EARTH SCIENCE
LAB & REVIEW BOOK
PART 1

LAWRENCE HIGH SCHOOL
DEPARTMENT OF SCIENCE

2 Reilly Road
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Lawrence High School Science Laboratory Policy

As stated in the new Standards from the New York State CORE Curricula Guides for all science regents courses: "as a prerequisite for admission to the regents exams (in science) students must have successfully completed 1200 minutes (30 labs each 40 minutes in duration) of laboratory experiences with satisfactory reports on file.

To help each student achieve a successful laboratory experience, the following is the mandated laboratory policy at Lawrence High School:

1. **All laboratory reports must be submitted during the marking period in which the laboratory experience is completed.** Laboratory reports will not be accepted after the end of that marking period.
2. **All students must complete a minimum of 70% of the laboratory reports required for each marking period to receive a passing grade in the course** Students who fail to submit the 70% will receive a maximum marking period grade of 60, regardless of the academic work already achieved in that course.
3. Laboratory work will have a weight of at least **20%** of the grade for each marking period.
4. A completed lab report does not mean it is satisfactory for a grade that can be used towards the state mandated 1200 minutes. The science teacher must accept the lab report as satisfactory with a passing grade. (Each teacher may establish his/her own policy regarding the time requirement for the submission of the report during a marking period. Further there is no departmental policy regarding the formatting of reports.)
5. Laboratory reports that are submitted late during a marking period may be considered for regents credit (towards the 1200 minutes), but may be considered too late for a passing grade.
6. Some teachers may require students to maintain their own laboratory folder throughout the school year It is the student's responsibility to present the completed folder at the end of the year in order to receive laboratory credit.

Date: _____ Teacher: _____

Student's Signature: _____

Parent's Signature: _____

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Date: _____ Teacher: _____

Student's Signature: _____

Parent's Signature: _____

Name: _____ Date: _____

LAWRENCE HIGH SCHOOL SCIENCE DEPARTMENT

STUDENT SAFETY CONTRACT

I will:

-Follow all instructions given by the teacher

-Protect eyes, face, hands and body while conduction class activities.

-Carry out good housekeeping practices.

-Know where to get help fast.

-Know the location of first aid and fire fighting equipment.

-Conduct myself in a responsible manner at all times in a laboratory situation.

-Never bring food or drinks into the laboratory

I, _____, have read and agree to abide by the safety regulations as set forth above and also any additional printed instructions provided by the teacher and / or district. I further agree to follow all other written and verbal instructions given in class.

_____ _____

Date Student's Signature

_____

Parent's Signature

Name:_____ Date:_____

Introduction to Earth s Changing Environment
Topic 1 Vocabulary

Classification. _____

Cyclic change: _____

Density: _____

Dynamic equilibrium: _____

Inference: _____

Instrument: _____

Interface. _____

Mass: _____

Measurement: _____

Natural hazard: _____

Natural resource: _____

Observation: _____

Name:_____ Date:_____

Percent deviation: _____

_____

Pollution: _____

_____

Predication: _____

_____

Rate of change. _____

_____

Universe: _____ _____

_____

Volume: _____

_____

Name _____ Date _____

More Measurement

Round off the following to the nearest tenth of a centimeter

1) 66.63 cm _____
2) 15.39 cm _____
3) 42.O6cm _____
4) 12.12 cm _____
5) 78.01 cm _____
6) 99.l5 cm= _____
7) 14.01 cm= _____
8) 16.32cm _____
9) 78.l6cm _____
10) 91.04cm _____

Fill in the following:

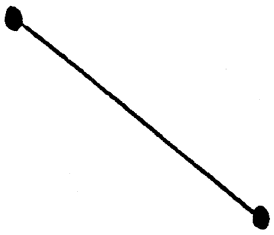
l) The units for volume are _____

2) The units for percent error are _____

3) The units for density are _____

4) The units for mass are _____

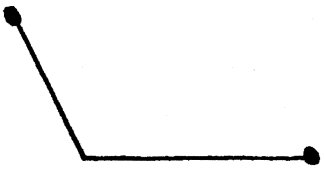
Use your Earth Science Reference Table to measure the following to the nearest tenth of a centimeter



A) _____

B) _____

C) _____



D) _____

Name _____ Date _____

Courtyard Observation Lab

Objective:
The student will learn to use observations to make predictions and inferences.

Materials:
The Courtyard
graph paper
colored pencils

Procedure:
1 Complete the vocabulary list below

Observation_____

Inference_____

Senses_____

Interpretation_____

Prediction_____ _____

2. Using the above words, create a web below

Name _____ Date _____

3. Carefully observe the courtyard. Record your observations on the back of this sheet. Sketch the area.

Analysis and Conclusions:
Answer each question in complete sentences on your answer sheet.

1 List some possible changes in the area that might occur in the next day the next month, over the next year

2. What is the difference between an observation and an inference?

3. Pick one observation you made about the courtyard, and come up with an inference for it.

4 Using that observation and inference come up with a prediction.

5. After observing the courtyard, what conclusions can you come to?

Name _____ Date _____

Answer sheet for Courtyard Observations

1 _____

_____

_____

_____

2. _____

_____

_____

_____

3. _____

_____

_____

_____

4 _____

_____

_____

_____

5. _____

_____

_____

_____

Name _____ Date _____

New York State Location Lab

Objective:
To become more familiar with the state of New York.

Materials:
Earth Science Reference Table (page three)
blue colored pencil

Procedure:
Use the earth Science Reference Table to answer the following questions.

1 Label the major bodies of water (numbers 1-6)

2. Label the major rivers. (numbers 7 11)

3. Label the cities. (numbers 12-26)

4. Label the capital (●)

5. Label the two mountains. (✕)

6. Label Lawrence and Long Island.

7 Label the five surrounding states. (numbers 27-31)

8. Label the country to the north. (32)

9. Color all the water blue.

Analysis and Conclusion
Write all answers on the answer sheet.

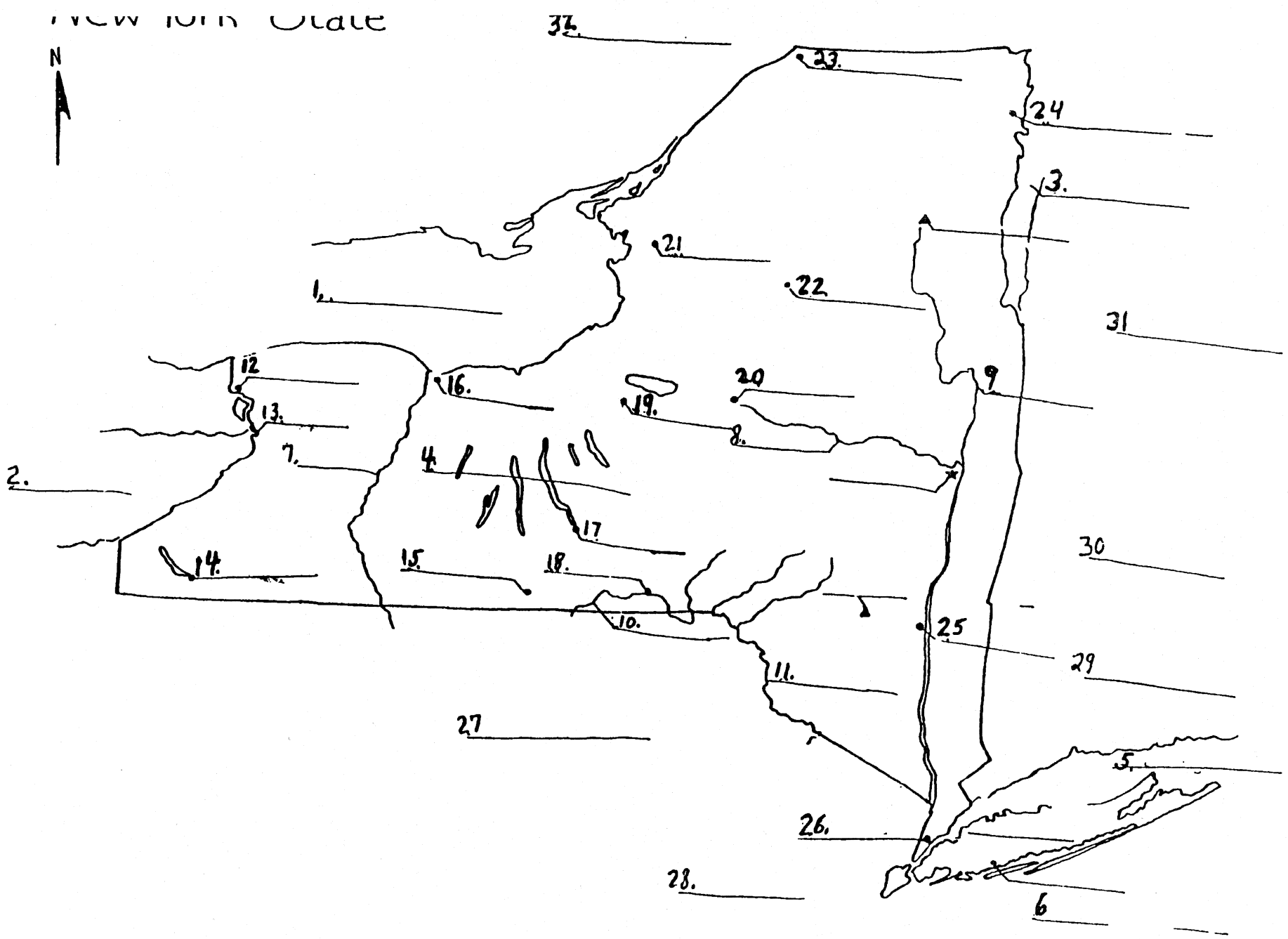
1. Which state is south of Massachusetts?

2. Which lake is west of Buffalo?

3. Which city is north of Lake Champlain?

4. How many Finger Lakes are there?

5. Which river is closest to Long Island?


New York State
N
32.
23.
24
3.
21.
22.
31
1.
12.
16.
20
9
19.
13.
8.
7.
4.
2.
17
30
14.
15.
18.
10.
25
29
11.
27
5.
26.
28.
6

Name _____ Date _____

Answer sheet for New York State Location Lab

Analysis and Conclusion

1 _____

2. _____

3. _____

4. _____

5. _____

Name:_____ Name:_____

Percent Error Worksheet

Predict how many times you can do the following activities, then test your predictions by actually doing each one. Using the percent error formula calculate your percent error

$$\text{Percent Error} \quad \frac{\text{Difference from Accepted value (Actual Prediction)}}{\text{Accepted Value (Actual)}} \times 100$$

In 15 Seconds: How many times can you:

	Prediction	Actual	Equation (Work)	Percent Error
Tap your Foot?				
Make a Fist?				
Snap Your Fingers?				

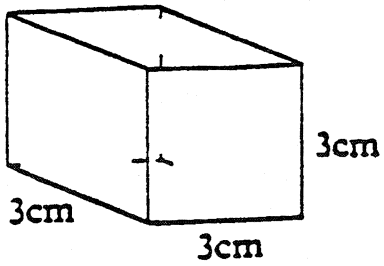
In 30 Seconds:

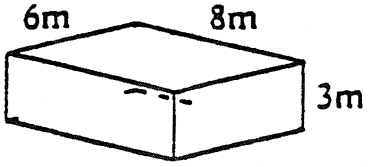
	Prediction	Actual	Equation (Work)	Percent Error
How far can you count by five?				
How many foods can you name?				

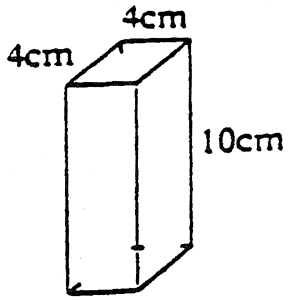
In 60 Seconds:

	Prediction	Actual	Equation (Work)	Percent Error
How far can you count by ones?				
How many times can you tap your foot?				

Determine the volume of the objects in each illustration:

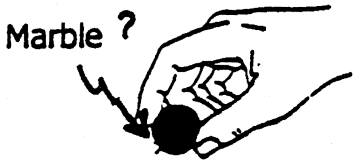


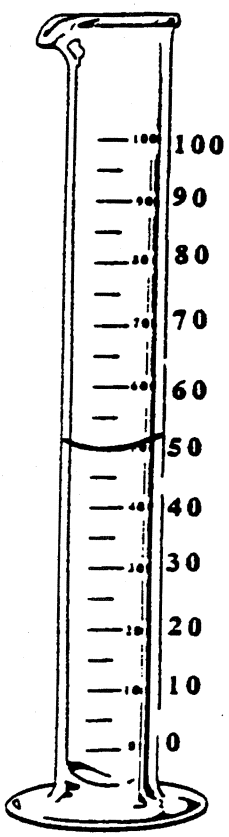


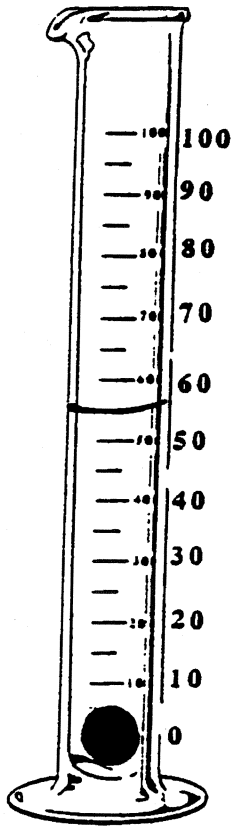


_____ _____ _____

Volume by Displacement







Volume of Water

Volume of Water and Marble

Volume of Marble

_____ _____ _____

Name _____ Date _____

Density Lab

Objective:
To understand density

Materials:
Minerals
Balance scale
Graduated cylinder

Procedure:

Use your Earth Science Reference Table and answer the following questions.

