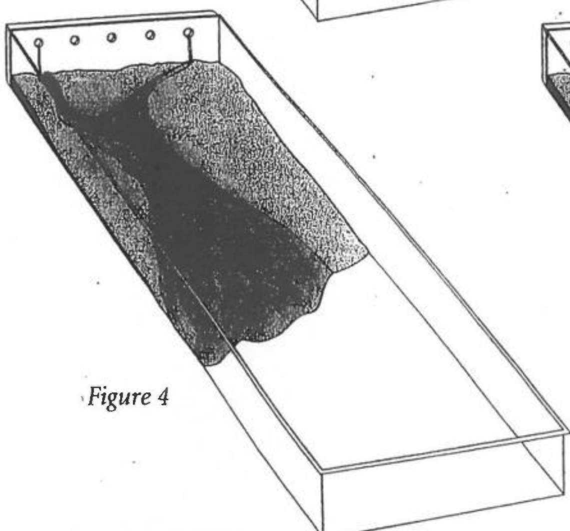


Figure 4

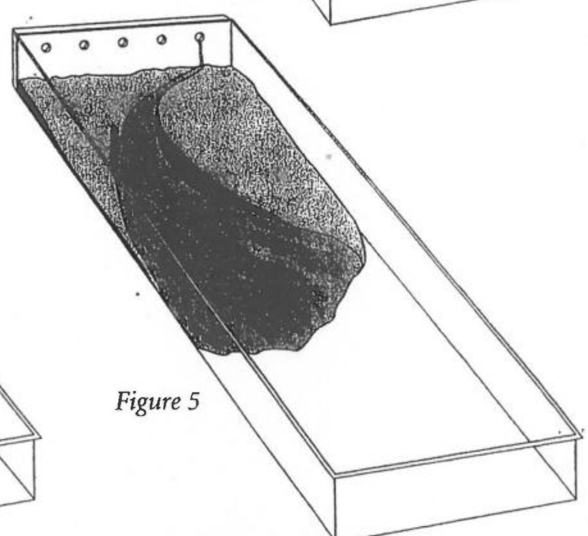


Figure 5

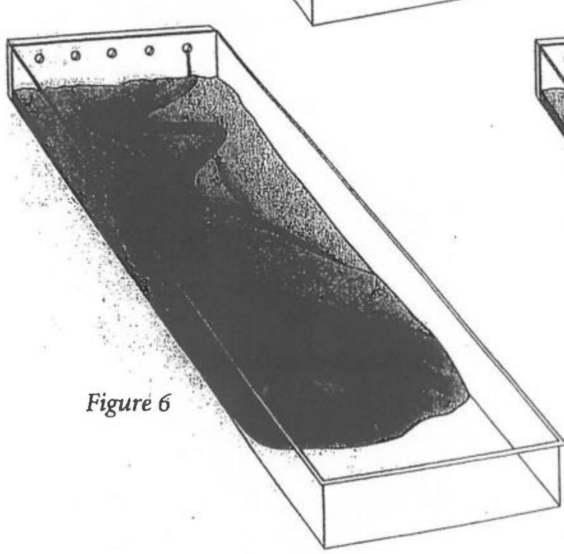


Figure 6

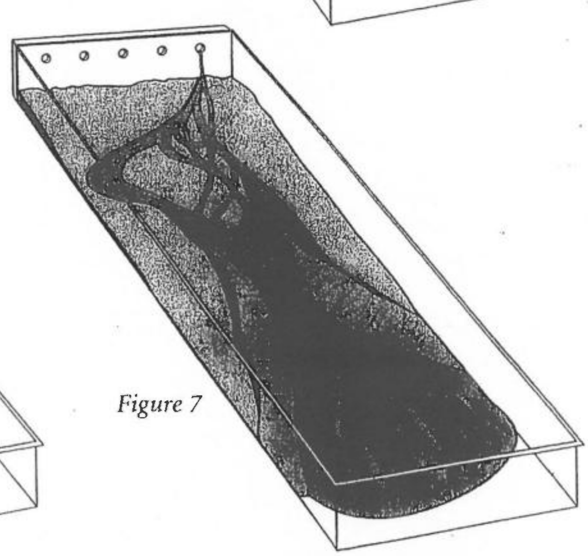


Figure 7

Name ______________________ Class ______ Date ______

ANALYZE

Figure 2

____

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Figure 3

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Figure 4

____

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Figure 5

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Figure 6

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Figure 7

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____

1. Based on your descriptions, make up a classification scheme for the figures. You may decide to classify them all in the same way. Or you may group individual figures into two or more classifications. Describe your classification system.

____

____

____

____

____

____

CONCLUDE AND APPLY

1. Describe the process of stream development based on your observations of Figures 2–7.

2. What modifications could you make to the stream table to gain further insight into stream development?

Lab

NAME

CLASS

DATE

How Is a Star's Color Related to Its Temperature?

On a clear night you have surely noticed that some stars are brighter than others. But stars also have different colors. Rigel is blue, and Betelgeuse is red. Capella and our sun are yellow. In this activity you will make your own Hertzsprung-Russell diagram. You will see how star brightness, color, temperature, and class are related.

Vocabulary
use text book
pg 382

1) red giant
2) supergiant
3) dwarf star

Materials

Colored pencils (red, orange, yellow, blue)

Procedure

1. Study the star data charts below. Note that the sun, used as a standard of brightness, is given a value of 1. The brightness given for each other star shows how that star compares with the sun.
2. Plot the data from both charts on the graph on the next page.
3. Stars with surface temperatures up to 3,500°C are red. Shade a vertical band from 2,000°C to 3,500°C a light red.
4. Shade other color bands as follows: Stars up to 5,000°C are orange-red, up to 6,000°C yellow-white, up to 7,500°C blue-white, and up to 40,000°C blue.
5. Look for patterns in your graph. Compare it to the H-R diagram in your textbook. pg. 382
6. Label the main sequence, the red supergiants, and the white dwarfs.

Star-Brightness Data

Star Name	Approximate Temperature, °C	Brightness (Sun = 1)	Star Name	Approximate Temperature, °C	Brightness (Sun = 1)
Sun	5,300	1	Canopus	7,100	1,500
Alpha Centauri A	5,500	1.3	Arcturus	4,200	90
Alpha Centauri B	3,900	0.36	Vega	10,400	60
Barnard's Star	2,500	0.0004	Capella	5,600	150
Lalande 21185	2,900	0.005	Rigel	11,500	40,000
Sirius A	10,100	23	Betelgeuse	2,900	17,000
Sirius B	10,400	0.008	Achernar	14,000	200
Ross 248	2,400	0.0001	Beta Centauri	21,000	3,300
61 Cygni A	3,900	0.08	Altair	7,700	10
61 Cygni B	3,600	0.04	Aldebaran	3,900	90
Procyon A	6,200	7.6	Spica	21,000	1,900
Procyon B	7,100	0.0005	Antares	3,100	4,400
Epsilon Indi	3,900	0.13	Deneb	9,900	40,000
			Beta Crucis	22,000	6,000

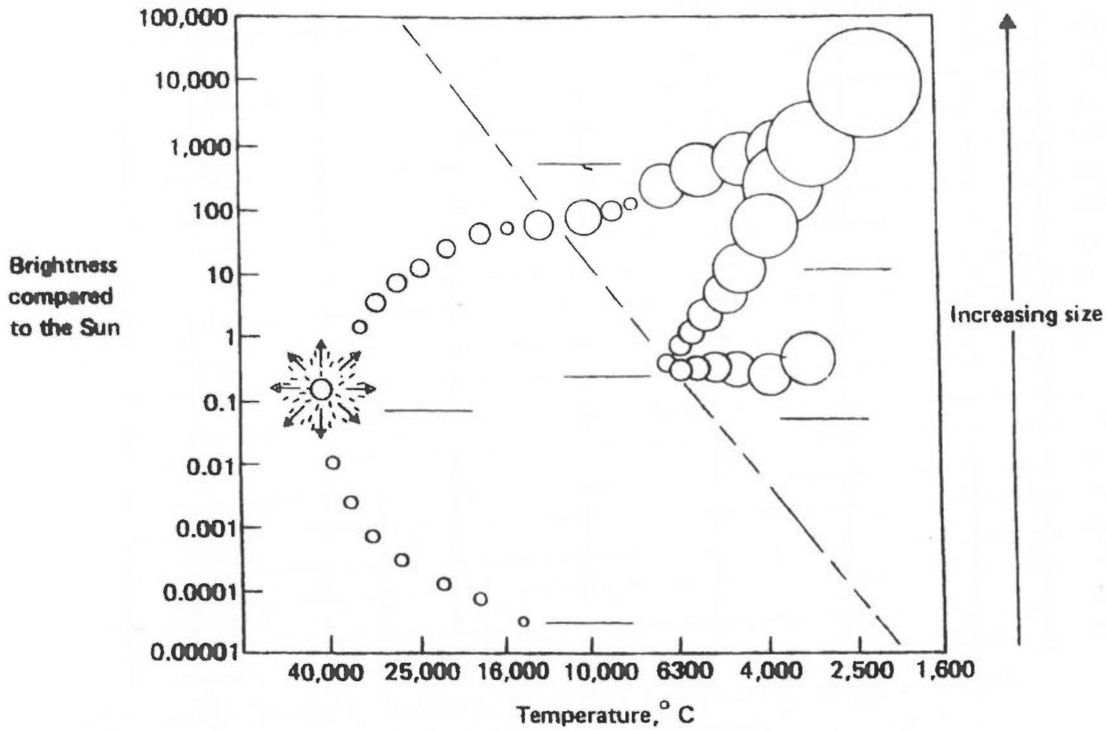
NAME ________________

CLASS ________________

DATE ________________

The Stages in a Star's Life Cycle

No one has ever observed a star's complete life cycle—it takes billions of years. Astronomers have, however, proposed a model that describes the process. Such a life cycle is illustrated and described below. Read the description of the various stages. Then write the correct number for each stage in the space provided on the diagram.



Stage 1. Protostar stage. Gravity pulls gas and dust together. The beginning star warms and starts to glow. Star size depends upon amount of dust.

Stage 2. Millions of years later the protostar becomes a main sequence star. A nuclear reaction changes hydrogen to helium. A great amount of heat and light is given off. The star remains on the main sequence for millions, even billions, of years.

Stage 3. The giant stage begins when most of the star's hydrogen is changed to helium. Nuclear reactions begin in the outer layers. The star expands and the outer layers cool.

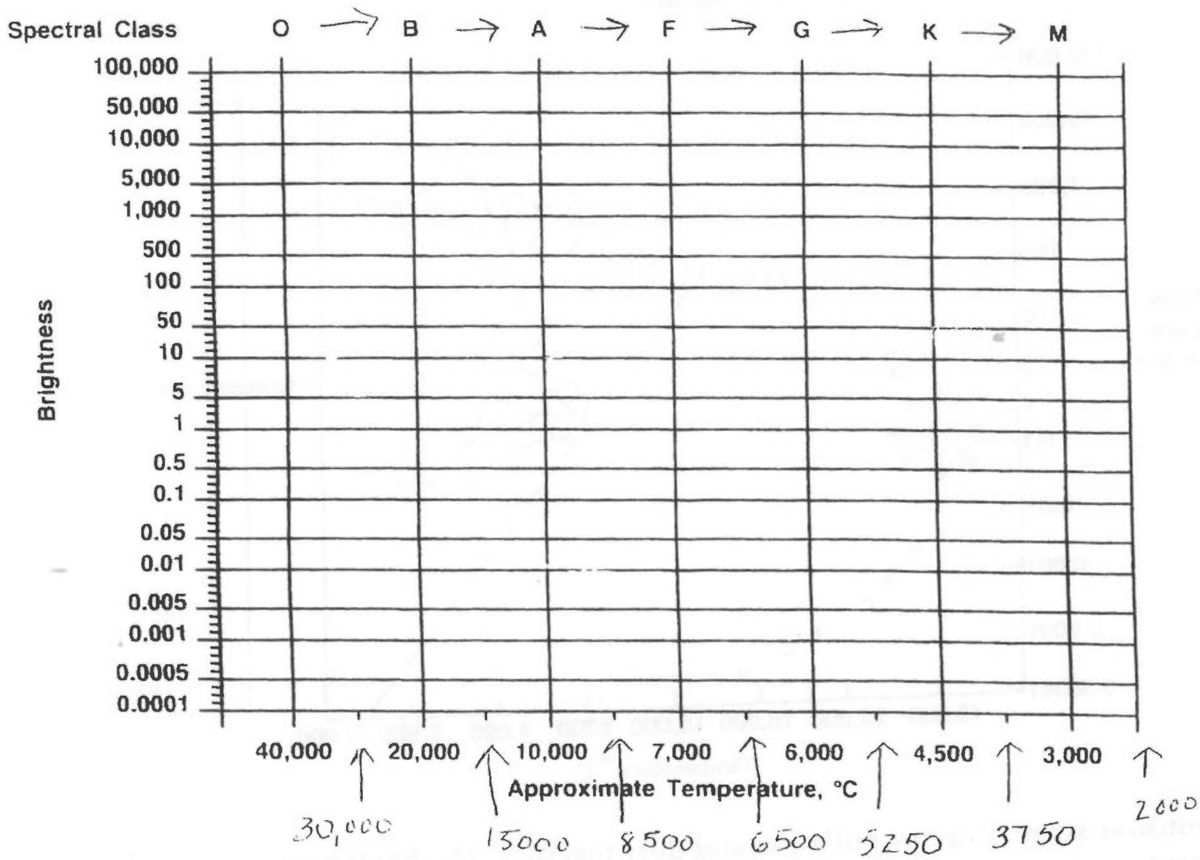
Stage 4. The red giant begins contracting as the rest of the hydrogen is changed to helium. The star may contract into a variable stage. In this stage it shrinks and expands again and again. Its size and brightness both change. This variable stage is not well understood.