1. Write the formula for density.

2. For each mineral listed in the following chart, fill in the missing measurement using the formula you found for density If more than one measurement is missing, use the balance scale or graduated cylinder to assist you.

Mineral	Mass (grams)	Volume (cm)	Density (g/cm)
1. Quartz			
2. Galena			
3 Olivine			
4. Orthoclase			2.6
5 Calcite			2.7
6. Amphibole			3.2
7 Magnetite		11.1	5.2
8. Copper	387 1		8.9
9 Calcopyrite		20.6	4.2
10. Dolomite		3.8	2.9

Analysis and Conclusions

1 Arrange the minerals quartz, olivine, and galena in order of increasing average density

_____

2. What is the name of the least dense mineral on the entire chart?

_____

Name _____ Date _____

3. What is the name of the most dense mineral on the entire chart?

_____

4. Arrange all of the minerals that begin with the letter "C" in order of increasing average density

_____

_____

5. Describe in complete sentences how to determine the volume when the density and mass are known.

_____

_____

_____

_____

6. Listed below are the densities of quartz, galena and olivine. Compare your measured densities with the accepted values. Determine your percent error for all three minerals. Show all work.

Quartz density – 2.6 g/cm^3

A) Percent error

B) Substitute data

C) Answer with units

Galena density = 7.5 g/cm^3

A) Percent error

B) Substitute data

C) Answer with units

Name _____ Date _____

Olivine density = 3.4 g/cm^3

A) Percent error

b) Substitute data

C) Answer with units

Name _____ Date _____

Sunspot Analysis Lab

Objective:
To be able to predict future events by graphing a natural; phenomenon.

Materials:
Pencil

Background Information:
In this lab we will plot the yearly changes in the number of sunspots that appear on the surface of the Sun. When photographs are taken of the Sun, dark areas appear on its surface. These spots are believed to be solar storms and are areas cooler than their surroundings. The number and pattern of these spots change with time.

Procedure:
1 Label each graph axis.

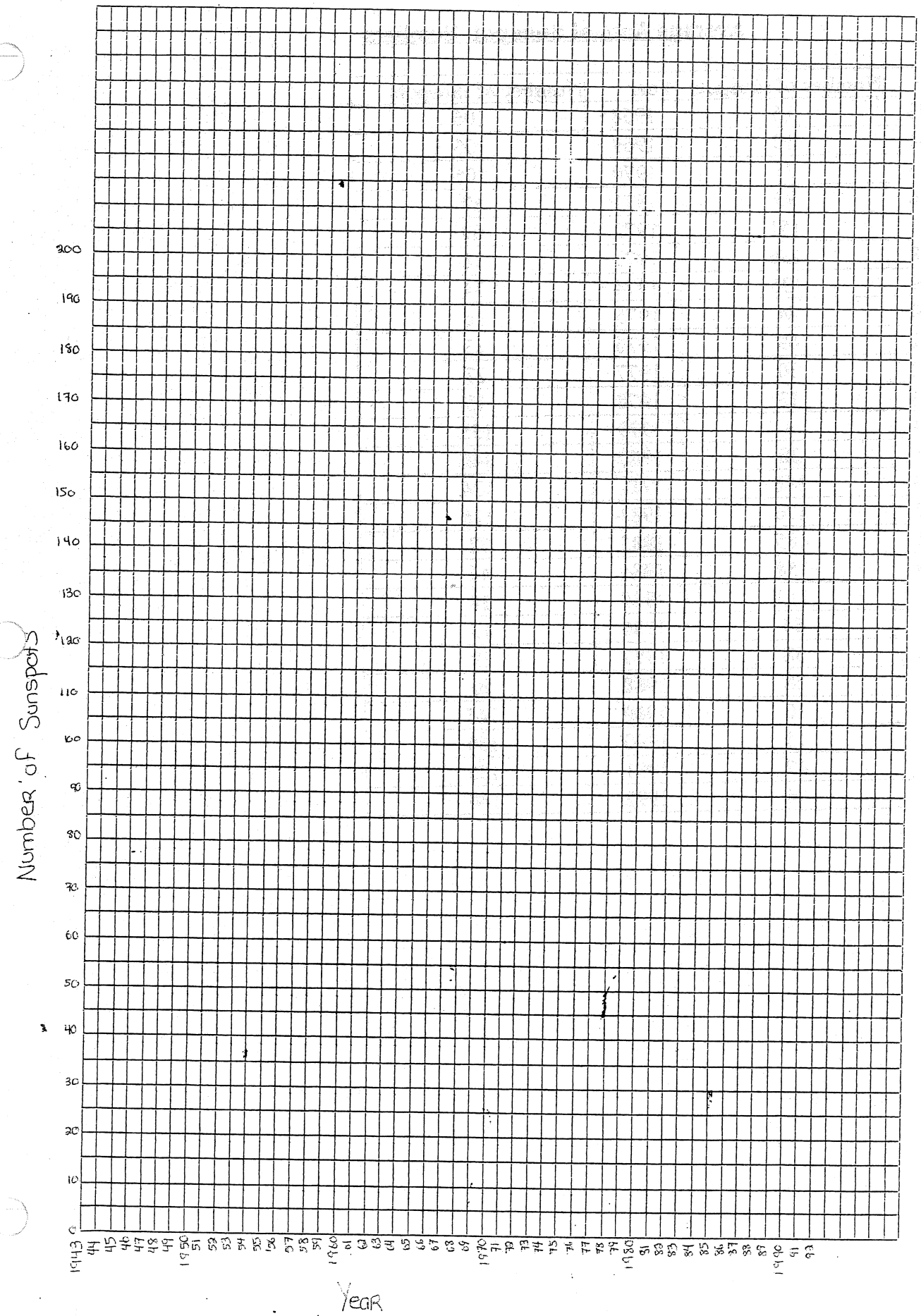
2. Using the data given, graph the number of sunspots in the years 1943 to 1992.

Name _____ Date _____

Average Annual Sunspot Numbers

Year	Number of sunspots	Year	Number of sunspots
1943	16	1968	106
1944	10	1969	105
1945	31	1970	105
1946	93	1971	67
1947	151	1972	69
1948	136	1973	38
1949	135	1974	34
1950	84	1975	16
1951	69	1976	13
1952	30	1977	27
1953	13	1978	93
1954	4	1979	155
1955	38	1980	146
1956	141	1971	134
1957	176	1982	116
1958	185	1983	72
1959	158	1984	46
1960	112	1985	18
1961	54	1986	13
1962	38	1987	29
1963	28	1988	50
1964	10	1989	145
1965	15	1990	155
1966	47	1991	150
1967	94	1992	140

Name _____ Date _____


Number of Sunspots
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1943
44
45
46
47
48
49
1950
51
52
53
54
55
56
57
58
59
1960
61
62
63
64
65
66
67
68
69
1970
71
72
73
74
75
76
77
78
79
1980
81
82
83
84
85
86
87
88
89
1990
91
92
93
Year

Name _____ Date _____

Answer Sheet for Sunspot Analysis Lab

1 _____

2. _____

3. _____

4. _____

5. _____

6. _____

7 _____

8. _____

Name _____ Date _____

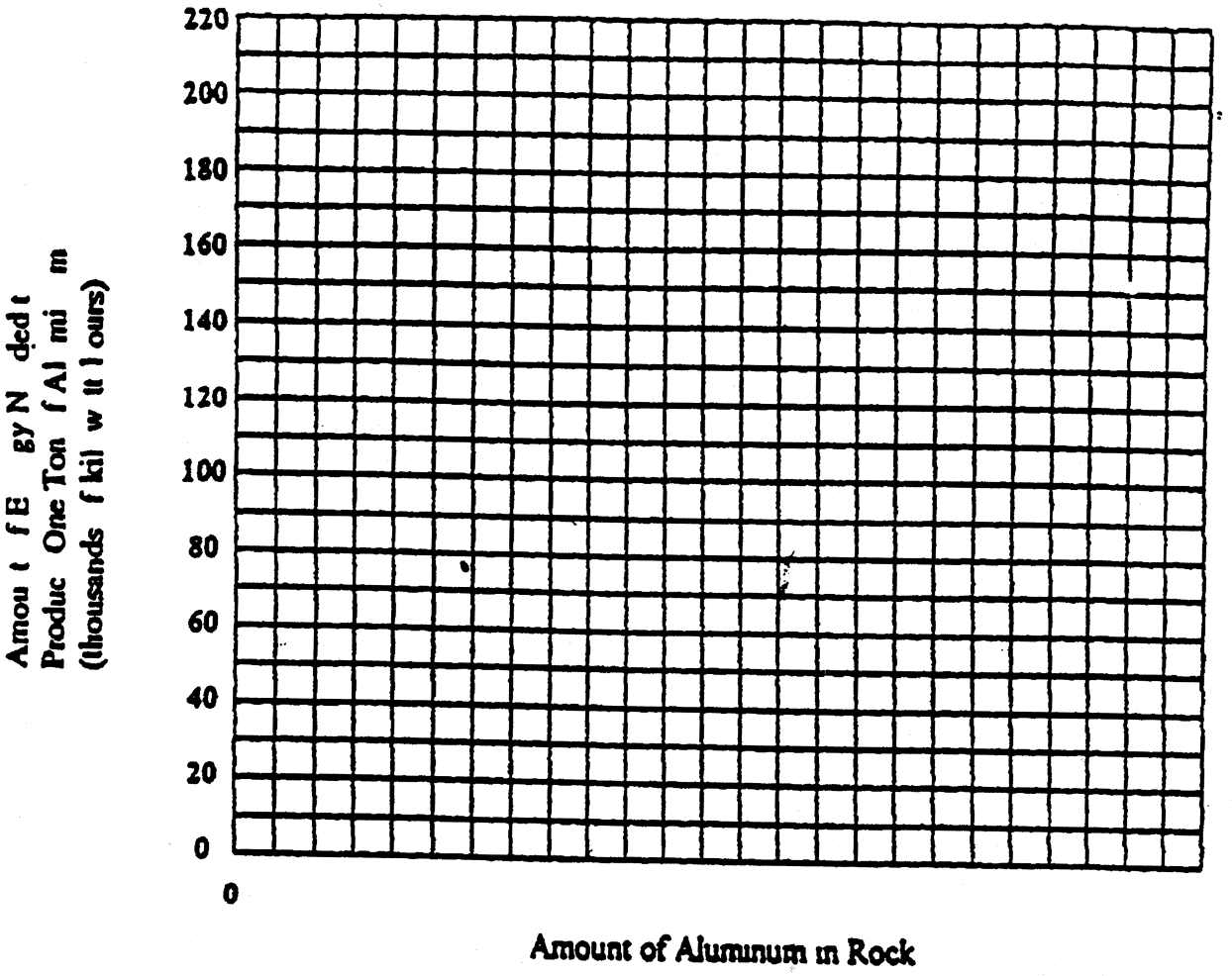
Graphing worksheet

Base your answers to the questions on the data table below. The data table shows the relationship between the amount of aluminum in a type of rock and the energy needed to extract the aluminum from the rock.

Amount of aluminum in rock (percent)	Amount of Energy needed to produce one ton of alum[illegible]m (thousands of kilowatt-hours)
3	220
5	140
10	90
20	65
30	54
40	49
50	48

1 Mark an appropriate scale on the axis labeled Amount of Aluminum in Rock"

2. Plot a line graph using the data in the table above.



Name _____ Date _____

3. Based upon the graph you constructed, how much energy is needed to produce aluminum from rock that is 15% aluminum?

_____
_____
_____
_____

4. Using one or more complete sentences, describe how the amount of aluminum in a rock is related to the amount of energy needed to extract the aluminum from the rock.

_____
_____
_____
_____

Name _____ Date _____

Graph Analysis Lab

Objective:
To review graph construction and interpretation in this lab.

Materials:
Pencil

Procedure:
1 Answer the following questions and write your answers on the answer sheet.

Vocabulary
Rate of change

_____

_____

Direct relationship

_____

_____

Inverse relationship

_____

_____

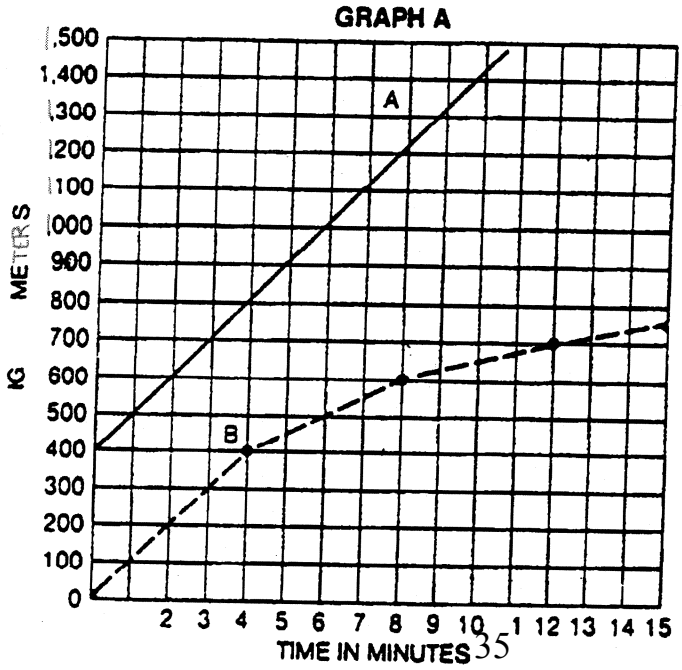
Dynamic equilibrium

_____

_____

Part A

Base your answers to the following questions on graph A. It represents the flight of two weather balloons that were released from different locations.



Name _____ Date _____

1 Was the altitude of the balloons increasing or decreasing as shown by lines A and B?

2. During the first 4 minutes (time 0 through 4 minutes) how many meters did A rise?

3. During the first 4 minutes (time 0 through 4 minutes) how many meters did B rise?

4. During the first 4 minutes what was the rate of increase for the balloon represented by line A?

5. During the first 4 minutes what was the rate of increase for the balloon represented by line B?

6. What was the rate of change along line A from 4 minutes to 8 minutes?

7 What was the rate of change along line B from 4 minutes to 8 minutes?

8. Do lines A and B show a direct or inverse relationship between altitude and time?

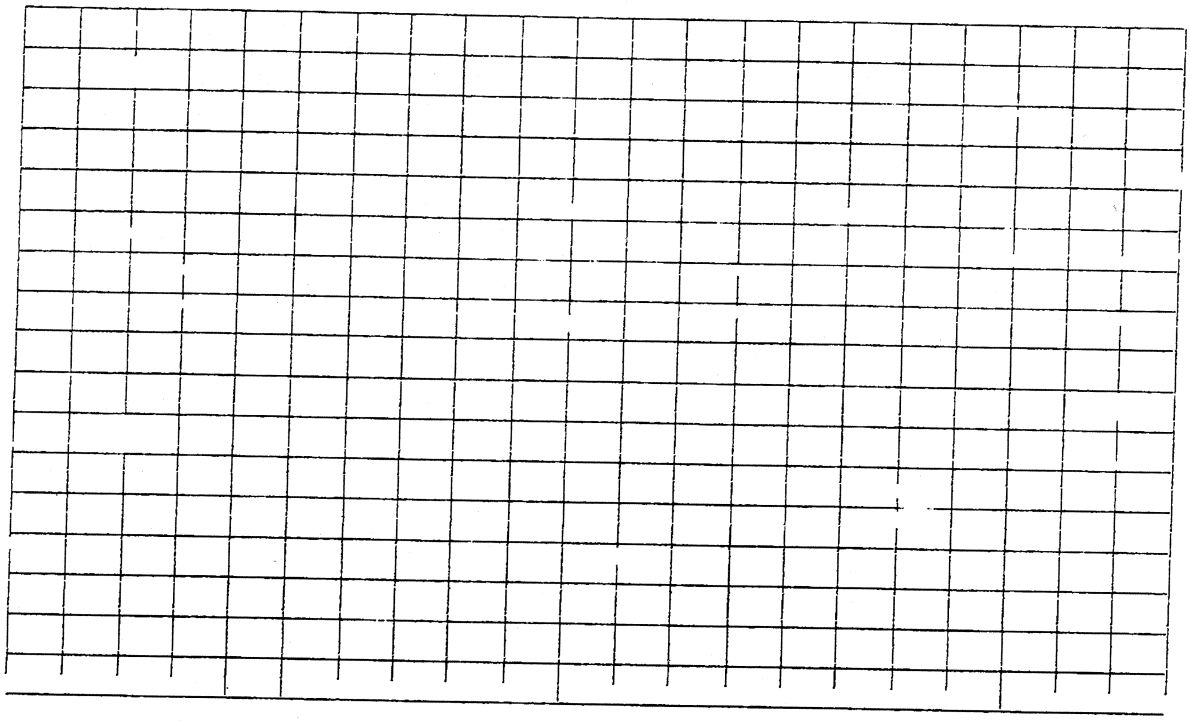
Part B

A cup of hot water was left standing on a lab table. Temperature was measured and recorded at one minute intervals. Plot the given data on the graph below. Be sure to label each axis.

Time (min)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7 0
Temp (C)	36.0	32.5	30.5	29.0	28.0	27 0	26.0	24.5

Time (min)	8.0	9.0	10.0	11 0	12.0	13.0	14.0	15.0
Temp (C)	24.0	23.5	23.2	23.0	23.0	23.0	23.0	23.0

Name _____ Date _____



1. Did temperature increase or decrease with time?

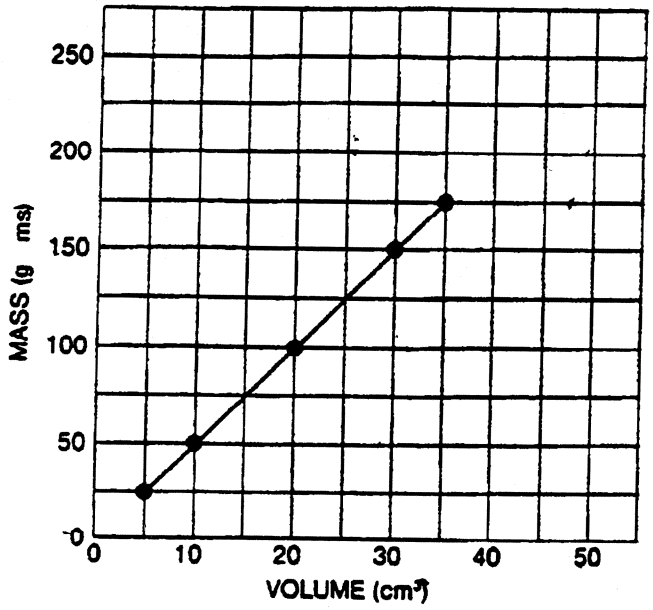
2. Calculate the rate of temperature change from time 0 to time 4.

3. calculate the rate of temperature change from time 4 to time 8.

4. Does this graph show a direct or inverse relationship?

Part C

Base your answers to the following questions on the graph below
The graph represents the mass and volume for five samples of pyrite.

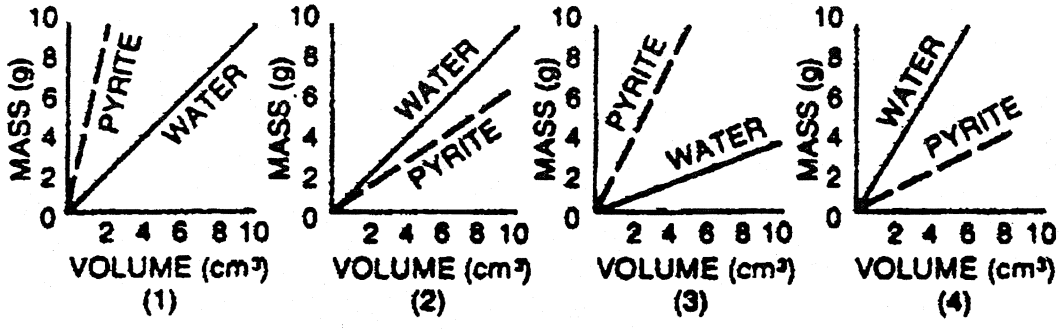


Name _____ Date _____

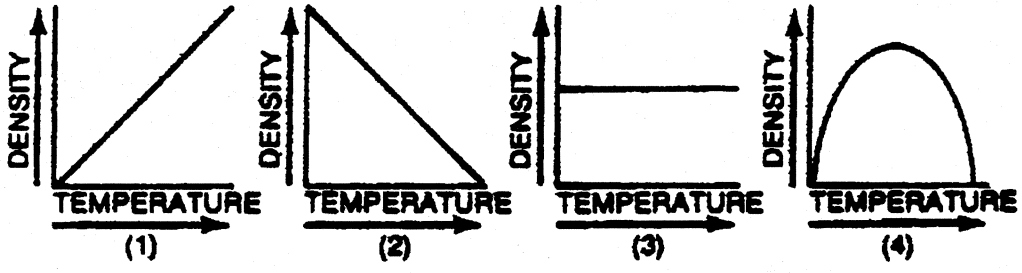
1 According to the graph, what is the density of pyrite?

2. If a sample of pyrite has a volume of 50 cm^3 what would its mass be?

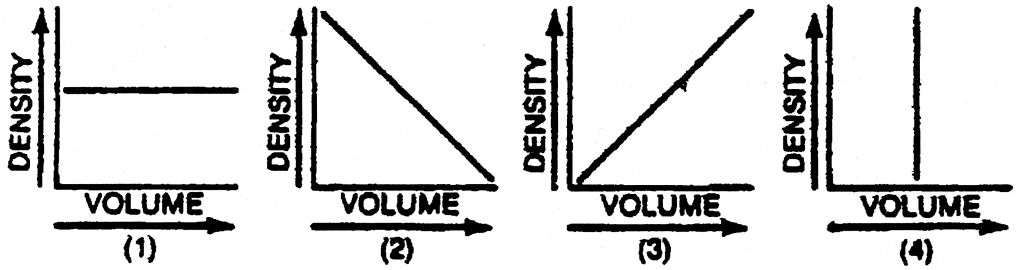
3. The density of pyrite and the density of water (1 0 g/cm^3) were plotted on the same graph. Which diagram below best represents how the graph should appear?



4. A mineral expands when heated. Which graph best represents the relationship between change in density and change in temperature when the mineral is heated?



5. A student calculated the density of 5 different pieces of aluminum, each having a different volume. Which graph best represents this relationship?



Name _____ Date _____

Analysis and Conclusion

1 In part A, what happened to the rate of increase along line A from time 0 to time 8 minutes?

2. In part A what happened to the rate of increase along line B from time 0 to time 8 minutes?

3. Describe the condition which exists for time and temperature between 12 to 15 in Part B.

4. What general appearance does a graph line have if the dependent variable does not change with time?

5. Describe the advantages of plotting data in graph form.

Name _____ Date _____

Answer sheet for Graph analysis Lab

Part A

1 _____
2. _____
3. _____
4. _____

5. _____

6. _____

7 _____

8. _____

Part B

1 _____
2. _____

3. _____

4. _____

Name _____ Date _____

Part C

1 _____

2. _____

3. _____
4. _____
5. _____

Analysis and Conclusions

1 _____

2. _____

3. _____

4. _____

5. _____

Name:_____ Date:_____

Measuring Earth
Topic 2 Vocabulary

Atmosphere: _____

_____

Contour line: _____

_____

Coordinate system: _____

_____

Crust: _____

_____

Earth's interior: _____

_____

Elevation: _____

_____

Equator: _____

_____

Field: _____

_____

Gradient: _____

_____

Hydrosphere: _____

_____

Name:_____ Date:_____

Isoline. _____

_____

Latitude. _____

_____

Lithosphere: _____

_____

Longitude: _____

_____

Model: _____

_____

Prime meridian: _____

_____

Profile: _____

_____

Topographic map: _____

_____

Name _____ Date _____

Using your reference tables, answer the following:

1) List the lowest zone of the atmosphere _____

2) Which is the warmest zone of the atmosphere? _____
Why do you think it is the warmest zone?
_____

3) What happens to the temperature as you go from the tropopause to the stratopause? _____

4) What is the temperature range in the mesosphere? _____

5) What is the altitude in Km of the mesopause? _____
What is the altitude of the mesopause in miles? _____

6) What is the atmospheric pressure at the tropopause? _____

7) What happens to the amount of atmospheric pressure as you increase your altitude? _____

8) Which element makes up the greatest percent by volume in the Earth's crust?
_____

9) What part of the earth contains hydrogen? _____

10) Which part of the earth contains nitrogen? _____

11) Which part of the earth contains the least amount of nitrogen?
_____

12) What is the thickness of the lithosphere? _____

13) Which is the thickest part of the earth's interior? _____

14) What is the density of water? _____

15) What is the earth's radius? _____

16) What is the earth's density? _____

17) Which zone of the atmosphere has the lowest temperature? _____
What is the lowest temperature in this zone? _____

Name _____ Date _____

18) Where in the atmosphere do we have the highest concentration of water vapor? _____

19) What happens to the concentration of water vapor as we increase our altitude? _____

20) Which is more dense, the continents or the ocean? _____

Name: _____ Date: _____

Structure of the Earth

The outer portion of the earth is generally classified into three major parts: lithosphere (solid), hydrosphere (liquid), and atmosphere (gas). The lithosphere is the dense, solid shell of the earth composed of rock and soil that surrounds the more fluid inner layers. It varies in thickness from 72 to 153 kilometers. Oxygen and silicon are the two most common elements that compose the lithosphere. It also contains many other elements, including aluminum, iron, and calcium.

The hydrosphere consists of the waters of the earth – the oceans, lakes, rivers, and water in the ground. The oceans extend to an average depth of 3.5 kilometers and cover about 70% of the earth's surface. Water is a chemical compound composed of hydrogen and oxygen with various other elements and compounds present in solution.

The atmosphere is the shell of gases that surrounds the earth. It extends out several hundred kilometers into space and is stratified, or layered, into zones.