Stage 5. The star may suddenly release large amounts of energy. It then expands rapidly to become a nova—the firecracker of space. The outer layers may be blown off.

Stage 6. If the star does not become a nova, it may begin contracting. It becomes first a white dwarf and later a red or black dwarf.

1. At which stage is our sun today? ________________

2. Which will the sun probably do—stay the same or change? ________________



Questions

1. What is the general relationship between temperature and star brightness? ______

______

2. What relationship do you see between star color and star temperature? ______

______

3. How does the sun compare to the other stars on the main sequence? ______

______

4. What star class does our sun belong to? ______

5. A star is classified as being in class B. What is its color? Temperature? ______

______

______

6. We know dwarfs are small—smaller than our sun. How can they be so bright? ______

______

Name _______________ Class _______

GeoLab Spectral Lines

An astronomer studying a star or other type of celestial object often starts by identifying the lines in the object's spectrum. The identity of the spectral lines gives astronomers information about the chemical composition of the distant object, along with data on its temperature and other properties.

PREPARATION

Problem

Identify stellar spectral lines based on two previously identified lines.

Materials

ruler

Objectives

In this Geolab, you will:

- **Develop** a scale based on the separation between two previously identified spectral lines.
- **Measure** wavelengths of spectral lines.
- **Compare** measured wavelengths to known wavelengths of elements to determine composition.

PROCEDURE

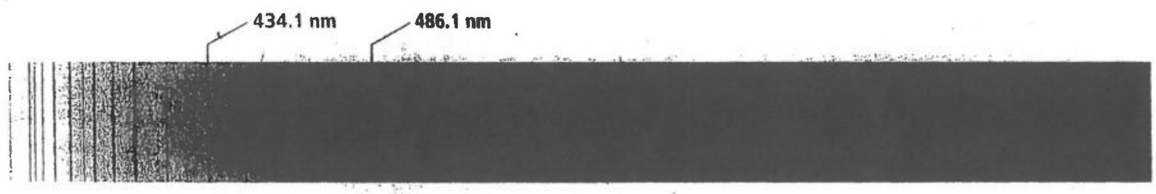
1. Read and complete the lab safety form.
2. Find the difference between the two labeled spectral line values on Star 1.
3. Accurately measure the distance between the two labeled spectral lines.
4. Set up a conversion scale by dividing the spectral difference by the measured distance. For example: 1 mm = 12 nm
5. Measure the distance from one of the labeled spectral lines to each of the unlabeled spectral lines.
6. Convert these distances to nm. Add or subtract your value to the original spectral line value. If the labeled line is to the right of the line measured, then subtract. Otherwise, add. This is the value of the wavelength.
7. Compare your wavelength measurements to the table of wavelengths emitted by elements, and identify the elements in the spectrum.
8. Repeat this procedure for Star 2.

Name Class Date

GeoLab Identify Stellar Spectral Lines

Star 1

Star 2



POSSIBLE ELEMENTS AND WAVELENGTHS

Element/Ion	Wavelengths (nm)
H	383.5, 388.9, 397.0, 410.2, 434.1, 486.1, 656.3
He	402.6, 447.1, 492.2, 587.6, 686.7
He^+	420.0, 454.1, 468.6, 541.2, 656.0
Na	475.2, 498.3, 589.0, 589.6
Ca^+	393.4, 480.0, 530.7

ANALYZE AND CONCLUDE

1. **Identify** Can you see any clues in the start's spectrum about which elements are most common in the stars? Explain.

2. **Explain** Do both stars contain the same lines for all the elements in the table?

Name Class

GeoLab Identify Stellar Spectral Lines

ANALYZE AND CONCLUDE

3. Evaluate How do the thicker absorption lines of some elements in a star's spectrum affect the accuracy of your measurements? Is there a way to improve your measurements? Explain.

INQUIRY EXTENSION

Obtain spectra from various sources, such as sunlight, fluorescent, and incandescent light. Compare their emission line to those from this lab. What elements are common to each?

Name Class Date

Mapping GeoLab Determine Relative Ages of Lunar Features

It is possible to use the principle of cross-cutting relationships, discussed in Chapter 21, to determine the relative ages of surface features on the Moon. By observing which features cross-cut others, you can infer which is older.

PREPARATION

Problem

How can you use images of the Moon to interpret relative ages of lunar features?

Materials

metric ruler

paper

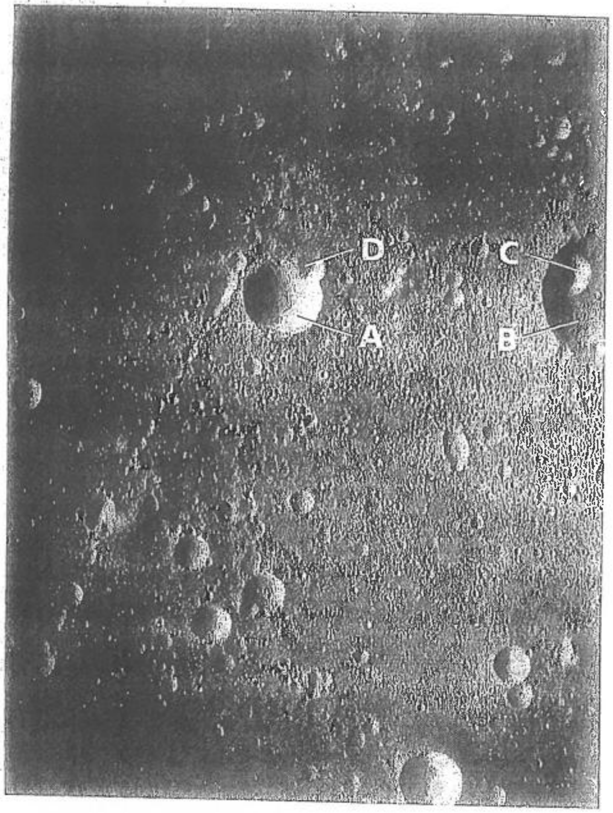
PROCEDURE

1. Read and complete the lab safety form.
2. Review the information about the history of the Moon and the lunar surface starting on page 772.
3. Observe Photo 1 and identify the older of the craters in the crater Pairs A-D and C-B using the principle of crosscutting relationships.
4. Observe Photo 2. Identify and list the features in order of their relative ages.
5. Observe Photo 3. Identify the mare, rille, and craters. Then list the features in order of their relative ages.
6. Observe Photo 4. Identify the features using your knowledge of crosscutting relationships and lunar history. Then list the features in order of their relative ages.

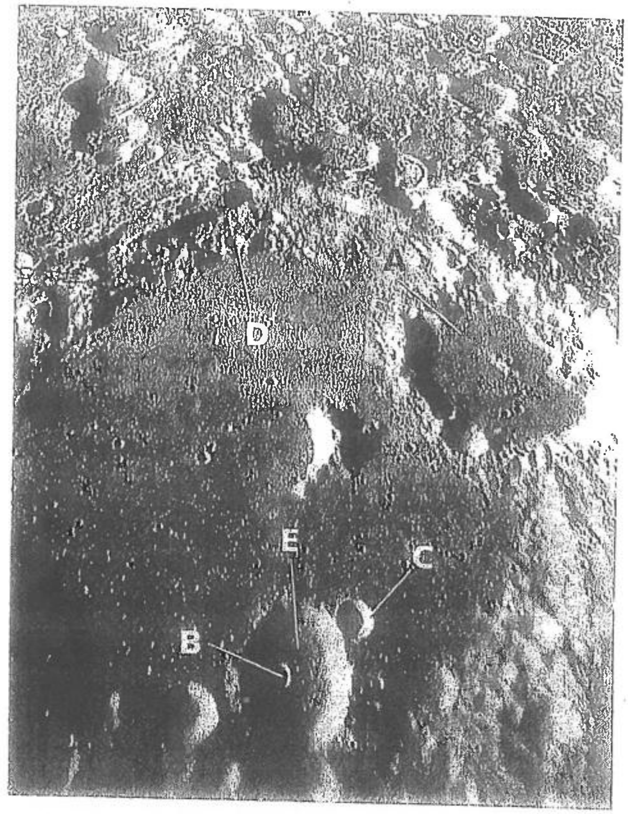
Name Class Date

Mapping GeoLab: Determine Relative Ages of Lunar Features

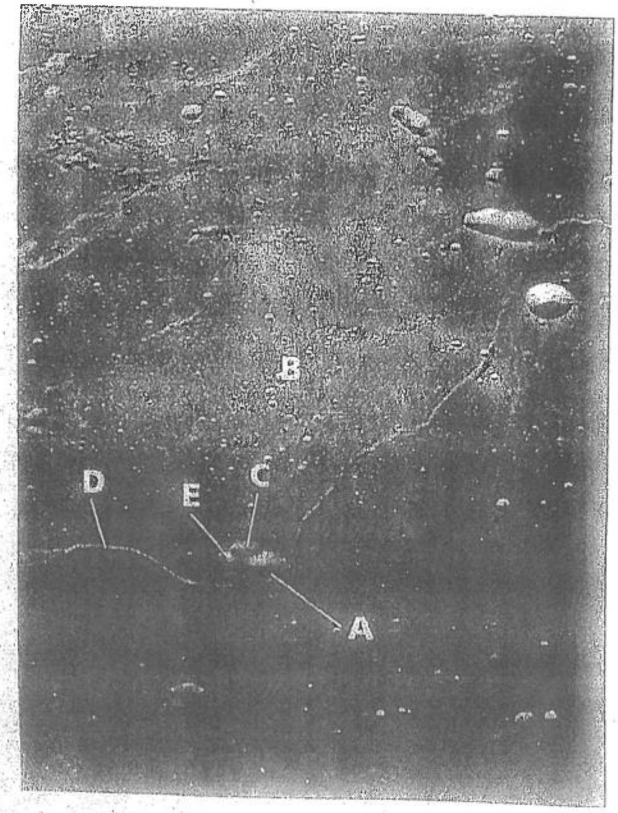
I



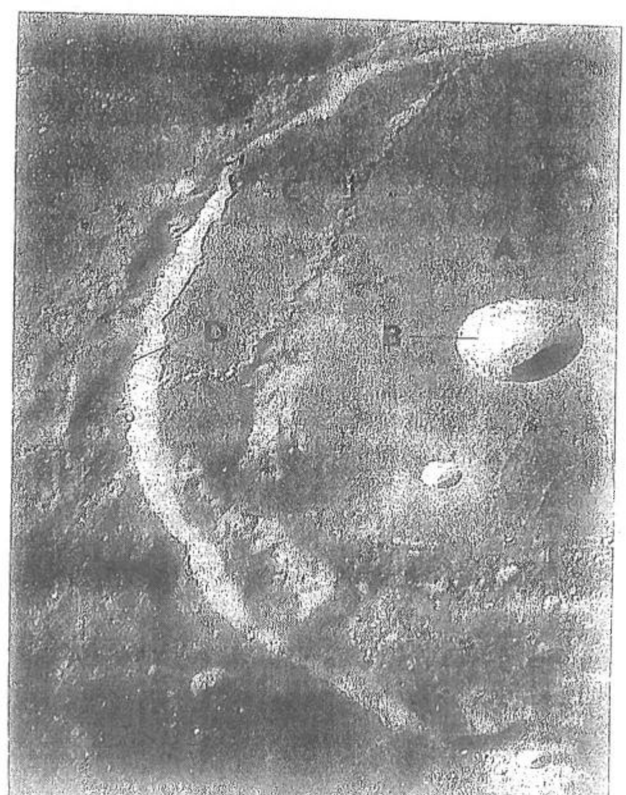
II



III



IV



Name ______________________ Class ______

Mapping GeoLab

Determine Relative Ages of Lunar Features

ANALYZE AND CONCLUDE

1. **Summarize** the problems you had in identifying and choosing the ages of the features.

____

____

2. **Select** Based on information from all the photos, what features are usually the oldest? The youngest?

____

____

3. **Explain** whether scientists could use this process to determine the exact age difference between two overlapping craters. Why or why not?

____

____

4. **Identify** the relative-age dating that scientists use to analyze craters on Earth.

____

____

5. **Evaluate** If the small crater in Photo 2, labeled *A*, is 44 km across, what is the scale for that photo? At that scale, what is the size of the large crater labeled *F*?

____

____

6. **Judge** Which would be older, a crater that had rays crossing it, or the crater that caused the rays? Explain.

____

____

7. **Estimate** If the crater labeled *A* in Photo 1 is 17 km across, how long is the chain of craters in the photo?

____

____

8. **Infer** What might have caused the chain of craters in Photo 1?

____

____

Name Date Class

Star Cluster Age

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. What are the horizontal and vertical axes of an H-R diagram?

2. What does a coordinate on an H-R diagram represent?

3. What is the main sequence on an H-R diagram?

Stars are plotted on the H-R diagram based on their temperature and brightness. You can determine the age of a cluster of stars by studying the H-R diagram of the stars within the cluster. Massive main sequence stars, located at the upper left of the diagram, evolve faster than stars farther down the main sequence. Stars in the lower right of the diagram evolve more slowly. How could you use this idea to help determine the relative ages of star clusters from their H-R diagrams?

Real-World Problem

How can the relative age of star clusters be determined from H-R diagrams of each cluster?

Goals

- **Compare and contrast** H-R diagrams of several star clusters.
- **Determine** the relative ages of four star clusters.

Materials

Four H-R diagrams of star clusters.

LAB (continued)

Procedure

1. Study the four H-R diagrams your teacher gives you.
2. Note which types of stars remain on the main sequence and which stars have evolved off of the main sequence.
3. Based on the evolution of the stars within each star cluster, decide which cluster is youngest and which is oldest. Also decide the relative ages of the other two star clusters. *HINT: The oldest clusters will have some stars that have evolved to white dwarfs.*

Conclude and Apply

1. **Compare and contrast** the H-R diagrams of the four star clusters.

2. **Determine** which star cluster is youngest and which is oldest.

3. **Explain** how you determined the ages of these two star clusters.

4. **Determine** the relative ages of the remaining two star clusters.

5. **Explain** how you determined the ages of these two star clusters.

Communicating Your Data

Explain to friends how the relative ages of star clusters can be found by studying H-R diagrams.

LAB A Case for Pacific Plate Motion

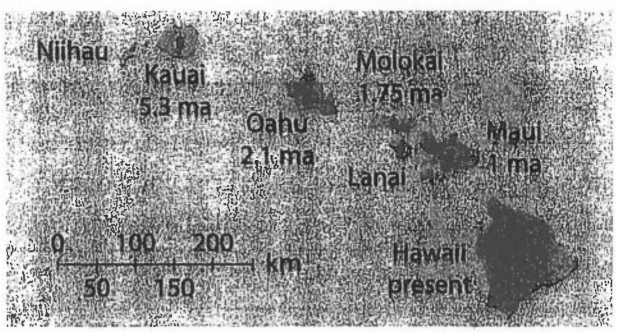
Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. What do you need to measure motion?

2. Why are the Hawaiian Islands important to geologists studying volcanic activity?

To measure motion you have to have a starting and an ending point. You must also know the time it took to get from start to end. Volcanic activity associated with a hot spot beneath Hawaii gives geologists exactly that.



Real-World Problem

How can scientists show that Earth's plates are moving?

Goal

- **Infer** a rate of movement for the Hawaiian Islands over a hot spot.

Materials

ruler
calculator
scale map of the Hawaiian Islands

Procedure

1. Review the data table shown in the Data and Obeservations section.
2. **Measure and record** the distances between the island sets in the data table. Use the map scale to convert measurements to km.
3. Refer to the average ages given for each island on the map. Calculate and record the age differences for each set of islands in the data table. Use the hot spot beneath the island of Hawaii as a starting reference point.
4. **Calculate** the rate of motion in km/year. Assume that the hot spot is stationary and that the Pacific Plate is moving over it.

(continued)

Distance / Time Data for Hawaiian Islands			
From / To	Distance (km)	Time (years)	Rate (km/year)
Hawaii to Maui			
Maui to Molokai			
Molokai to Oahu			
Oahu to Kauai			

Conclude and Apply

1. **Evaluate** how meaningful your calculated rate numbers are. Determine a better rate unit and convert your km/year rates into these new units.

2. **Infer** why the rates are not consistent using what you know about plate movement.

3. **Describe** the overall motion of the Pacific Plate based on your data.

4. **Observe** a map of the Pacific Ocean and infer the location of a divergent zone that could be "pushing" the Pacific Plate.

Communicating Your Data

Share your findings with the class and discuss alternative interpretations.

Name ______________________________

Period# __________ Date ______________

EARTH'S ROTATION

Introduction: Earth's rotates or turns around an imaginary axis in a direction from west to east. This daily motion of Earth causes the apparent motions of celestial objects (such as the sun, moon, planets and stars) to move across the sky in a general direction from east to west.

Procedure: Follow the directions given by your teacher to construct the diagram shown on the following page; answer the questions by referring to the diagram that you constructed.

1. The diagram shows Earth as it would appear looking down at the North Pole. Divide Earth into 15° intervals as shown by your teacher.

2. Very lightly and neatly shade the side of Earth away from the sunlight to represent the area of Earth in darkness. Use pencil for this!

3. Since Earth rotates 15° each hour, every 15° represents a different hour of the day. Starting with 12:00 noon (where the sun is directly over the meridian) number each hour of the day. The times on the left side of the diagram will be times of "post meridian" (P.M.); times on the right side of the diagram will represent hours of "ante meridian" (A.M.)

Questions:

1. How many degrees are there in a circle? 1. __________

2. Approximately how long does it require Earth to rotate once on its axis? 2. __________

3. How many degrees does Earth rotate each hour? (Hint: divide your answer to question #1 by #2) 3. __________

4. How many hours would it take Earth to rotate from B to C? 4. __________

5. How many hours would it take Earth to rotate from D to F? 5. __________

6. How many hours would it take until a person at E saw the sun cross the celstial meridian? 6. __________

7. How many hours would it take for the sun to cross the celestial meridian for a person at position B? 7. __________

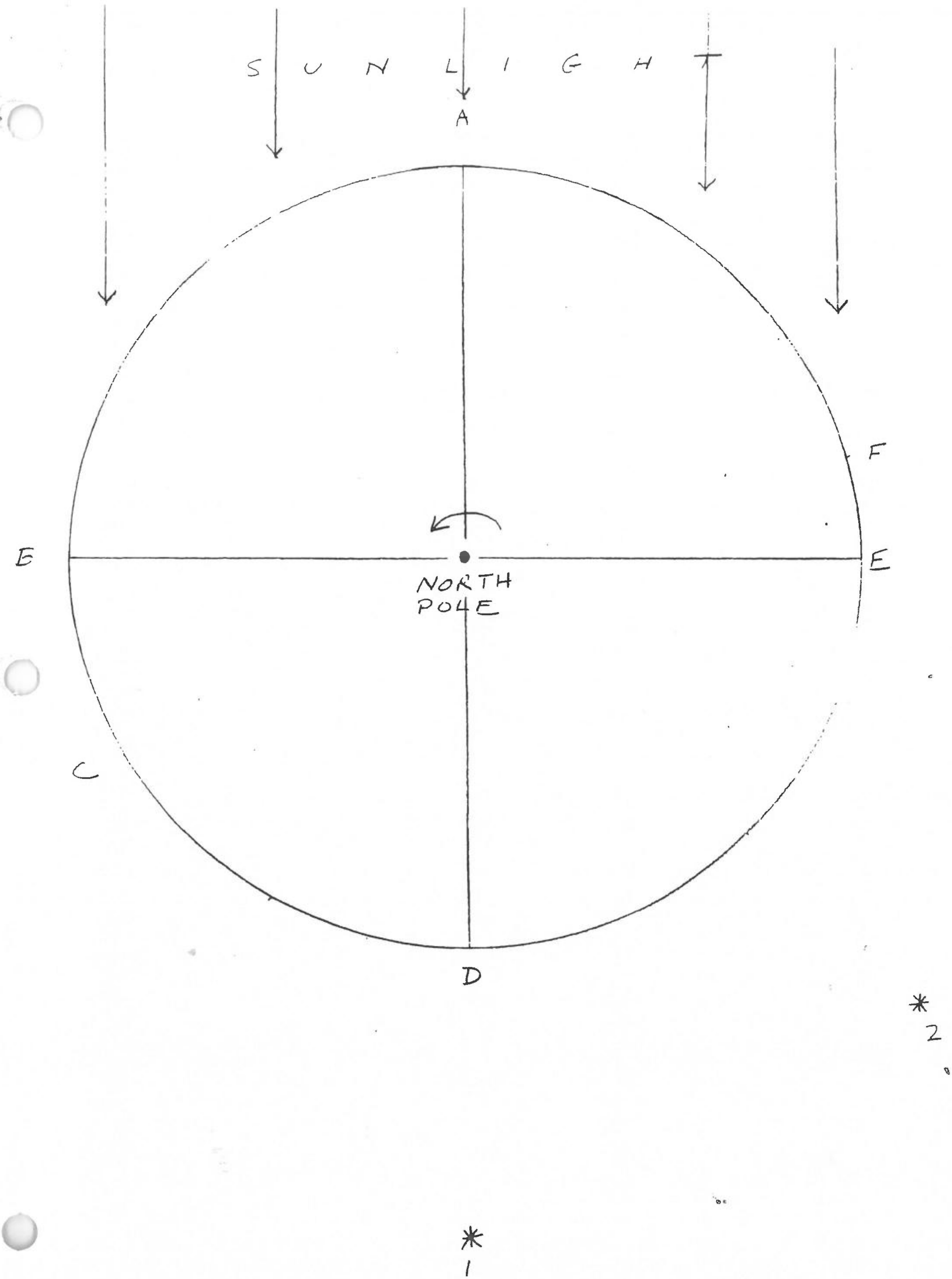
8. How many hours would it take for a person at position B to have star #1 cross directly overhead (cross his celestial meridian)? 8. ________

9. How many hours would it take for a person at position A before star #2 would cross the celestial meridian? 9. ________

10. The diagram shown below represents the northern sky region around Polaris. It shows one circumpolar star apparently revolving around Polaris, as the star trail would appear in a long exposure photograph. Use your protractor to figure how long it took to take a picture of this star trail around Polaris. 10. ________

11. Draw an arrow on the diagram above to show the direction that the star appears to revolve around Polaris.

12. What is the direction of the apparent motion of circumpolar stars? (clockwise or counterclockwise) 12. ________


SUNLIGHT
A
F
E
E
NORTH POLE
C
D
* 2
* 1

Name Class Date

LAB 6.2

Use with Section 6.2

Grand Canyon Formations

The Grand Canyon is not only a famous recreational site, but it is the subject of intense scientific research. The Grand Canyon is composed of many layers of rock, most of which are sedimentary. These rocks often contain fossils that help scientists determine how and when the rock formed. If you were to hike through the Grand Canyon today, you would be exposed to numerous rock layers that represent more than 2 billion years of geologic history.

PREPARATION

PROBLEM

How can you use a geologic map of the Grand Canyon to interpret the geologic history of the area?

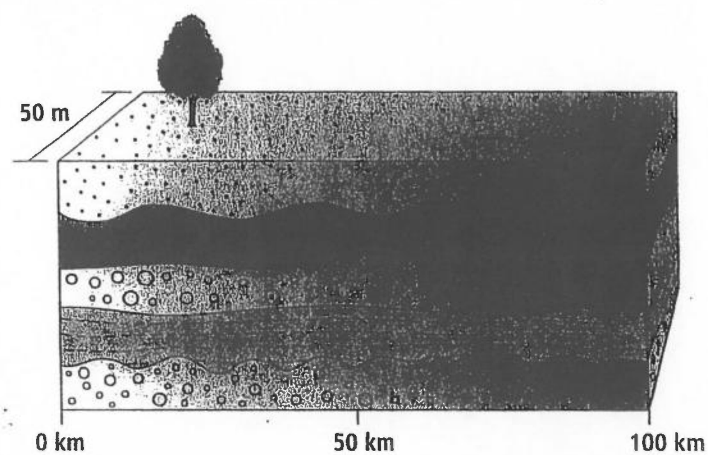
OBJECTIVES

- **Interpret** information about rock layers in the Grand Canyon.
- **Create** a geologic cross section.
- **Hypothesize** about how rock layers formed.