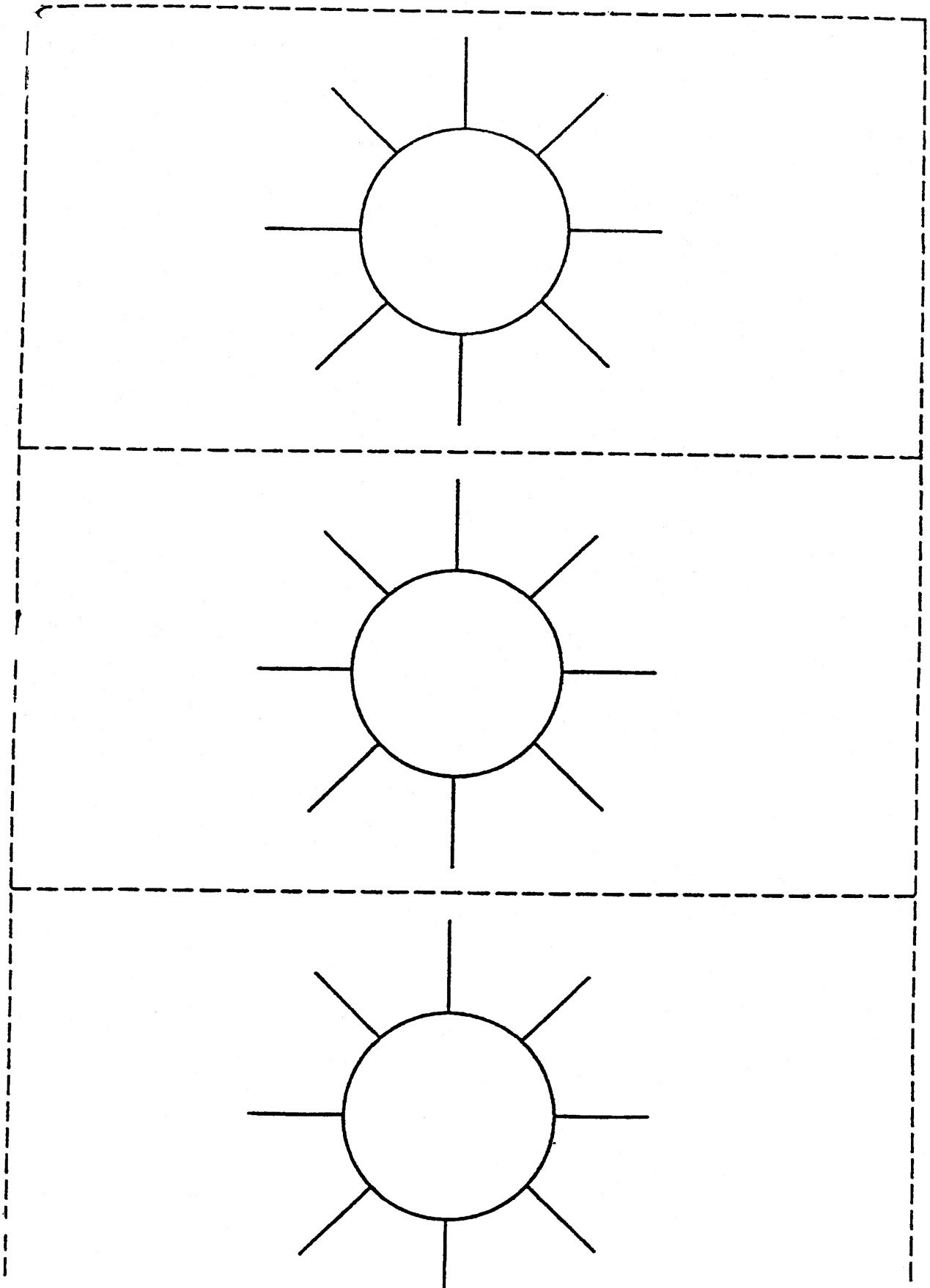
The principal layers of the atmosphere, listed in order of increasing altitude, are the *troposphere*, the *stratosphere*, the *mesosphere*, and the *thermosphere*. Each layer is characterized by the pattern of vertical temperature trends shown in the *Earth Science Reference Tables* (page 14).

The lowest layer the troposphere, is the most important to life on earth since it contains elements necessary to support life. Although it is relatively thin, it contains most of the mass of the atmosphere. The composition of the troposphere is generally 78% nitrogen and 21% oxygen, with water vapor carbon dioxide, argon, neon, and other gases making up the remainder Strong winds, storms, and turbulence occur in this layer of the atmosphere. Most of the water vapor in the atmosphere is in the troposphere and, hence, most of the clouds. Temperature in the troposphere generally decreases with increasing altitude.

The tropopause is the layer of the atmosphere separating the troposphere from the stratosphere. Likewise, the stratopause is the boundary layer between the stratosphere and the next layer of the atmosphere, the mesosphere. And the mesopause is the boundary layer between the mesosphere and the thermosphere.

Name: _____ Date: _____

Bases on the reading about the structure of the earth, create a word web for the three main spheres of earth.



Name _____ Date _____

Lab: Layers of the Atmosphere

Purpose: To become familiar with the different layers of the atmosphere, to gain further practice with graphing and the Earth Science Reference Tables.

Materials: Earth Science reference Tables and a colored pencil.

Background: The Earth's atmosphere is divided into four layers: the troposphere, stratosphere, mesosphere and thermosphere.

Where each layer ends and a new one begins, a name is given to this boundary. For example, the boundary between the troposphere and stratosphere is: the tropopause.

Distinct temperature differences are found within each layer. At the stratopause, the temperature stops increasing with altitude. The overlying mesosphere does not absorb solar radiation, so the temperature decreases with altitude. At the mesopause the temperature begins to increase with altitude and this trend continues in the thermosphere. Because the atmosphere is so thin, a thermometer cannot measure the temperature accurately, and special instruments are needed.

Procedure:

1) Table I contains average temperature readings at various altitudes in the Earth's atmosphere. **Plot** this data on the graph (Figure 1) on the worksheet, and then... **connect** adjacent points with solid lines.
This profile provides a general picture of temperature conditions in the atmosphere; at any given time and place, however, the actual temperature may deviate from the average values, particularly in the lower atmosphere.

Table 1
Average Temperature Readings At Various Altitudes

Altitude (km)	Temperature (C)	Altitude (km)	Temperature (C)
0	15	52	-2
5	-18	55	-7
10	-49	60	-17
12	-56	65	-33
20	-56	70	-54
25	-51	75	-65
30	-46	80	-79
35	-37	84	-86
40	-22	92	-86
45	-8	95	-81
48	-2	100	-72

Name _____ Date _____

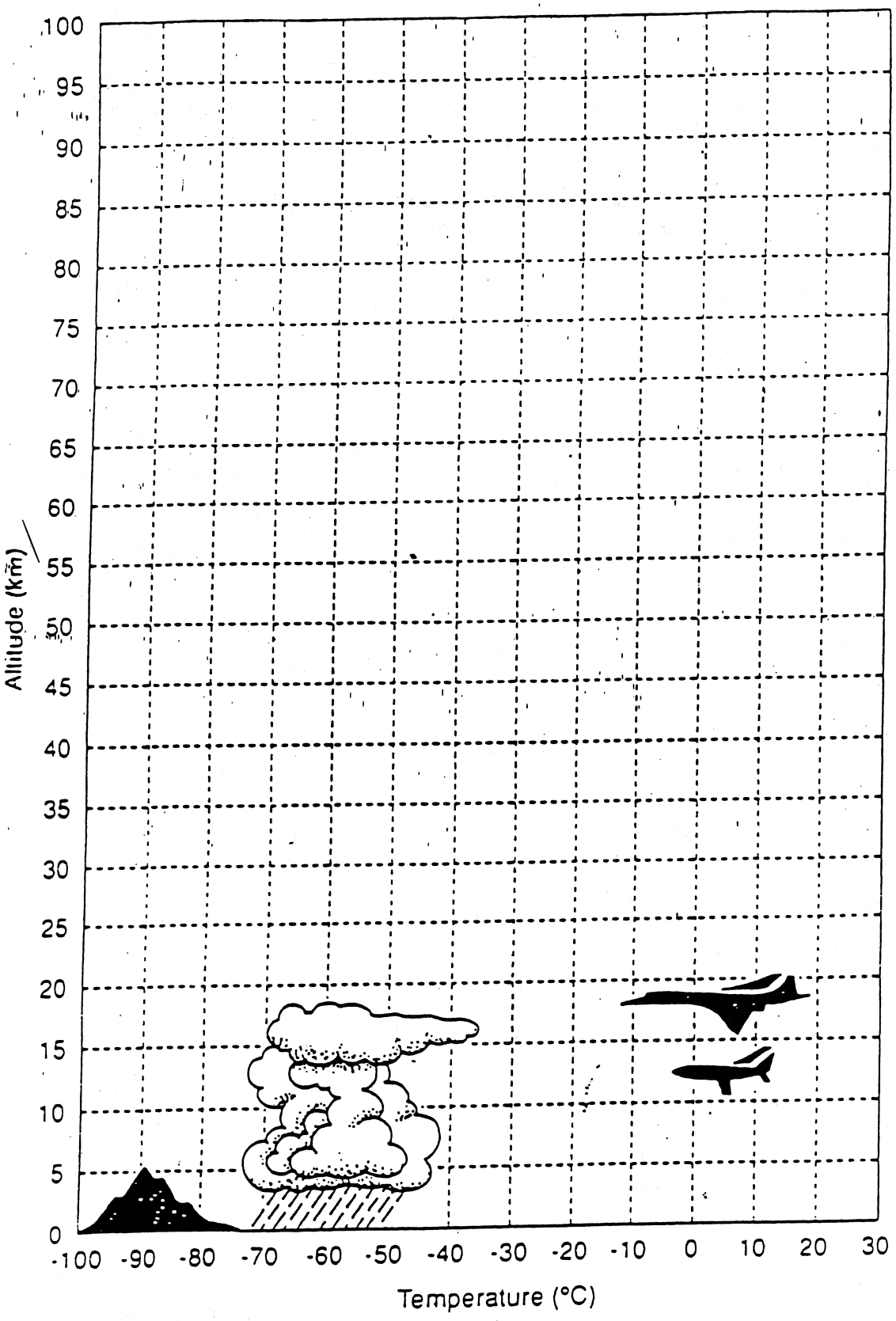


Figure 1. Graph of temperature at various altitudes.

Name _____ Date _____

2) Label the different layers of the atmosphere and the separating boundaries between each layer. Refer to page 15 in the Earth Science Reference Tables **"Selected Properties of Earth's Atmosphere" for assistance.**

3) **The ozone layer** is located in the lower stratosphere.
Mark the general location of the ozone layer by writing the words **"OZONE LAYER"** on your graph.

4) Using a colored pencil, shade the layer where **water vapor** is found. (Refer to the Reference Tables).

Questions: Answer the following questions, using your graph and the Reference Tables and place your answers on the answer sheet.

1) What is the basis for dividing the atmosphere into four layers?

2) Does the temperature increase or decrease with altitude in the:
Troposphere?
Stratosphere?
Mesosphere?
Thermosphere?

3) What is the approximate height and temperature of the tropopause, stratopause, and mesopause?

4) What causes the temperature to decrease with height through the mesosphere?

5) Name the layer where most weather occurs.

6) Why do you think weather occurs in this particular layer?

7) What layer supports life on Earth?

8) Why is it necessary to use special instruments to measure the temperature of the atmosphere in the thermosphere layer?

9) Name the layer(s) where planes fly.

10) According to the Reference Tables, what happens to air pressure with an **increase** in **altitude?**

Name _____ Date _____

ANSWER SHEET FOR ATMOSPHERE LAB QUESTIONS

1) _____

_____

2) Troposphere: _____

Stratosphere: _____

Mesosphere: _____

Thermosphere: _____

3)

	HEIGHT	TEMPERATURE
Tropopause:	_____	_____
Stratopause:	_____	_____
Mesopause:	_____	_____

4) _____

_____

5) _____

6) _____

_____

7) _____

8) _____

_____

9) _____

10) _____

Name _____ Date _____

Earth's Interior Worksheet

Objective:
To become more familiar with the properties of the Earth s interior

Materials:
Textbook
review book
Earth Science Reference Tables

Procedure:
1 Use your reference materials to answer the following questions.

Vocabulary; Define each in a co: plete sentence.

1 Lithosphere

_____

_____

2. Hydrosphere

_____

_____

3. Troposphere

_____

_____

4. Mantle

_____

_____

5. Core

_____

_____

6. Asthenosphere

_____

_____

7 Density

_____

_____

8. Compare the densities of the continental and oceanic crust.

_____

_____

Name _____ Date _____

9. What element comprises the greatest percent by volume of the earth's crust?

_____

_____

10. To what height in km does the troposphere reach?

_____

_____

11 Name two other layers of the atmosphere.

_____

_____

12. What is the percentage by mass of silicon in the earth's crust.

_____

_____

13. What is the pressure at a depth of 5,000 km with in the earth?

_____

_____

14. At what depth is the boundary between the core and mantle?

_____

_____

15. Which layer of the earth is found at a depth of 2,000 km?

_____

_____

16. Which layer of the earth is found at a depth of 6,000 km?

_____

_____

17 At what depth will the melting point of earth material be lower than the temperature?

_____

_____

18. What land features are found where the Pacific and South American plates meet?

_____

_____

19. What is the density of the inner core?

_____

_____

Name _____ Date _____

20. What phase of matter is the outer core?

_____

_____

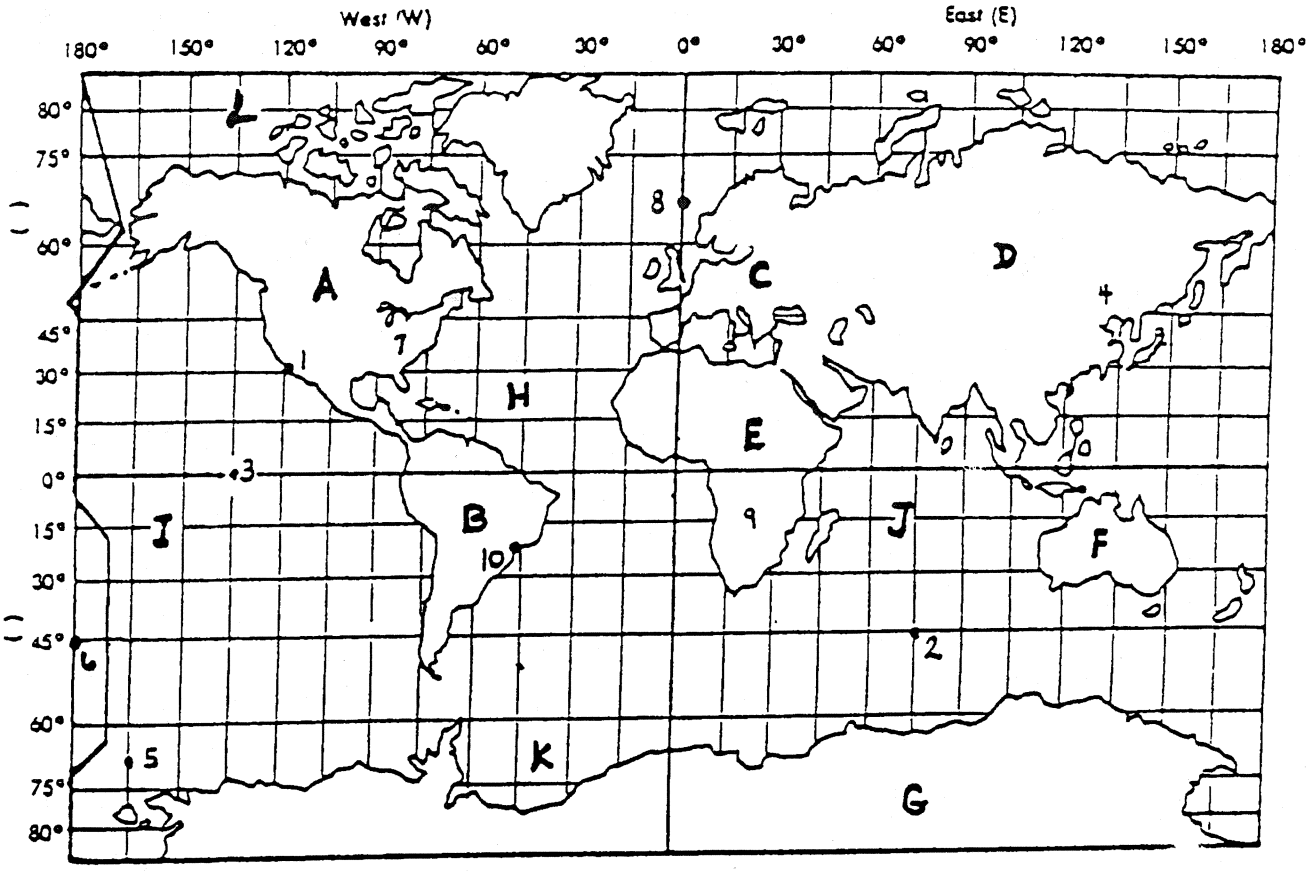
21 What is the temperature at a depth of 1 500 km?

_____

_____

Name _____ Date _____

Activity: Determining Latitude and Longitude



Use the map above to determine the latitude and longitude of these numbered and lettered locations. Name the continents and oceans indicated by the letters.

Location	Latitude	Longitude
1		
2.		
3.		
4		
5		
6.		
7		
8.		
9.		
10		

Continents	Oceans
A.	H.
B.	I.
C	J.
D	K.
E.	L.
F	
G.	

Name:_____ Date:_____

Longitude and Latitude Worksheet

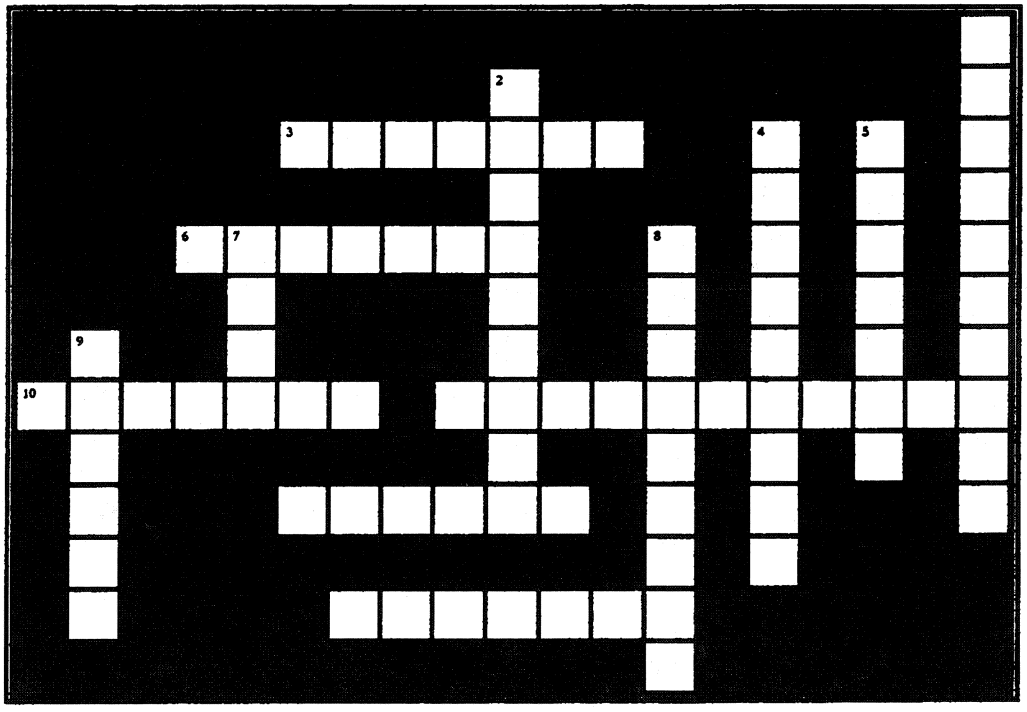
Using the Generalized Bedrock Geology of New York State Map in the *Earth Science Reference Table* complete the cross word puzzle by locating the city for each of the given coordinates.

Across

Question	Latitude (N)	Longitude (W)
3	42° 50'	78° 50'
6	42° 30'	78°
10	42°	74° 25'
11	41 30'	73°
12	42° 45'	73° 50'
13	44° 55'	74° 55'

Down

Question	Latitude (N)	Longitude (W)
1	42° 05'	75° 55'
2	42° 05'	79° 10'
4	43° 55'	75° 55'
5	44° 10'	73° 55'
7	42° 30'	79 °30'
8	40° 55'	72° 30'
9	42° 05'	76°50'



Name _____ Date _____

Locations in New York Lab

Objective:
The student will become more familiar with latitude and longitude, and the Earth Science Reference Table.

Materials:
Earth Science Reference Tables
Ruler
Colored Pencils

Procedure:
1 Open the Earth Science Reference Tables to page 3.

2. Remember that latitude lines are lines parallel to the Equator and run across the page. Longitude lines go from pole to pole and run up and down the page.

   On the map the latitude numbers are on the **SIDES** of the map and the **longitude** numbers are on the **TOP and BOTTOM** of the map.

   Latitude lines in the United States always have the letter "N" after them because they are North of the Equator

   Longitude lines in the Unites States always have the letter "W" after the because they are West of the Prime Meridian.

3. Using a red pencil and a ruler lightly draw latitude lines across the map of New York State. Draw a line for latitudes of 41° 42° 43° 44° and 45° N. Connect the "tick" marks where the numbers are on the sides of the map.

4 Using an orange pencil and ruler connect the "tick" marks that are half way between each of the lines that you just drew. These lines will represent points that are 41° 30' 42° 30' 43° 30' and 44° 30'

5. Lightly draw longitude lines in green from top to bottom of the map. Connect lines of 73° 74° 75° 76° 77° 78°, and 79° W

6. Lightly color blue lines of longitude of 73° 30' 74° 30' 75° 30' 76° 30' 77° 30' 78 30' and 79 30' W

Analysis and Conclusion:
Answer each question in complete sentences on your answer sheet.

1 What is the latitude of Slide Mountain?

2. What is the longitude of Watertown?

Name _____ Date _____

3. What is the latitude of the border between New York and Canadian province of Ontario where the land is not covered by water?

4 What is the latitude of the south shore of Long Island near the star marked on the map?

5 What is the latitude of the middle of Lake Ontario?

6. What is the longitude of Jamestown?

7 What is the longitude of Old Forge?

8. What is the longitude of New York City?

9. What is the longitude of the south shore of Long Island near the star marked on the map?

10. What is the longitude of the next line that would appear to the west of New York State?

11 What is the closest city to 43° N, 75° W?

12. What is the closest city to 43°N, 76°W?

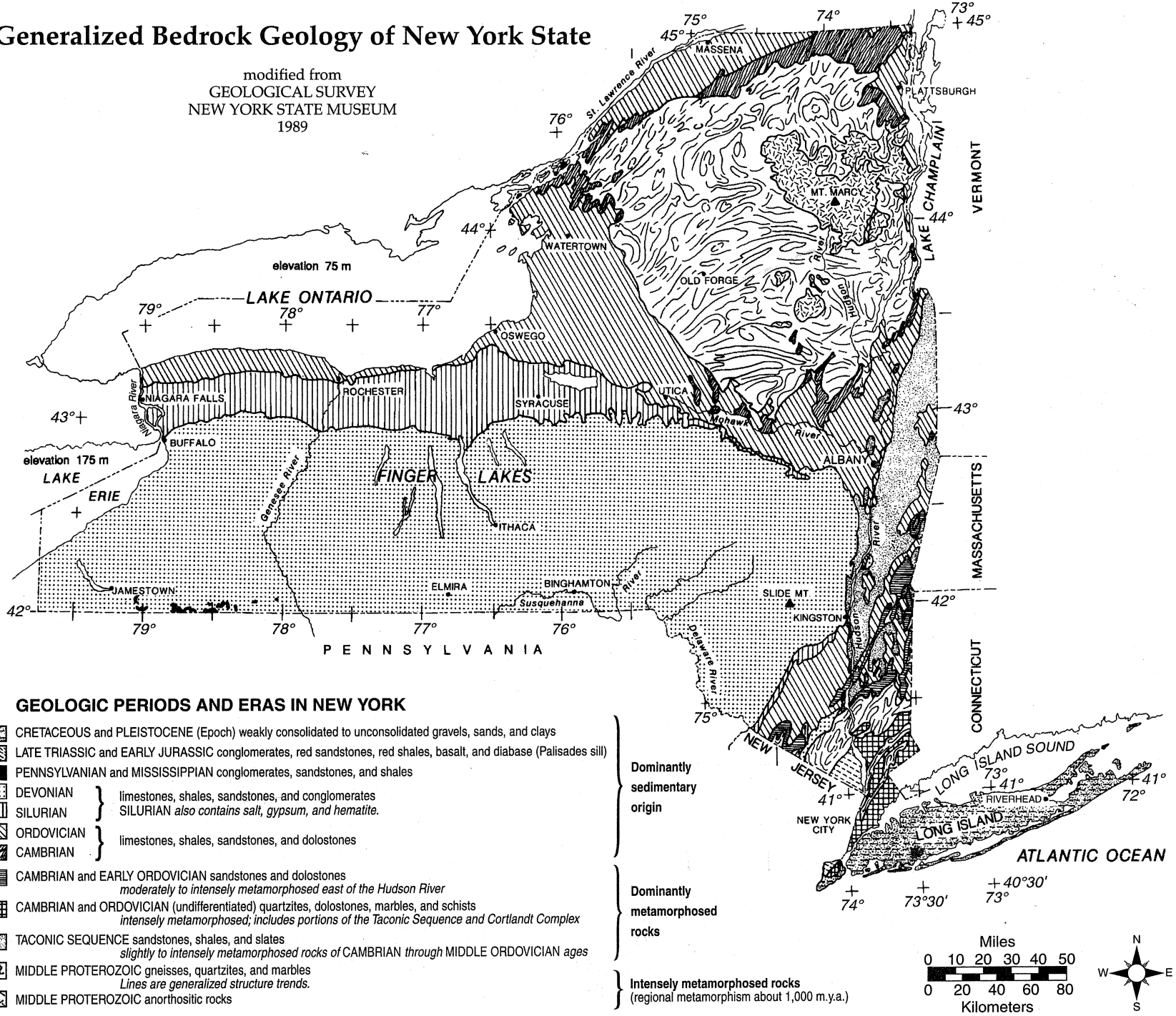
13. What lake is located at 44°30' N, 73°30'W?

14 What famous feature is located at 44°N, 74°W?

15. What goes on at 42°40'N, and 73°40'W that affects our lives?

Generalized Bedrock Geology of New York State

modified from
GEOLOGICAL SURVEY
NEW YORK STATE MUSEUM
1989



GEOLOGIC PERIODS AND ERAS IN NEW YORK

Dominantly sedimentary origin

- CRETACEOUS and PLEISTOCENE (Epoch) weakly consolidated to unconsolidated gravels, sands, and clays
- LATE TRIASSIC and EARLY JURASSIC conglomerates, red sandstones, red shales, basalt, and diabase (Palisades sill)
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, and shales
- DEVONIAN, SILURIAN — limestones, shales, sandstones, and conglomerates; SILURIAN *also contains salt, gypsum, and hematite.*
- ORDOVICIAN, CAMBRIAN — limestones, shales, sandstones, and dolostones

Dominantly metamorphosed rocks

- CAMBRIAN and EARLY ORDOVICIAN sandstones and dolostones
  moderately to intensely metamorphosed east of the Hudson River
- CAMBRIAN and ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, and schists
  intensely metamorphosed; includes portions of the Taconic Sequence and Cortlandt Complex
- TACONIC SEQUENCE sandstones, shales, and slates
  slightly to intensely metamorphosed rocks of CAMBRIAN *through* MIDDLE ORDOVICIAN *ages*
- MIDDLE PROTEROZOIC gneisses, quartzites, and marbles
  Lines are generalized structure trends.
- MIDDLE PROTEROZOIC anorthositic rocks

Intensely metamorphosed rocks
(regional metamorphism about 1,000 m.y.a.)