MATERIALS

colored pencils

PROCEDURE



1. Examine the geologic cross section in the figure above.
2. Using the figure above as a guide, construct a cross section of the Grand Canyon rock layers listed in Table 1. Draw the cross section on the grid in Data and Observations.
3. Once you have drawn in the rocks, color each layer to match the colors in Table 1.

PROCEDURE, *continued*

Table 1

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kaibab Limestone	Sandy limestone	Grayish white	250	300–500
Toroweap Formation	Sandy limestone	Grayish yellow	255	250–450
Coconino Sandstone	Quartz sand	Cream	260	350–50
Hermit Shale	Shale	Rusty red	265	250–1000
Supai Formation	Shale	Red	285	950–1350
Redwall Limestone	Marine limestone	Red	335	450–700
Temple Butte Limestone	Freshwater limestone	Cream	350	0–450
Muav Limestone	Limestone	Gray	515	400–1000
Bright Angel Shale	Mudstone shale	Greenish brown	530	300–450
Tapeats Sandstone	Sandstone	Dark brown	545	250–150
Great Unconformity	Rock layers eroded or never deposited			
Chuar Group	Sandstone Shale Limestone	Tan Black Green	825–1000	6900
Nankoweap Formation	Sandstone	Gray	1050	6900
Cardenas Basalt	Basalt	Dark brown	1100	980
Dox Sandstone	Sandstone	Orange red	1190	3000
Shinumo Quartzite	Sandstone	Purplish brown	1200	1070–1560
Hakatai Shale	Shale	Orange red	1225	430–830
Bass Formation	Limestone	Grayish	1250	120–340
Early Unconformity	Rock layers eroded or never deposited			
Zoroaster Granite	Granite	Dark gray	1700–1900	?
Vishnu Schist	Mica schist	Black	2000	?

Name ______________________ Class ______ Date ______

LAB 6.2

DATA AND OBSERVATIONS

ANALYZE

1. What problems did you have with the vertical scale of the cross section? Will the cross section be the same in a different area? How will it change?

2. Which layers in the Grand Canyon are metamorphic rocks? What factors contributed to their formation?

CONCLUDE AND APPLY

1. Over 2 billion years ago, the area that is now to the north of the Grand Canyon in Colorado and Utah was once a mountain range taller and wider than the Rocky Mountains. What happened to those mountains over time?

2. Scientists have found two spans of geologic time in the Grand Canyon for which no rock layers exist. These are called the Great Unconformity (~550–820 million years ago) and the Early Unconformity (~1255–1695 million years ago). How are the unconformities related to changes in depositional environment?

Scientists have been able to hypothesize the environmental conditions that existed when the layers of the Grand Canyon formed by examining the characteristics of each layer. Use Table 2 to answer the following questions.

Table 2

Rock Layer	Description	Fossils
Redwall Limestone	Marine limestone	Brachiopods, clams, snails, corals, fish, trilobites
Coconino Sandstone	Pure quartz sand, basically a petrified sand dune	No bone fossils; invertebrate tracks and burrows
Hermit Shale	Soft, easily eroded shale	Ferns, conifers, other plants; reptile and amphibian tracks; no bones
Zoroaster Granite	Granite	None

3. Hypothesize about the environment that existed when the Coconino Sandstone formed. Give reasons for your hypothesis.

4. What does the information given about the Hermit Shale suggest about the environment that existed when it formed?

5. Why do you suppose that no fossils are present in Zoroaster Granite?

[illegible]

Scientists have found two types of geologic [illegible] in the Grand Canyon for which the [illegible] these rocks. These are called the Great Unconformity—[illegible] million years ago and [illegible]

[illegible]

[illegible] of the Grand Canyon [illegible] the characteristics of each [illegible]

Table 2

[illegible]	Marine limestone	Brachiopods, [illegible], trilobites
[illegible]	Near-shore sand [illegible]	[illegible] tracks, [illegible] tracks and burrows
[illegible]	[illegible]	Ferns, [illegible], insect wings, [illegible]
[illegible]	Sands	None

[illegible]

Name ______________________ Date __________ Class ______________

You Be the Detective

Finding Clues to Rock Layers

Fossil clues give geologists a good idea of what life on Earth was like millions or even billions of years ago.

◆ Problem

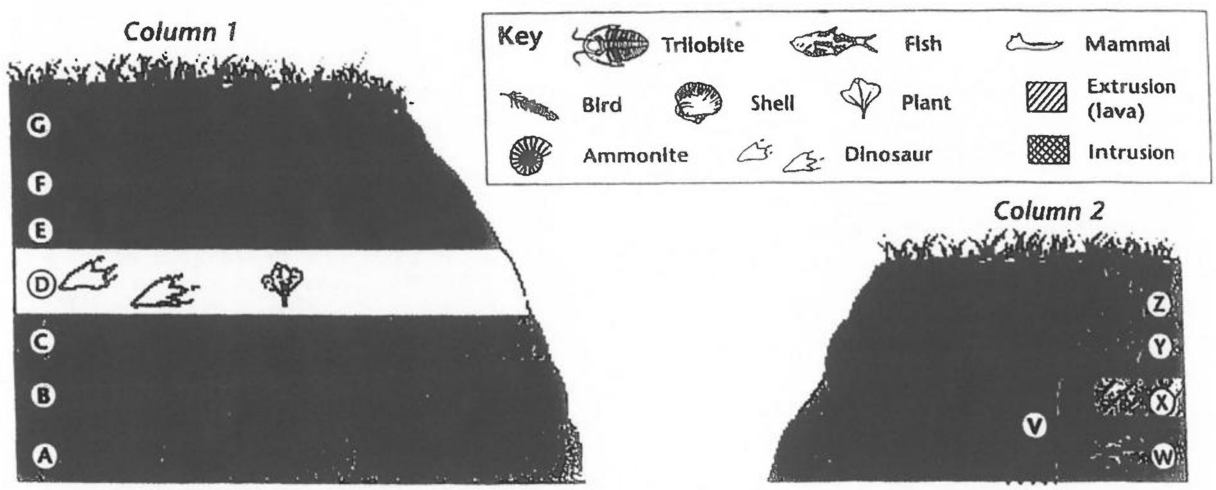
How can you use fossils and geologic features to interpret the relative ages of rock layers?

◆ Skills Focus

interpreting data, drawing conclusions

◆ Procedure

1. Study the rock layers at Sites 1 and 2. Write down the similarities and differences between the layers at the two sites.
2. List the kinds of fossils that are found in each rock layer of Sites 1 and 2.



◆ Analyze and Conclude

Write your answers in the spaces provided.

◆ **Site 1** (See attached page)

1. What "fossils clues" in layers A and B indicate the kind of environment that existed when these rock layers were formed? How did the environment change in layer D?

____

____

REAL-WORLD LAB *(continued)*

2. Which layer is the oldest? How do you know?

3. Which of the layers formed most recently? How do you know?

4. Why are there no fossils in layers C and E?

5. What kind of fossils occurred in layer F?

◆ **Site 2**

6. Which layer at Site 1 might have formed at the same time as layer W at Site 2?

7. What clues show an unconformity or gap in the horizontal rock layers? Which rock layers are missing? What might have happened to these rock layers?

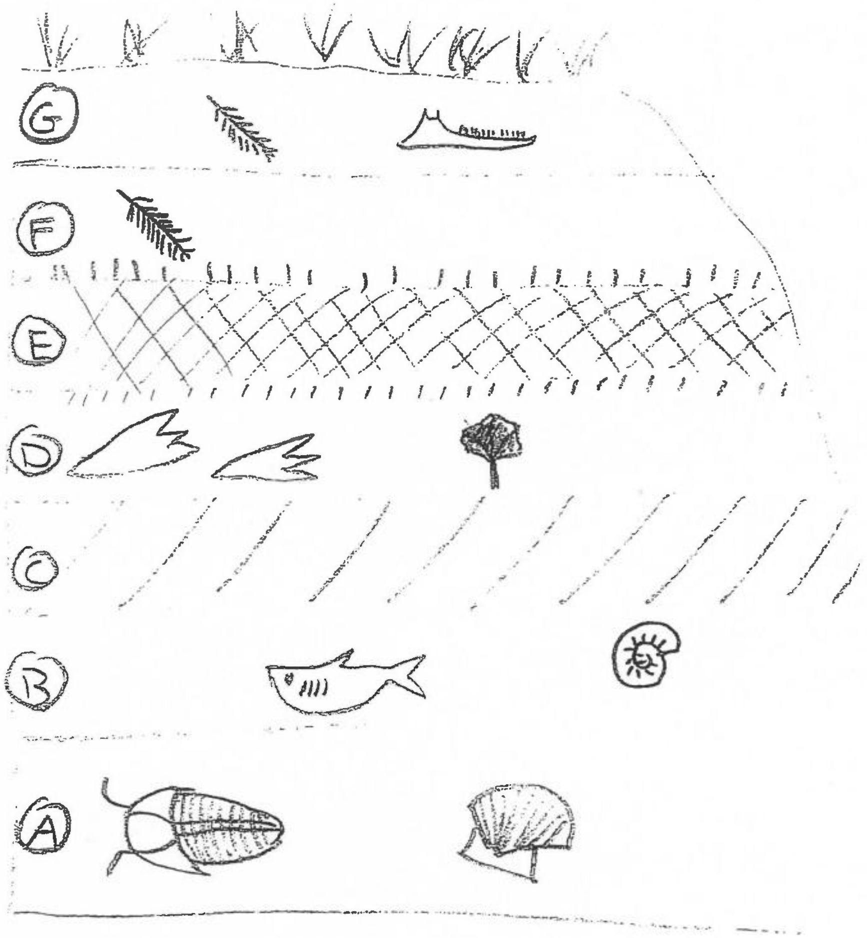
8. Which is older, intrusion V or layer Y? How do you know?

9. **Think About It** Working as a geologist, you find a rock containing fossils. What information would you need in order to determine this rock's age relative to one of the rock layers at Site 1?

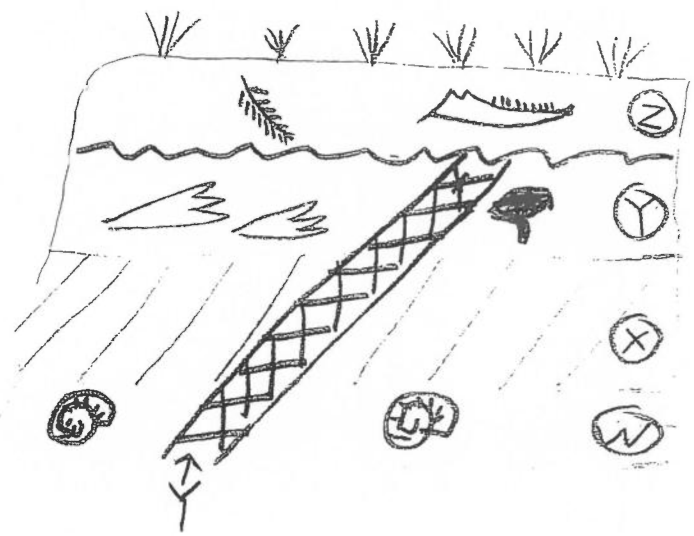
◆ More to Explore

Draw a sketch similar to Site 2 and include a fault that cuts across the intrusion. Have a partner then identify the relative age of the fault, the intrusion, and the layers cut by the fault.

Site 1



Site 2



Name ______________________ Date ______________ Class __________

Investigating Weather Maps

Pre-Lab Discussion

Accurate weather forecasting requires analysis of detailed information about atmospheric conditions in many locations. In the United States, weather data from more than 300 local weather stations are used to prepare daily maps of the weather throughout the country. A detailed map may contain more than 10,000 data points. Such detailed maps are useful for making weather predictions.

Every minute of the day, weather stations, weather ships, satellites, balloons, and radar are recording temperature, pressure, wind direction, and other data and feeding them into the Global Telecommunications System (GTS). From this information, powerful supercomputers develop an image of conditions in the entire atmosphere and make forecasts for up to one week.

In this investigation, you will study how weather is presented and then prepare a simplified weather map and analyze it to discover relationships between weather and certain variables such as temperature and pressure.

1. What are three kinds of information that you could get from a newspaper weather map?

   ____

   ____

2. What kind of weather is associated with a low?

   ____

3. What kind of weather is associated with a high?

   ____

Problem

How can you make a weather map and use it to understand relationships between weather and certain atmospheric variables?

Materials *(per group)*

pencil

colored pencil

Procedure

Part A

Read the following steps and study the diagrams to learn how weather data are presented on station circles.