Name _____ Date _____

Answer sheet for Locations in New York Lab

1 _____

2. _____

3. _____

4 _____

5. _____

6. _____

7 _____

8. _____

Name _____ Date _____

9. _____

10 _____

11 _____

12. _____

13. _____

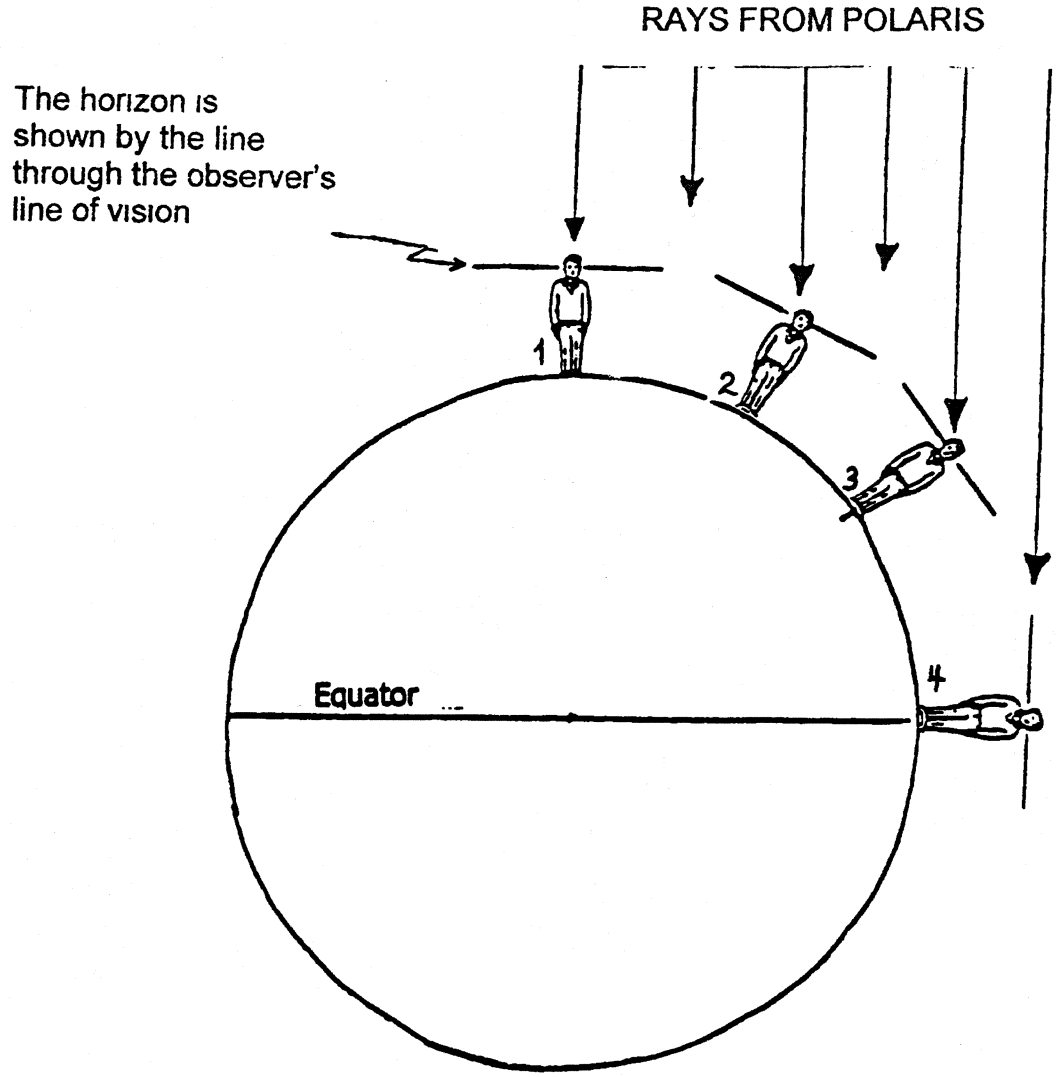
14 _____

15. _____

Name:_____ Date:_____

Observation of the North Star (Polaris)

The altitude of Polaris changes as an observer changes their latitude in the Northern Hemisphere. This is because the Earth is an oblate spheroid. As an observer moves north the altitude of Polaris increases. As an observer moves south the altitude of Polaris decreases. (Altitude is the height, measured in degrees above the horizon of the observer).



Observer	Latitude	Altitude of Polaris
1		
2		
3		
4		

Name _____ Date _____

Latitude and Longitude

Use your knowledge of Earth Science and *The Earth Science Reference Tables* to answer the following questions.

1) What is the difference between latitude and longitude?

2) What is the reference line for latitude? _____
What is the reference line for longitude? _____

3) How many minutes are found between each degree of latitude or longitude? _____

4) Look at the *Generalized Bedrock Geology Map of New York State.* Does this map represent North or South latitude? _____ How do you Know?

5) Does the map represent East or West longitude? _____ How do you know?

6) Determine the latitude and longitude of the following places to the nearest minute.

a) Elmira _____ lat. _____ long.
Slide Mountain _____ lat. _____ long.

b) Plattsburg _____ lat. _____ long
Ithaca _____ lat _____ long

c) Massena _____ lat _____ long
Albany _____ lat _____ long

d) Binghamton _____ lat _____ long
Oswego _____ lat _____ long

e) Old Forge _____ lat. _____ long.
Mt. Marcy _____ lat _____ long

Name _____ Date _____

Latitude and Longitude

7) How can we determine our latitude without using a map or globe?

8) What do people with same longitude have in common?

9) What happens to your time as you travel east of the Prime Meridian?

10) Where is the International Date Line?

11) What does the International Date line look like on the Globe?

12) Why does the International Date Line look like that?

13) What happens to the altitude of Polaris as you travel north of the Equator? Why?

14) What happens to the altitude of Polaris as you travel east? Why?

Name_____ Period_____

Lawrence High School Date_____

Class work on Latitude, Longitude, and Polaris

Refer to page 3 in the *Earth Science Reference Table*

1. Please Fill in the chart below and remember to include the direction in your answers.

Location	Latitude	Longitude
Albany		
	40° 50' N	**72° 45' W**
Syracuse		
Binghamton		
	44° 39' N	**73° 28' W**

Please answer the following question in complete sentences.

2. Which city would see Polaris approximately 45° below the northern horizon?

3. If you were standing on the top of Mt. Marcy, how many degrees above the horizon would you have to look in order to find Polaris?

4. If you were to travel due east from Elmira to Binghamton, what would happen to the altitude of Polaris?

5. What is the altitude of Polaris in Niagara Falls, New York?

6. If Polaris altitude is 42°, what latitude would you be on to see that angle?

7. If you were traveling due south, from Massena to Long Island, What would happen to the altitude of Polaris?

8. If you were on 22°S, what is the angle of Polaris?

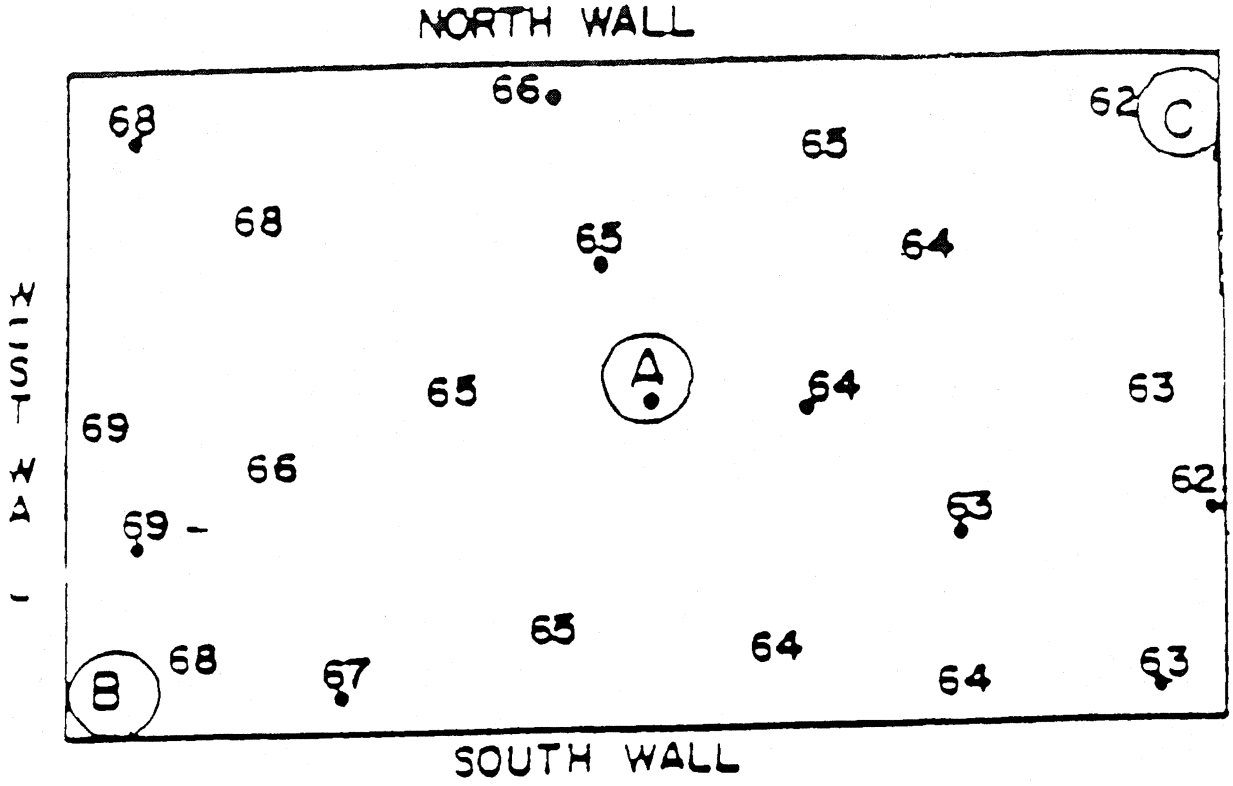
9. Complete the following chart. Remember to include direction in your answers.

Longitude	Greenwich Mean Time (0°)	Local Time
	5:00 pm	12 noon
120°E		12 midnight
165°W	1:00 am	
	8:00 am	3:00 pm
15°E	4:00 pm	
90°W		7:00 pm

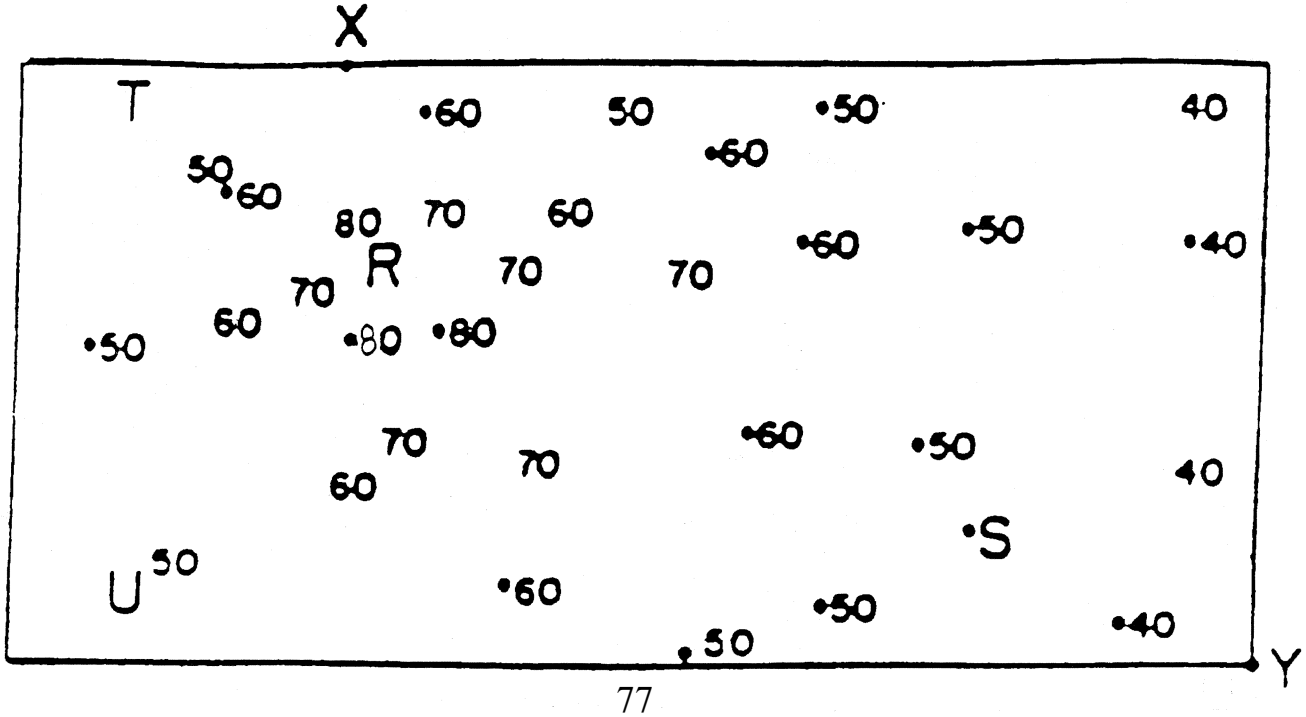
Name _____ Date _____

Class Work Activity: Field Maps

Directions: On the field map below connect the points of equal temperature. Use an interval of one.



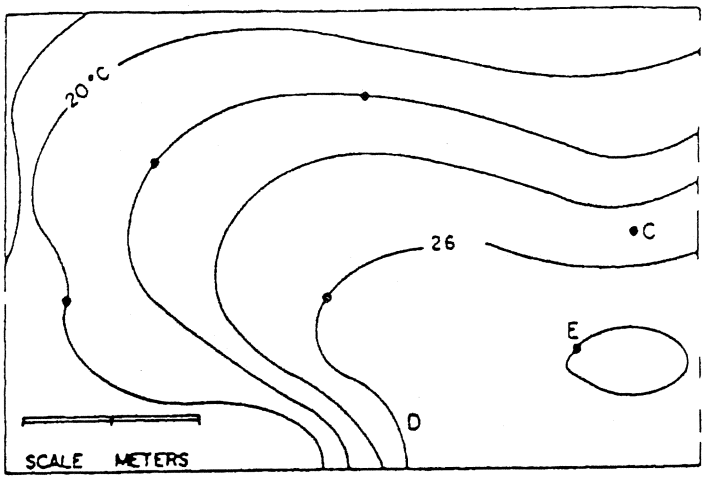
Direction: On the field map below, connect the points of equal temperature. Use an interval of ten.



Name _____ Date _____

Class Work Activity: Field Maps

Directions: Base your answers to questions 1 through 5 on the field map below The field map represents temperature field map of the air near the ceiling of a room. The letters represent points in the field.



1) What kinds of isolines are shown on this field map?

2) In a sentence, tell between which two letters the greatest temperature gradient is found.

3) Write the equation for determining gradient.

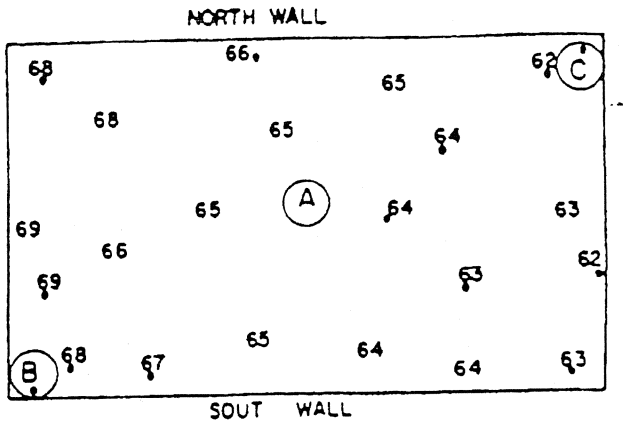
4) Substitute the appropriate data into the equation and determine the gradient between letters X and Y

5) In a sentence, tell what happens to the temperature along the isoline from A to F

Name _____ Date _____

Class Work Activity: Field Maps

Directions. Base your answers to the following questions on the diagram below that represents field intensity measurements taken at equal elevations within a room. Letters A, B and C are reference points on the plane where the readings were taken.



1) Estimate the field intensity value at point A. _____

2) Draw in the isolines to make a field map using an interval of one.

3) The measurements represent sound intensity (loudness) reading taken during a science class. In a sentence, tell near which wall the source of the loudest sound would most likely be located.

4) If the measurements represent Fahrenheit air temperatures, and the distance between the east and west wall is 12 meters, determine the approximate temperature gradient.
   A) Write out the formula for gradient:
   B) Substitute the data from the map:
   C) Calculate the gradient and label your answers with the proper units:

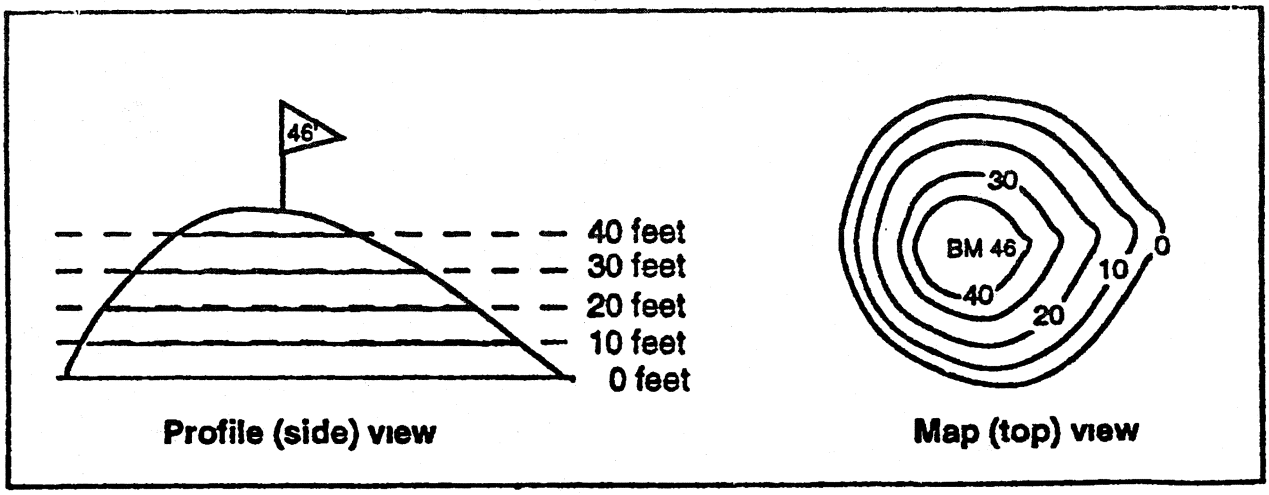
A) Gradient
B) Gradient
C) Gradient

Name:_____ Date:_____

Introduction to Topographic Maps, Contour Lines, Profiles, and Gradients

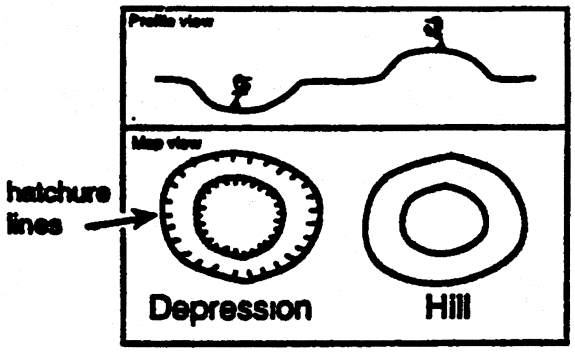
Hofstra Geology

Topographic maps are maps that show the changes in elevation throughtout the map area using lines of equal elevation called **contour lines**. The change in height from one line to the next is called the **contour interval (C.I.)**. The highest point marked at the top of a hill is called the **bench mark (BM)**.



Rules of Contour Lines

1 Closed contour lines on a map indicate either a hill or a hole. Closed contours that indicate that the land slopes down into a hole are marked by hachured lines.



2. A single contour line represents a single elevation along its entire length. In other words, the elevation of all points along a contour line are the same.

3. Contour lines **never** touch or cross. At a vertical cliff they do, however come together

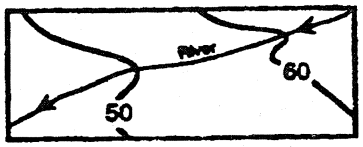
4 The elevation of a contour line is always a simple multiple of the contour interval. Each fifth contour line is an **index contour** (drawn as a thicker line than the adjacent contours).

Name:_____ Name:_____

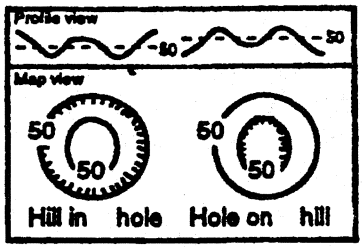
5. Widely spaced contour lines indicate a gentle slope. Closely spaced contours indicate a steep slope.

6. Every contour line eventually closes on itself. However some maps will not be large enough to show the entire contour line and it will end at the edge of the map Where one closed contour line surrounds another the inner contour line marks the higher elevation. If the contour lines are hachured, then the inner contour line marks the lower elevation.

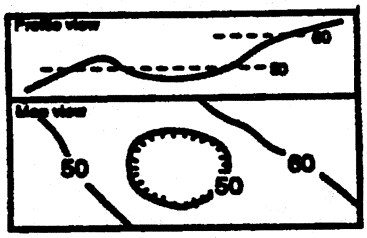
7 Where a contour line crosses a stream, the contour bends to form 'V' that points upstream.



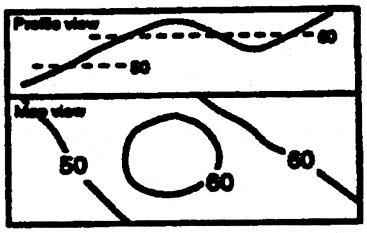
8. When a hachured contour is next to a normal contour both lines are the same elevation.



9. A hachured contour line, lying between two different contour lines, is the same elevation as the lower contour line

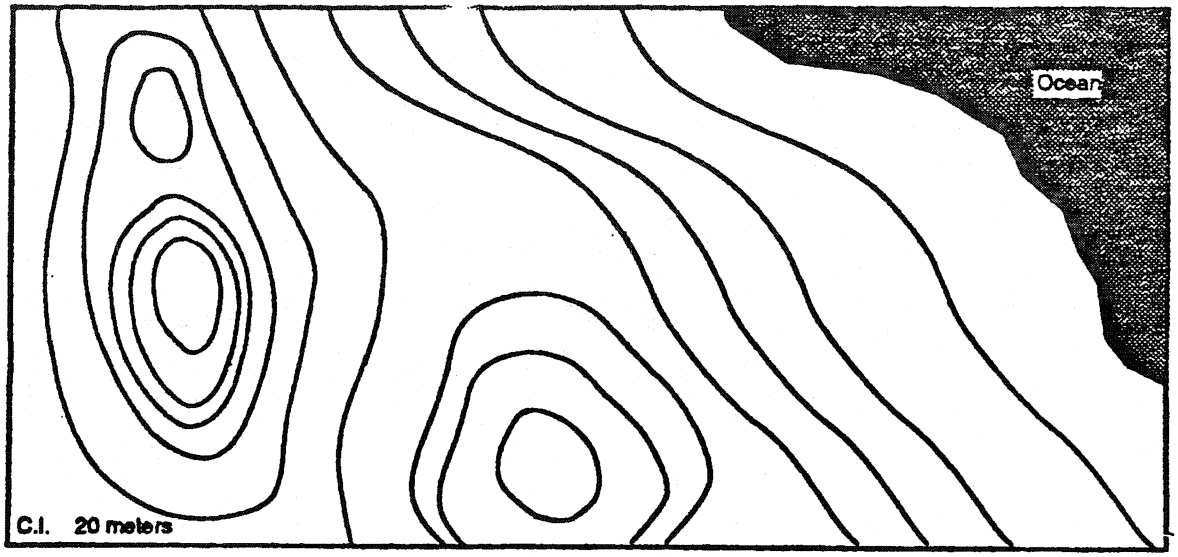


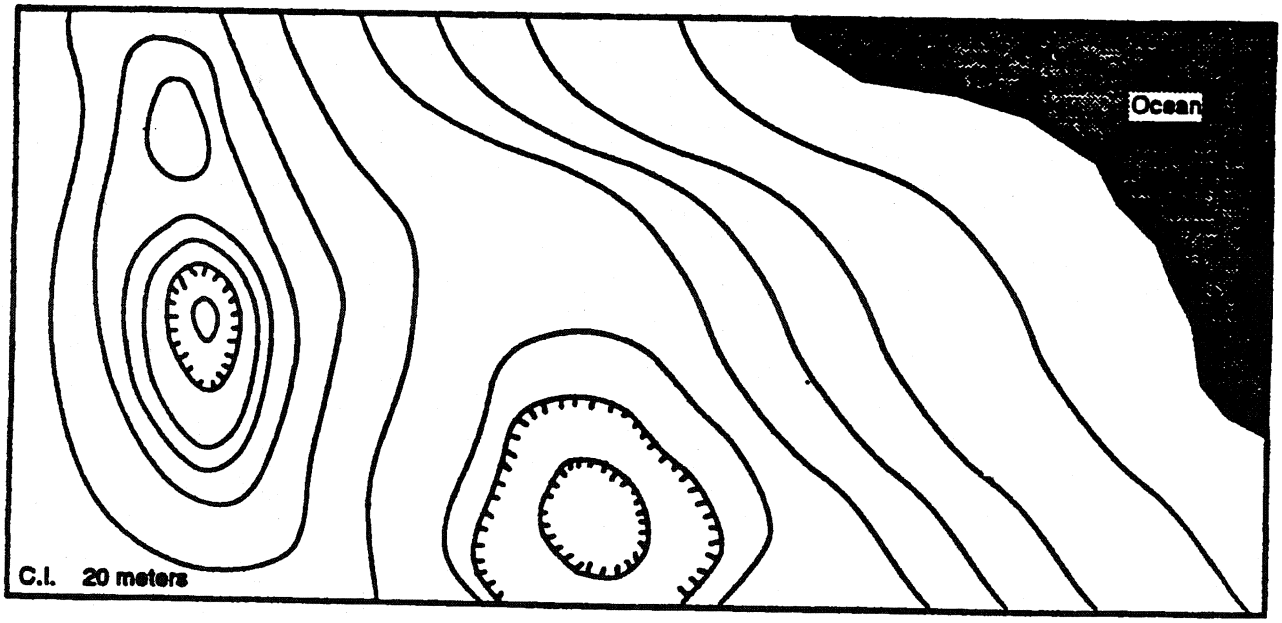
10. A closed contour line, lying between two different contour lines, is the same elevation as the higher contour line.