1. Figure 1 shows the correct notation of some weather data recorded at an observation station. The circle represents the observation station. The data have specific positions inside and outside the station circle.

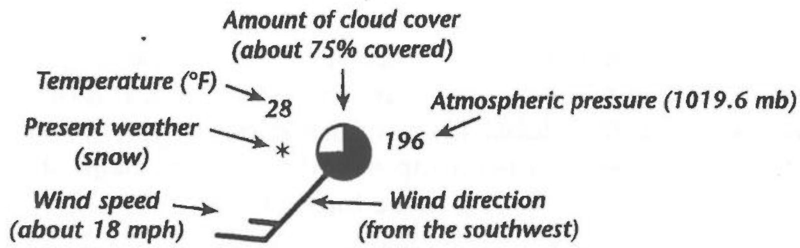


Figure 1
Station Circle

2. Isobars are lines on a weather map that connect stations that report the same atmospheric pressure. These pressures are measured in millibars (mb), so isobars are labeled in millibars. To record the pressure on the station circle, use only the last three digits of the pressure and omit the decimal point. Look at the atmospheric pressure shown on the station circle in Figure 1. The atmospheric pressure is 1019.6 mb, which is recorded on the station circle as 196.
3. Think of the station circle as the point of an arrow. Attached to the station circle is a line, which is the arrow's shaft. The wind direction is represented as moving along the arrow's shaft toward the center of the station circle. Wind directions are given in degrees and represent the direction from which the wind is blowing. Figure 2 will help you determine wind direction. In Figure 1, the wind is blowing from the southwest toward the northeast.
4. Look at the figure of the Weather Map in your textbook. It shows the data from station circles placed on a map. Compare the symbols discussed above with the symbols on that map. Notice that the temperature is in degrees Fahrenheit.

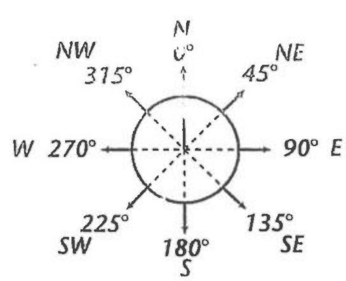


Figure 2

Part B

1. The Data Table lists data collected at various weather stations on a particular day. Starting with Seattle, transfer all of the data provided on the table to the appropriate observation stations on the map. Use the station circles and weather symbols discussed previously. The station circle for San Francisco is done for you.

Data Table: Observation Stations

Weather Station	Wind Speed (mph)	Wind Direction	Atmospheric Pressure (mb)	Temperature (°F)	Type of Precipitation	Cloud Cover (%)
Seattle	7	260°	1020.8	42		0
Bend	10	200°	1023.5	40		0
San Francisco	8	135°	1020.0	48	fog	25
Los Angeles	12	150°	1021.1	41	fog	25
Phoenix	11	50°	1021.1	45		0
Ely	2	15°	1025.1	37		0
Dubois	18	225°	1024.0	38		0
Helena	15	315°	1020.0	41		0
Medicine Hat	20	345°	1020.1	40		0
Bismarck	18	0°	1014.3	48		0
Casper	12	350°	1016.0	50		0
Pueblo	8	315°	1015.3	50		0
Roswell	22	350°	1016.0	48		0
Del Rio	38	315°	1012.0	50	thunderstorms	100
Galveston	5	225°	1016.0	72		25
Dallas	29	315°	1007.9	60	hail	100
Oklahoma City	45	315°	1007.7	57	thunderstorms	100
Kansas City	2	215°	1002.3	58	rain	100
Burwell	22	325°	1009.3	52	rain	100
Minneapolis	15	45°	1008.2	51	drizzle	100
Sioux Lookout	20	50°	1016.8	46		25
Chicago	10	45°	1005.2	58	drizzle	100
Little Rock	8	225°	1009.3	67		25
New Orleans	5	225°	1017.9	73		0
Nashville	5	220°	1011.1	68		25
Cincinnati	7	90°	1009.8	57	rain	100
Detroit	10	75°	1011.9	54	drizzle	100
Sault Ste. Marie	15	45°	1013.1	50	drizzle	100
Quebec	8	100°	1017.0	50		25
Boston	12	100°	1018.1	52	fog	25
Buffalo	7	75°	1016.0	52	drizzle	100
New York	10	80°	1017.6	56	fog	50
Hatteras	14	90°	1019.1	60		50
Charleston	15	225°	1017.8	70		25
Atlanta	3	225°	1014.6	70		0
Jacksonville	2	200°	1018.1	73		0
Tampa	2	230°	1018.0	74		25
Miami	8	180°	1019.8	78		0

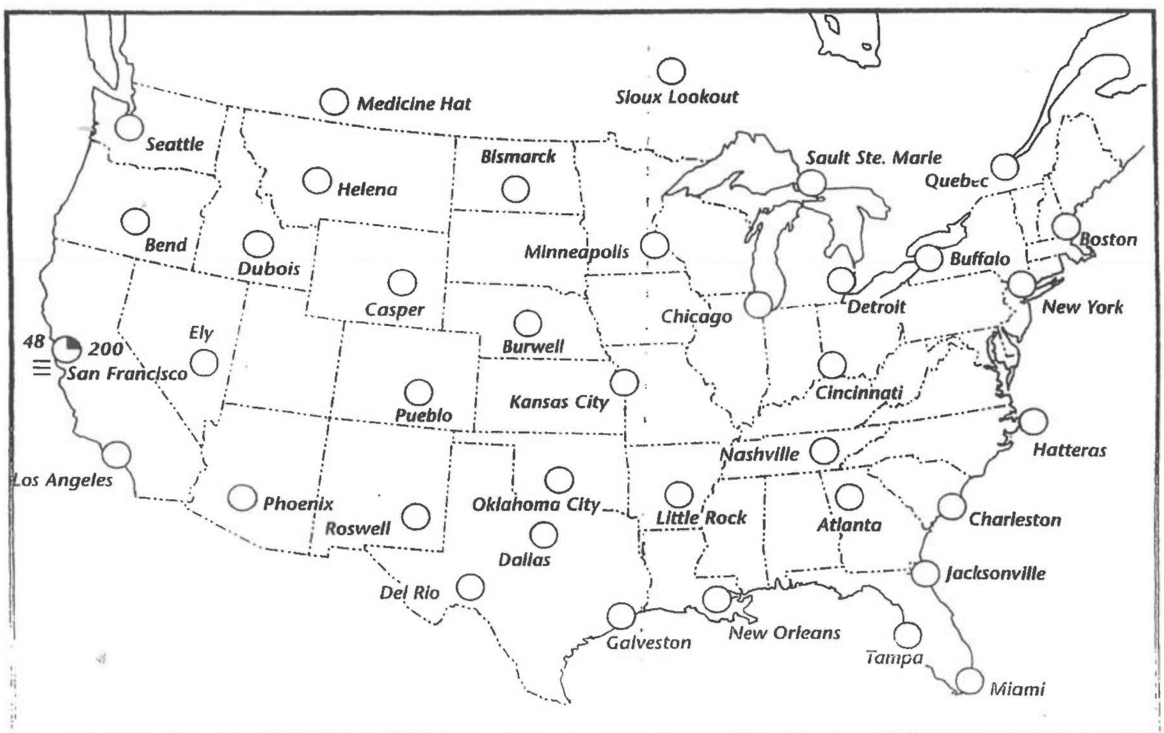
Name ______________________ Date ______________________ Class ______________________

Investigating Weather Maps *(continued)*

2. On your map, find the observation station with the highest atmospheric pressure. Just above it, write H (for high). Find the observation station with the lowest atmospheric pressure. Just above it, write L (for low). Starting at this point, which is the center of a low-pressure area, sketch a cold front and a warm front. Refer to your textbook for the way fronts should look. The cold front will be between stations where winds change from southwest to northwest and temperatures decrease suddenly. The warm front will be between stations where winds change from east to southwest and temperatures rise suddenly.
3. Draw the following isobars on your map: 1008 mb, 1012 mb, 1016 mb, 1020 mb, and 1024 mb. Label each isobar.
4. Draw a line around all the locations where precipitation has fallen. Shade the precipitation area with a colored pencil.

Observations

Weather Map



1. Which observation station reported the highest atmospheric pressure? The lowest atmospheric pressure?

____

____

Name ______________________ Date ________________ Class __________

Investigating Weather Maps *(continued)*

Analyze and Conclude

1. According to your map, is precipitation usually associated with an area of low pressure or an area of high pressure?

____

2. Compare wind direction around the low-pressure center with wind direction around the high-pressure center. Use clock directions in your answer.

____

____

3. Compare the type and location of precipitation associated with the cold front with those associated with the warm front.

____

____

____

4. Describe changes in temperature and wind direction associated with the passage of the warm front.

____

____

____

5. Describe changes in temperature, wind direction, and atmospheric pressure associated with the passage of the cold front.

____

____

____

Critical Thinking and Applications

1. Look at your weather map. Assume that the storm center is moving in a northeasterly direction. Describe at least three changes in the weather in Cincinnati, Ohio, if the low-pressure center moves to Sault Ste. Marie.

____

____

____

2. Can yesterday's weather map help you predict tomorrow's weather? Give a reason for your answer.

____

____

3. Before weather satellites existed, weather forecasts for cities on the West Coast were not as reliable as those for cities in the Midwest. Explain this difference.

____

____

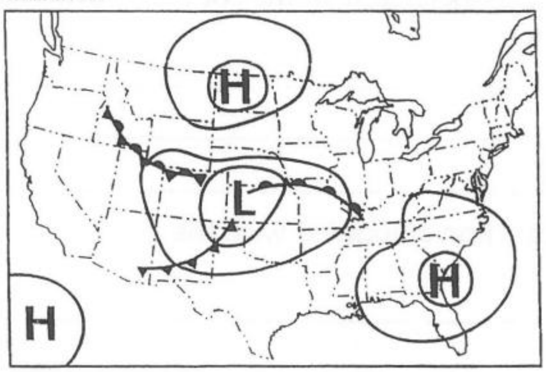
____

____

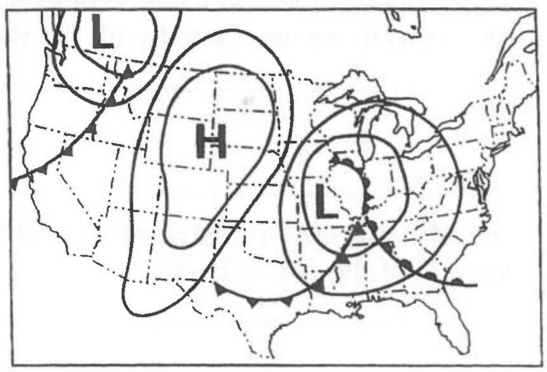
More to Explore

Refer to the two maps to answer the questions.

March 27



March 28



1. If the low-pressure area in the middle of the country on March 27 continues at its present speed and direction, where will it be centered on March 29?

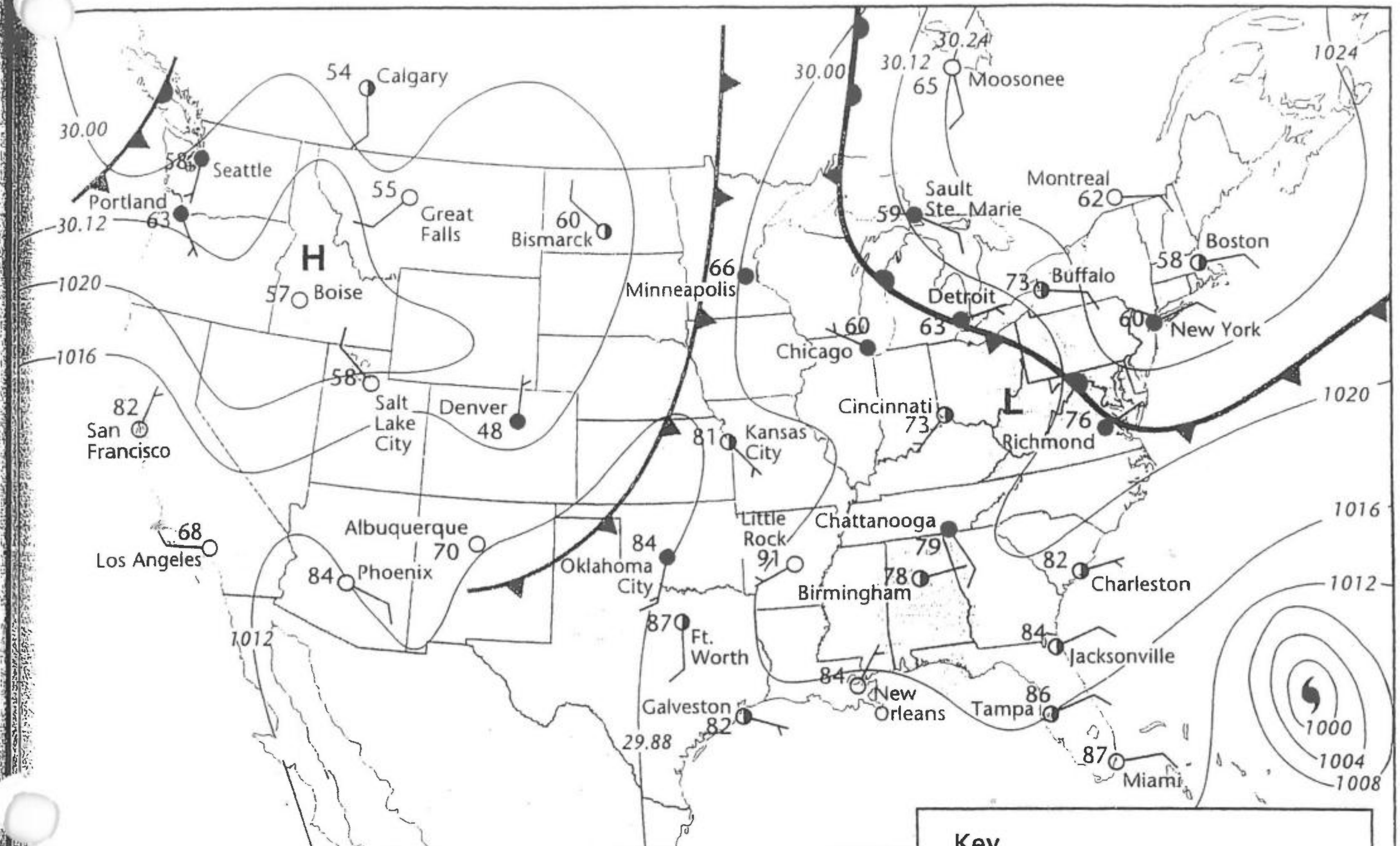
____

2. Predict the weather conditions in Mississippi as the cold front moves through on March 29.

____

____

3. Draw a weather map that predicts the locations of the fronts, highs, and lows for March 29.



Newspaper Weather Maps Maps in newspapers are simplified versions of maps produced by the National Weather Service. Figure 22 on the next page shows a typical newspaper weather map. From what you have learned in this chapter, you can probably interpret most of the symbols on this map. **Standard symbols on weather maps show fronts, areas of high and low pressure, types of precipitation, and temperatures.** Note that the high and low temperatures are given in degrees Fahrenheit instead of Celsius.

Limits of Weather Forecasts As computers have grown more powerful, and new satellites and radar technologies have been developed, scientists have been able to make better forecasts. But even with extremely fast computers, it is unlikely that forecasters will ever be able to predict the weather a month in advance with great accuracy. This has to do with the so-called "butterfly effect." The atmosphere works in such a way that a small change in the weather today can mean a larger change in the weather a week later! The name refers to a scientist's suggestion that even the flapping of a butterfly's wings causes a tiny disturbance in the atmosphere. This tiny event might cause a larger disturbance that could—eventually—grow into a large storm.

NAME ______________________________ DATE ______________

INSTRUCTOR ________________ PERIOD ____ PARTNER______________

UNIT 6: Weather

LAB 6-2: WEATHER WATCH ANALYSIS

INTRODUCTION: Weather records are interesting as a recollection of previous phenomena. They can also be used to draw inferences as to the cause of weather and hence to predict future changes. Although weather cannot be predicted with absolute accuracy, a probability of occurrence, based on percentage, can be established.

OBJECTIVE: You will learn to determine a relationship between weather variables using contingency tables to analyze weather information plotted on graphs.

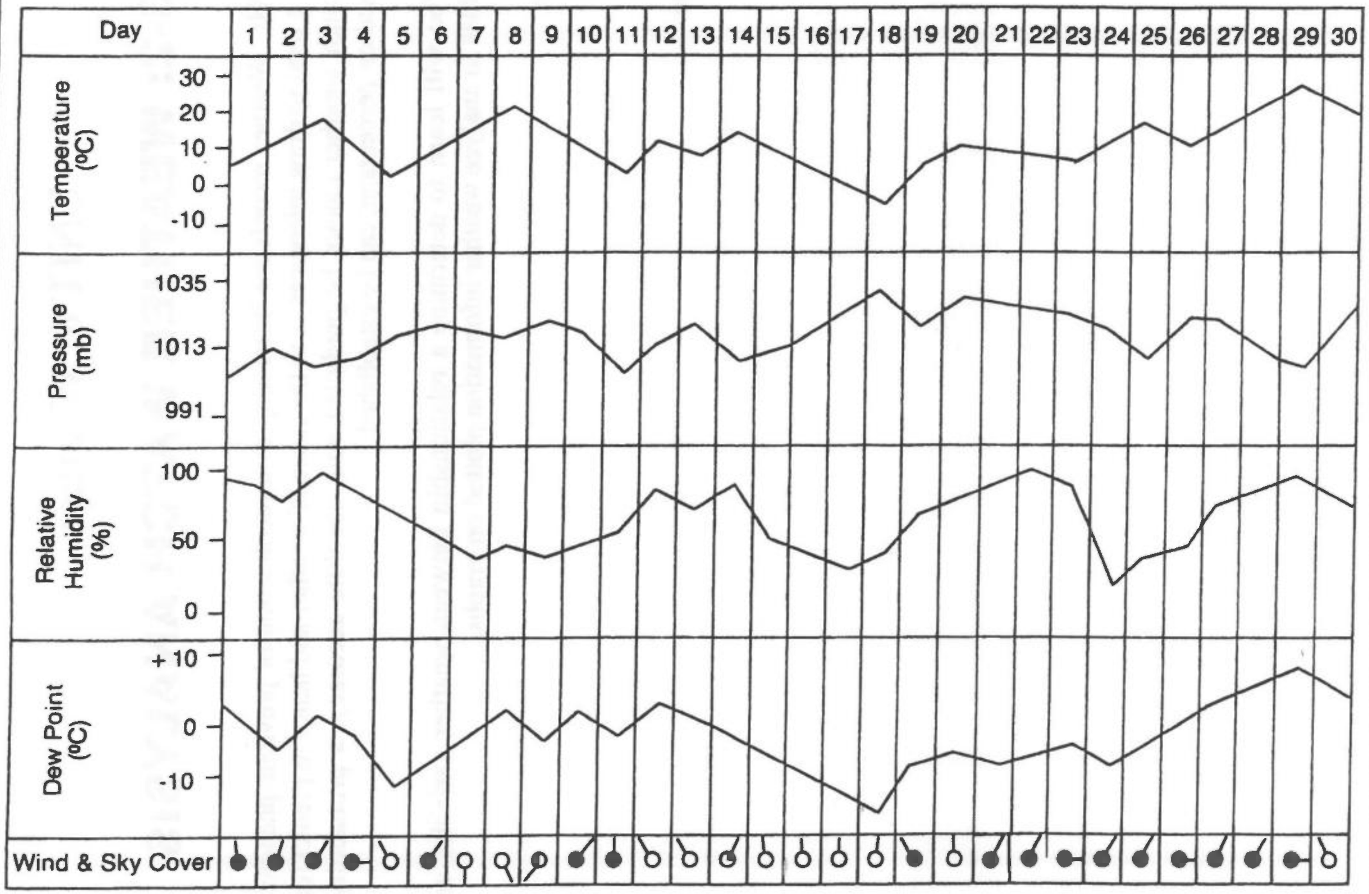
VOCABULARY:

contingency:

weather variable:

probability:

WEATHER CONDITIONS FOR A 30-DAY PERIOD

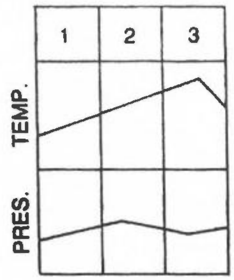


PROCEDURE:

The weather conditions for a 30-day period are shown on the chart.

You are to analyze the relationships between pairs of weather variables. These will be recorded on the Report Sheet.

As an example, to compare the changes in air pressure that occur at the same time there is a change in temperature, you will look at the first two graphs.



AIR PRESSURE CHANGE

TEMPERATURE CHANGE	Rising	Falling	Total
Rising	#1 ____ %	#2 ____ %	
Falling	#3 ____ %	#4 ____ %	

1. On Day 1 the temperature is rising. Find the temperature on Report Sheet # 1. Since temperature is rising, you are going to keep score for this day by placing a mark in one of the two boxes across the top (1 or 2 in the example). But which one?
2. On Day 1 the pressure is rising. To score that, you would use Box 1 or 3 on the example.

Temperature Rising: Box 1 or Box 2

Pressure Rising: Box 1 or Box 3

The relationship shown by Box #1 is that, on this day the temperature was rising and the pressure also was rising. Place a mark in Box #1.

On Day #2 the pressure changes during the day. In such cases, use the trend for most of the day. If it changes in the middle of the day, use the afternoon trend. You now have temperature rising (Box 1 or 2) and pressure falling (Box 2 or 4). They match in Box #2. Place a mark in Box #2.

Continue this procedure for each of the 30 days keeping score in the proper boxes.

3. Under "Total", enter the sum of the markings in the first two columns.

AIR PRESSURE CHANGE

TEMPERATURE CHANGE	Rising	Falling	Total
Rising	/ 1 +	// 2 =	3
Falling	/// 3 +	//// 4 =	7

For each box, calculate the percent probability that two factors vary in this pattern.

In the sample shown:

Temperature and pressure were both rising on only one day out of a total of three days.

$$\frac{1}{3} \times 100 = 33.3\%$$

The temperature was falling while pressure was rising on 3 out of the total of 7 times.

$$\frac{3}{7} \times 100 = 43\%$$

4. Analyze the 30 day weather chart and fill in the required data and calculations on your Report Sheet.

REPORT SHEET

AIR PRESSURE CHANGE

TEMPERATURE CHANGE	Rising	Falling	Total
Rising	________ %	________ %	
Falling	________ %	________ %	

DEWPOINT CHANGE

RELATIVE HUMIDITY CHANGE	Rising	Falling	Total
Rising	________ %	________ %	
Falling	________ %	________ %	

AIR PRESSURE CHANGE

CLOUD COVER	Rising	Falling	Total
Clear	________ %	________ %	
Partly Cloudy	________ %	________ %	
Cloudy	________ %	________ %	

AIR PRESSURE CHANGE

WIND DIRECTION	Rising	Falling	Total
N-NW	________ %	________ %	
NE-E	________ %	________ %	
SE-S-SW	________ %	________ %	

DISCUSSION QUESTIONS: *(Answer in Complete Sentences)*

1. What do you think is the least percentage of occurrence that two factors must vary in a given pattern before you decide that there is a connection between them?

2. List the 6 changes in atmospheric variables that usually precede rain, as shown by the contingency tables.

3. List the 6 changes in atmospheric variables that usually precede fair weather, as shown by the contingency tables.

4. What is the relationship between the following variables?
   a) Air Pressure and Temperature:

   b) Air Pressure and Cloud Cover:

   c) Air Pressure and Wind Direction:

5. As the relative humidity increases, what change in dew point temperature can you predict?

6. As the difference between dew point temperature and air temperature decreases, what is the probability of precipitation?

CONCLUSION: How can contingency tables be used for predicting the weather?

Mapping GeoLab: Interpret a Weather Map

The surface weather map on the following page shows actual weather data for the United States. In this activity, you will use the station models, isobars, and pressure systems on the map to forecast the weather.

PREPARATION

Question

How can you use a surface weather map to interpret information about current weather and to forecast future weather?

Materials

pencil
ruler
Reference Handbook, Weather Map Symbols, p. 959

PROCEDURE

1. Read and complete the lab safety form.
2. The map scale is given in nautical miles. Refer to the scale when calculating distances.
3. The unit for isobars is millibars (mb). In station models, pressure readings are abbreviated. For example, 1021.9 mb is plotted on a station model as 219 but read as 1021.9.
4. Wind shafts point in the direction from which the wind is blowing. Refer to Weather Map Symbols, in the table on the right and the *Reference Handbook* to learn about the symbols that indicate wind speed.
5. Each number around a city represents a different atmospheric measure. By convention, the same atmospheric measure is always in the same relative location in a station model. Refer to **Figure 12.17** and Weather Map Symbols in the *Reference Handbook* to learn what numbers represent in a station model.

Symbols Used in Plotting Report

Fronts and Pressure Systems	
(H) or High **(L) or Low**	Center of high- or low-pressure systems
	Cold front
	Warm front
	Occluded front
	Stationary front

Name ______________________ Class ________ Date ________

Mapping GeoLab Interpret a Weather Map

ANALYZE AND CONCLUDE

1. **Identify** the contour interval of the isobars.

2. **Find** the highest and lowest isobars and where they are located.

3. **Describe** the winds across Texas and Louisiana.

4. **Determine** and record with their locations the coldest and warmest temperatures on the map.

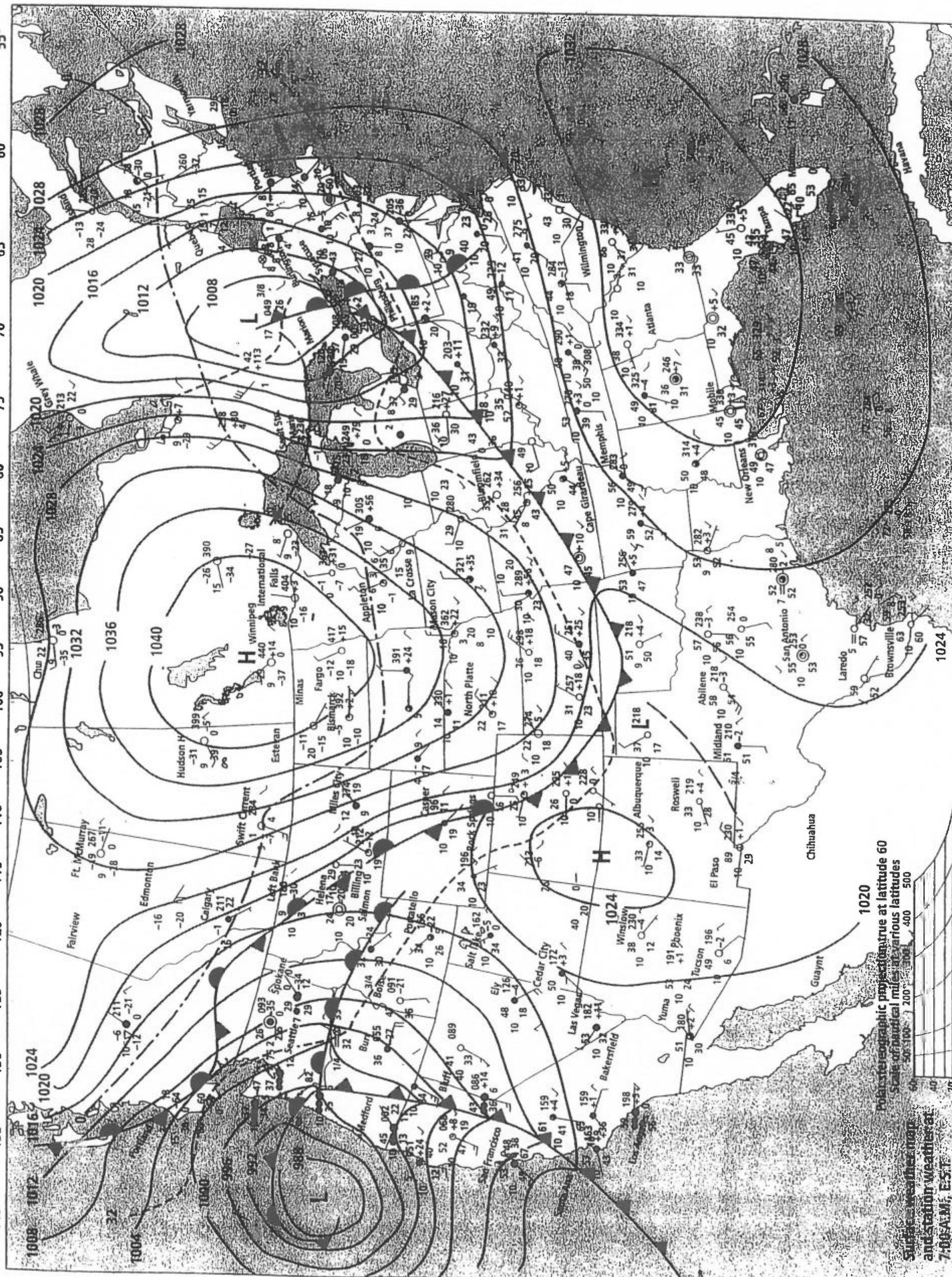
5. **Infer** whether the weather in Georgia and Florida is clear or rainy. Explain.

6. **Predict** Low-pressure systems in eastern Canada and off the Oregon coast are moving toward the east at about 24 km/h. Predict short-term weather forecasts for northern New York and Oregon.

Forecasting Find your area on the map. Based on the data shown in the map, use the extrapolation method to forecast the next day's weather for your location.

Name Class Date

Mapping GeoLab Interpret a Weather Map



Name Class Date

Internet GeoLab Track a Tropical Cyclone

Tropical cyclones form very violent storms. That is why it's important to have advancewarning before they hit land. By tracking the changing position of a storm on a chart and connecting these positions with a line, you can model or predict a cyclone's path.

PREPARATION

Problem

What information can you obtain by studying the path of a tropical cyclone?

Objectives

In this GeoLab, you will:

- **Gather** and **communicate** data about hurricanes.
- **Plot** data on a tropical cyclone-tracking chart.
- **Predict** where storm-inflicted damage might occur.

PROCEDURE

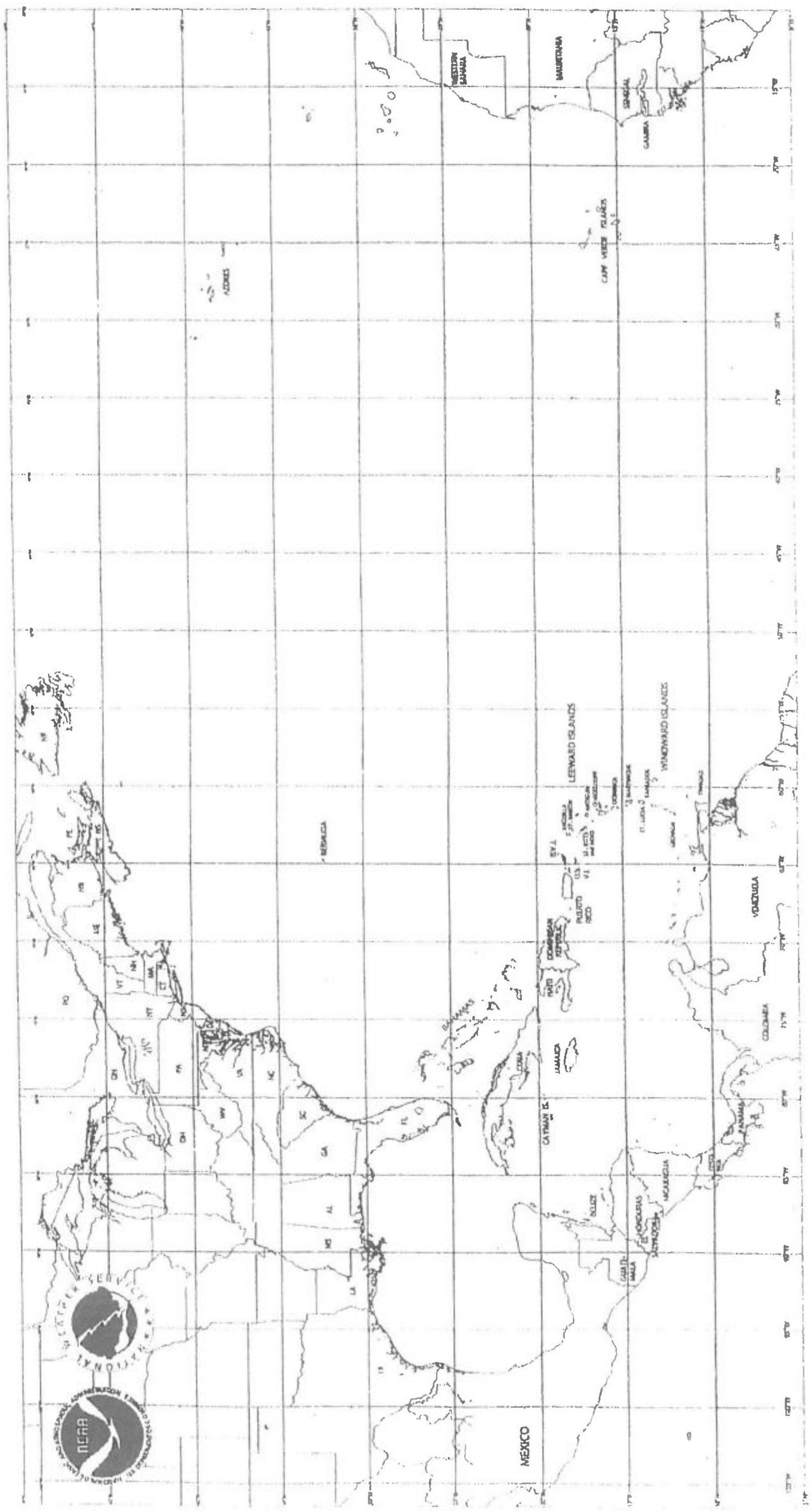
1. Read and complete the lab safety form.
2. Form a hypothesis about how a tropical cyclone's path can be used to predict the strength of the storm and where the most damage might be inflicted.
3. Visit glencoe.com to find links to tropical cyclone data.
4. Choose the track of a tropical cyclone that has occurred during the past five years.
5. Plot the position, air pressure, wind speed, and stage of the tropical cyclone at 6-h intervals throughout its existence.
6. Plot the changing position of the tropical cyclone on your hurricane-tracking chart.
7. Incorporate your research into a data table. Add any additional information that you think is important.

Name Class Date

Internet GeoLab Track a Tropical Cyclone

DATA TABLE

Atlantic Basin Hurricane Tracking Chart
National Hurricane Center, Miami, Florida



This is a reduced version of the chart used to track hurricanes at the National Hurricane Center

Name Class Date

Internet GeoLab Track a Tropical Cyclone

ANALYZE AND CONCLUDE

1. **Identify** What was the maximum wind speed in knots that the tropical cyclone reached?

2. **Calculate** Multiply the value from question 3 by 1.85 to find the wind speed in kilometers per hour. Based on this value, how would the hurricane be classified on the Saffir-Simpson scale shown in **Figure 13.15?**

3. **List** the landmasses over which the tropical cyclone passed.

4. **Identify** What was the life span of your tropical cyclone? What was the name of your cyclone?

5. **Infer** Where would you expect the storm surge to have been greatest? Explain.

6. **Examine** How was the tropical cyclone's strength affected when its center passed over land?

Peer Review Visit glencoe.com and post a summery of your data. Compare your data with other data collected for this investigation.

Name ______________________ Date ______________ Class ______________

Tracking a Hurricane

Problem

How can you predict when and where a hurricane will come ashore?

Skills Focus

interpreting data, predicting, drawing conclusions

Materials

ruler

red, blue, green, and brown pencils

tracing paper

Procedure

1. Look at the plotted path of the hurricane on the map in your textbook. Each dot represents the location of the eye of the hurricane at six-hour intervals. The last dot shows where the hurricane was located at noon on August 30.
2. Predict the path you think the hurricane will take. Place tracing paper over the map in your textbook. Using a red pencil, place an X on your tracing paper where you think the hurricane will first reach land. Next to your X, write the date and time you think the hurricane will come ashore.
3. Hurricane warnings are issued for an area that is likely to experience a hurricane within 24 hours. On your tracing paper, shade in red the area for which you would issue a hurricane warning.
4. Using the following data table, plot the next five positions for the storm, using a blue pencil. Use your ruler to connect the dots to show the hurricane's path.

Date and Time	Latitude	Longitude
August 30, 6:00 P.M.	28.3°N	86.8°W
August 31, midnight	28.4°N	86.0°W
August 31, 6:00 A.M.	28.6°N	85.3°W
August 31, noon	28.8°N	84.4°W
August 31, 6:00 P.M.	28.8°N	84.0°W

Tracking a Hurricane *(continued)*

5. Based on the new data, decide if you need to change your prediction of where and when the hurricane will come ashore. Mark your new predictions in blue pencil on your tracing paper.
6. During September 1, you obtain four more positions. (Plot these points only after you have completed Step 5.) Based on these new data, mark in green pencil when and where you now think the hurricane will come ashore.

Date and Time	Latitude	Longitude
September 1, midnight	28.8°N	83.8°W
September 1, 6:00 A.M.	28.6°N	83.9°W
September 1, noon	28.6°N	84.2°W
September 1, 6:00 P.M.	28.9°N	84.8°W

7. The next day, September 2, you plot four more positions using a brown pencil. (Plot these points only after you have completed Step 6.)

Date and Time	Latitude	Longitude
September 2, midnight	29.4°N	85.9°W
September 2, 6:00 A.M.	29.7°N	87.3°W
September 2, noon	30.2°N	88.8°W
September 2, 6:00 P.M.	31.0°N	90.4°W

Analyze and Conclude

Write your answers in the spaces provided.

1. Interpreting Data Describe in detail the complete path of the hurricane you tracked. Include where it came ashore, and identify any cities that were in the vicinity.

2. **Predicting** How did your predictions in Steps 2, 5, and 6 compare with what actually happened?

3. **Interpreting Data** What was unusual about your hurricane's path?

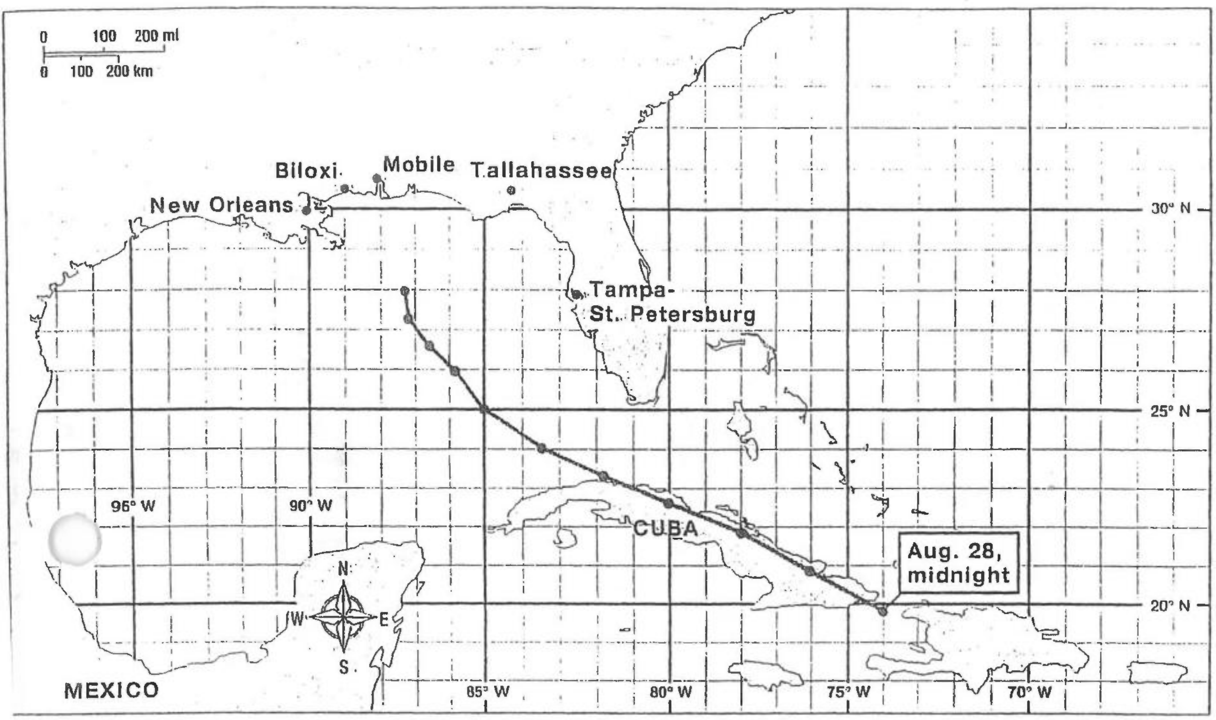
4. **Inferring** How do you think hurricanes with a path like this one affect the issuing of hurricane warnings?

5. **Drawing Conclusions** Why do you have to be so careful when issuing warnings? What problems might be caused if you issued an unnecessary hurricane warning? What might happen if a hurricane warning were issued too late?

6. **Communicating** In this activity, you had data for only the hurricane's position. If you were tracking a hurricane and issuing warnings, what other types of information would help you make decisions about the hurricane's path? Write a paragraph describing the additional information you would need.

More to Explore

With your teacher's help, search the Internet for more hurricane tracking data. Map the data and try to predict where the hurricane will come ashore.



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6. **Communicating** In this activity you only had data for the hurricane's position. If you were tracking a hurricane and issuing warnings, what other types of information would help you make decisions about the hurricane's path? Write a paragraph describing the additional information you would need.

More to Explore

With your teacher's help, search the Internet for more hurricane tracking data. Map the data and try to predict where the hurricane will come ashore.

Name Class Date

Mapping GeoLab — Pinpoint a Source of Pollution

Iris City and the surrounding region are shown in the map on the facing page. Iris City is a medium-sized city of 100,000. It is experiencing many types of environmental impacts. Iris City obtains its drinking water from Opal Lake. Studies of the lake have detected increased levels of nitrogen, phosphorus, hydrocarbons, sewage, and silt.

The northwest end of Opal Lake is experiencing increased development while the remainder of the watershed is a mix of forest and logging clear-cuts. Last spring, blooms of cyanobacteria choked parts of the Vista Estuary Nature Preserve. Commercial shellfish beds in Iris Bay have been closed because of sewage contamination.

A natural-gas power plant has been proposed for location A, near the Vista Cutoff, an abandoned channel of the Vista River. The plant would provide jobs as well as generate electricity. The company plans to divert 25 percent of the Vista River through the Vista Cutoff.

The Lucky Mine was abandoned 60 years ago. A mining company has applied for permits to reopen the mine. An estimated 1 million ounces of gold can be recovered using modern - techniques.

You will work with a small group of students to make recommendations to the residents of Iris City. Included in your recommendations should be: possible pollution sources for Opal Lake, possible causes of the cyanobacteria bloom, recommendations for the development of the natural-gas power plant, and the opening of Lucky Mine.

PREPARATION

Problem

How can the residents of Iris City best manage their water supply?

Materials

metric ruler
science notebook

PROCEDURE

1. Read and complete the lab safety form.
2. Working in small groups, brainstorm possible sources of pollution in Opal Lake.
3. Discuss what steps the residents of Iris City might take to protect their drinking water.
4. Research common causes of cyanobacteria blooms. Discuss what might be causing the bloom in the Vista Estuary Nature Preserve.
5. Discuss the positive and negative aspects of diverting water from the Vista River through the Vista Cutoff. What are other possible impacts (both positive and negative) in the development of the natural-gas power plant?
6. Discuss the possibility of reopening Lucky Mine. If it is reopened, brainstorm ways the mining company might minimize negative environmental impacts.
7. Prepare to present your recommendations to the class.

[illegible] Pollution

[illegible]

[illegible] of the water and [illegible] of forest and logging [illegible] parts of the [illegible] [illegible]

[illegible]

[illegible]

This field work [illegible] a group of students to make recommendations [illegible] City. Included in [illegible] recommendations should be [illegible] [illegible] of the [illegible]

PREPARATION

Problem

How can the [illegible] level [illegible]

[illegible]

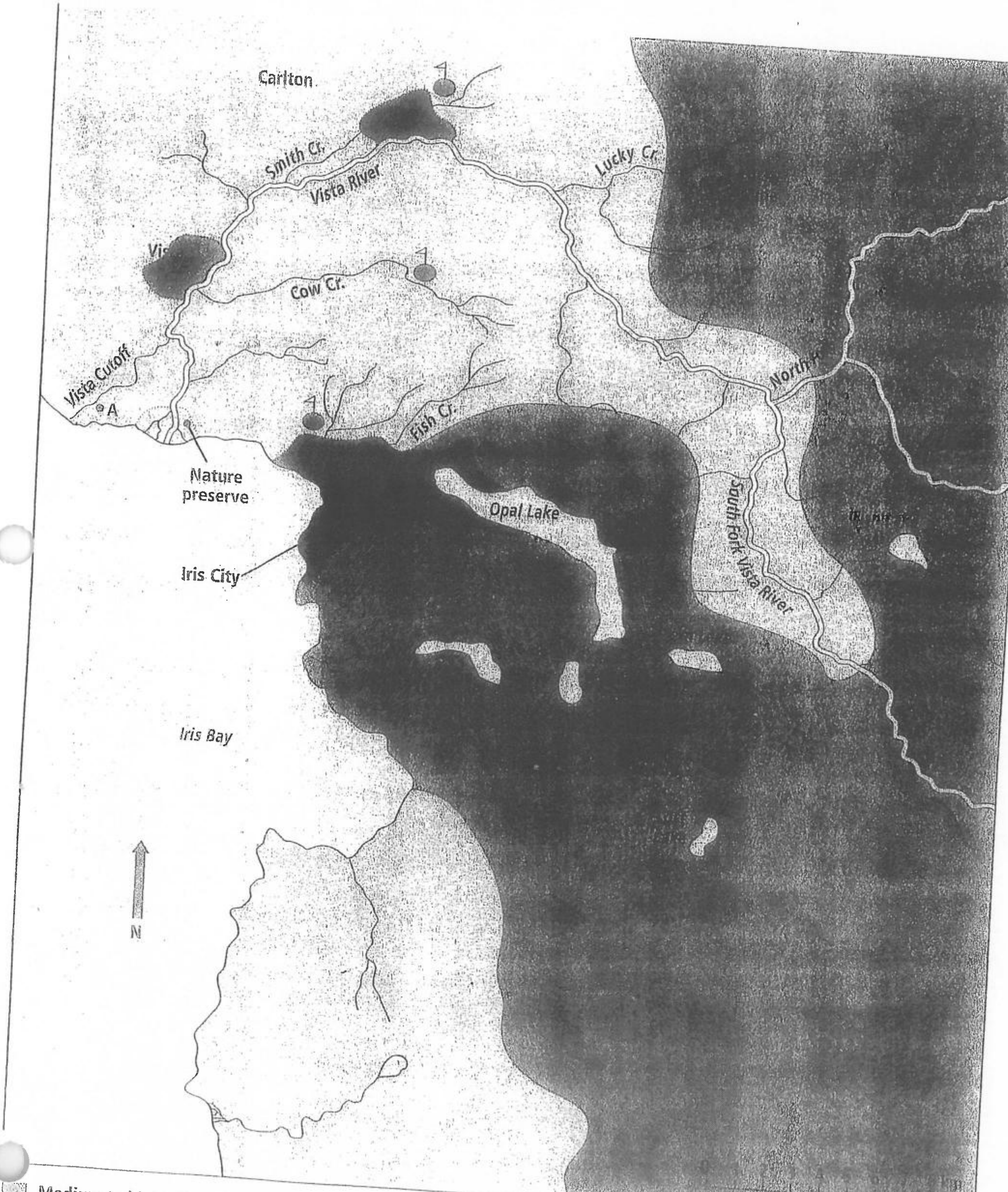
PROCEDURE

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

Name Class Date

Mapping GeoLab: Pinpoint a Source of Pollution



Medium to high urban development
River
Forest land
Agriculture/Dairy farms
Golf course
Mine

Mapping GeoLab

Pinpoint a Source of Pollution

ANALYZE AND CONCLUDE

1. **Identify** What did your group list as possible sources of pollution for Opal Lake and Iris Bay? Are these point sources or nonpoint sources of pollution?

2. **Experiment** How would you determine if you were correct about the source of the cyanobacteria bloom in Vista Estuary? What tests might you run to confirm your predictions?

3. **Research** What information did you discover in your research on cyanobacteria that applied to Iris City? List all the possible sources your group identified.

4. **Research** You've identified the possible sources of pollution for Opal Lake. Reports indicate increased levels in nitrogen, phosphorus, hydrocarbons, sevage, and silt. Research how this might affect the health of the residents that obtain their water from the lake.

Name Date Class

Who contributes CO_2?

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. What is the connection between Earth's surface temperature and carbon dioxide?

____

2. What is the connection between carbon dioxide and fossil fuels?

____

Many scientists believe that Earth's surface temperature is rising because of increasing levels of heat-trapping carbon dioxide, CO_2, in Earth's atmosphere. The combustion of fossil fuels contributes CO_2 to Earth's atmosphere. Significant amounts of CO_2 are produced by cement production and gas flaring.

Real-World Problem

Which countries produce the most carbon dioxide from the combustion of fossil fuels?

Materials

Pen or pencil

Goals

- **Compare and Contrast** the total carbon dioxide emissions from selected countries.
- **Calculate** the average annual per capita amount of carbon dioxide for each country.
- **Form a hypothesis** that explains the amount of carbon dioxide produced by each country.

Procedure

1. Complete the data table by calculating the amount of carbon dioxide produced per person for each country.

Country	CO_2 Emissions (millions of tons of carbon)	Total Population (millions of persons)	CO_2 Produced (tons per person)
United States	1,446.8	263.8	
China	918.0	1210.0	
Russian Federation	431.1	149.9	
Japan	318.7	125.5	
India	272.2	936.5	
Canada	111.7	28.4	
France	98.8	58.1	