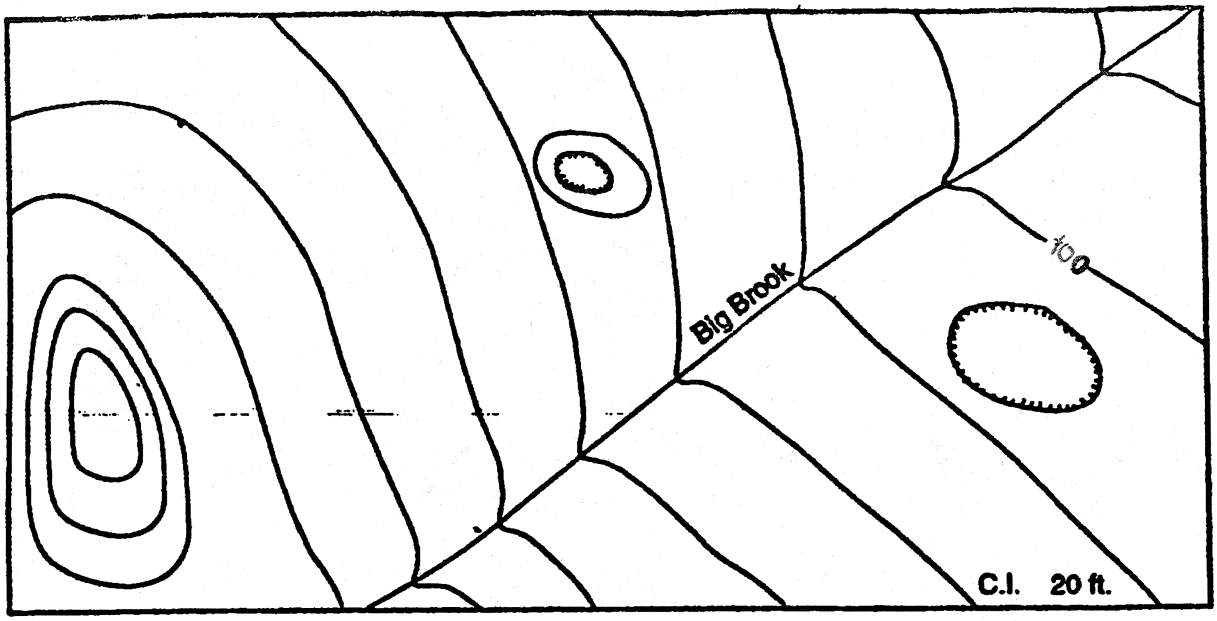
Name:_____ Name:_____

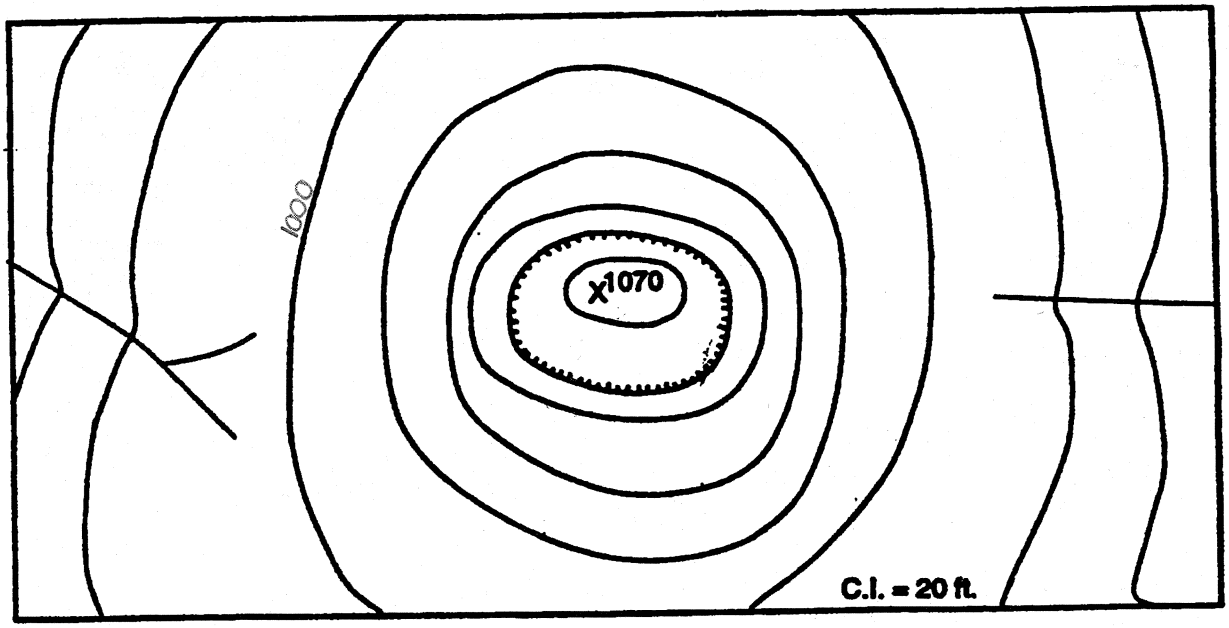
Using the rules of topographic contours listed above, label all of the topographic contour lines in the following maps with their correct elevations. Zero elevation is sea-level (shore line). Note the contour interval (C.I.) is given on each map.





Name:_____ Name:_____

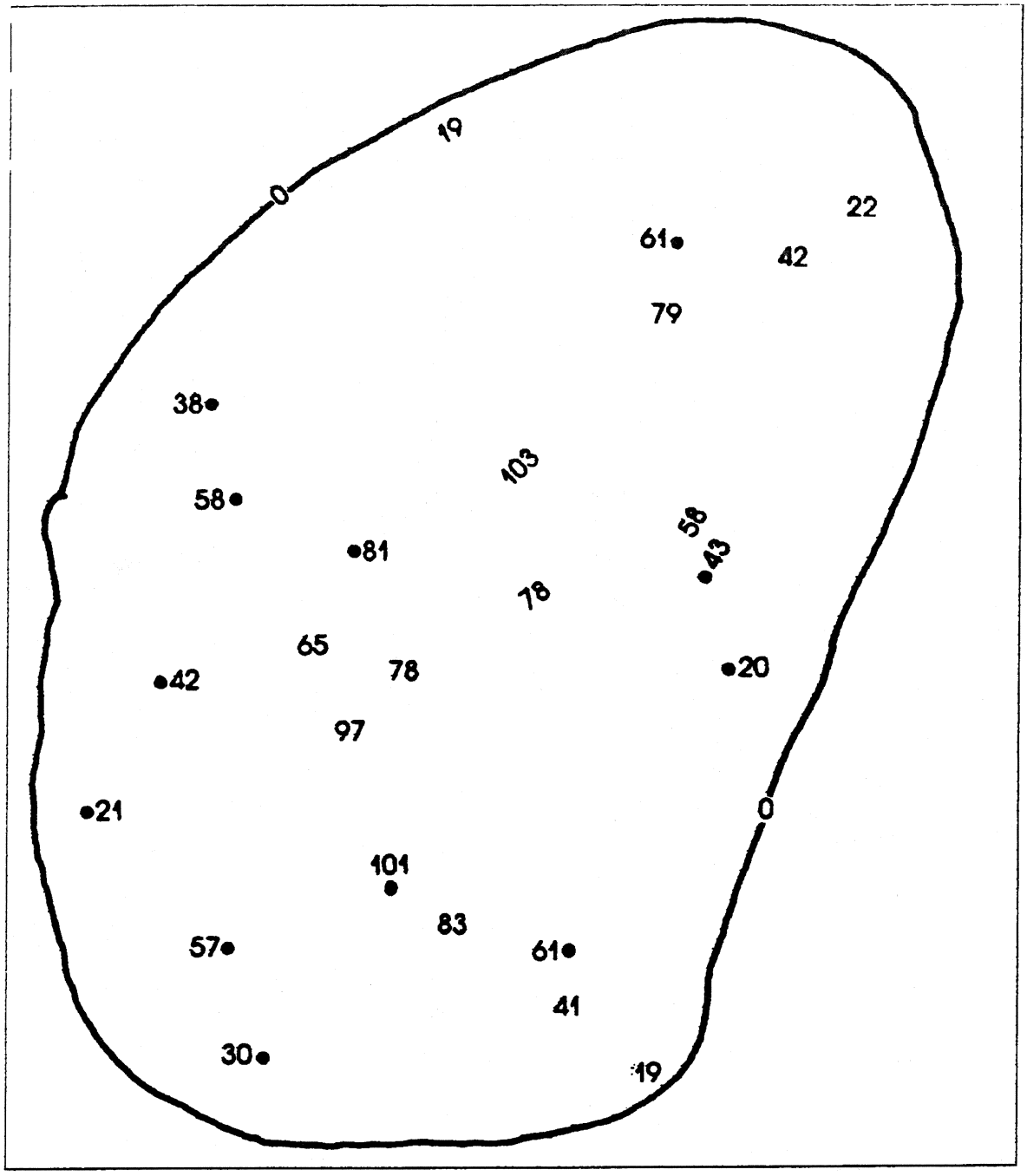




Name _____ Date _____

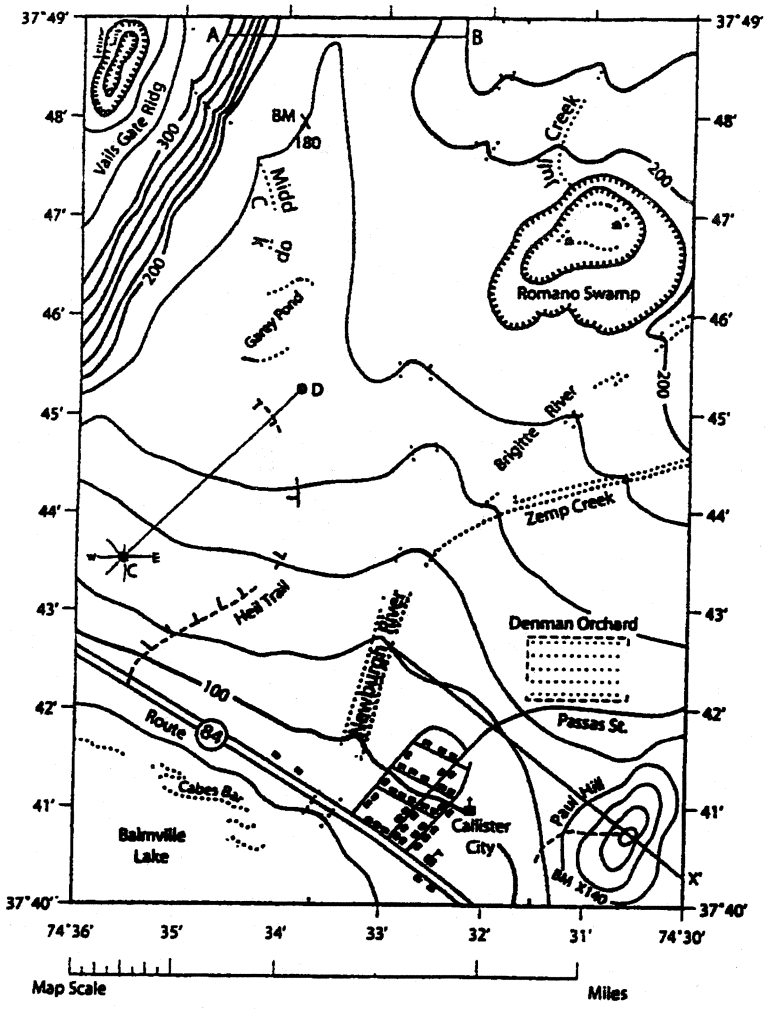
Contour Line Worksheet

Procedure:
Complete the map below by drawing contour lines at 20 foot intervals.



Name:_____ Date:_____

Activity· Contour Maps



1 What is the contour interval? _____ ft
2. List three (3) ways you can determine the direction that a river is flowing.
   a.
   b.
   c.
3. Which way is the Newburgh River flowing? _____
4. What is the latitude, longitude, and approximate elevation of point D?
   _____ Latitude _____ Longitude _____ elevation
5. Determine the gradient of line A-B. Write the formula and show all work.

6. Where is the steepest part of this map located? _____
7 What is the highest possible elevation of Paul Hill? _____ ft
8. Determine the distance of the Heil Trail. _____ miles

Name:_____ Name:_____

Lab: Topographic Maps

Background Information

In this investigation you will work with an elevation field model. Often, it is helpful to represent a three-dimensional feature on a two-dimensional map. Topographic maps are models that represent a portion of the Earth's surface. The relief, or topography can be shown by using isolines called contour lines. A contour line is a line drawn through points of equal elevation, or distance above sea level. Contour lines show both the shape and relief of the feature or area being mapped. The difference in elevation between adjacent, or successive, contour lines is the contour interval. The contour interval for Figure 1 is 10ft.

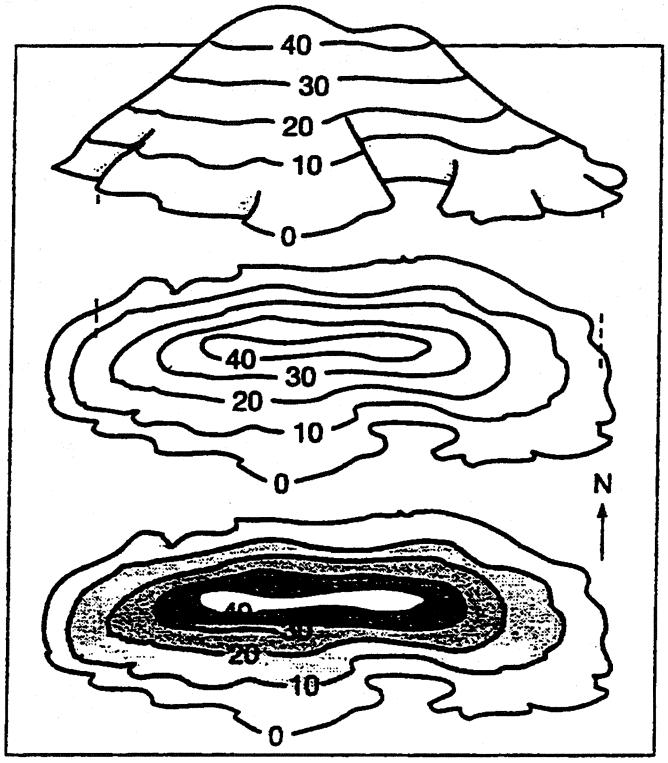


Figure 1

Problem

How are contour lines used to create a map that shows the shape of the land with relief?

Name:_____ Name:_____

Materials

Landform model, clear plastic box with lid, plastic sheets, colored water tape, metric ruler

Procedure

1. Place the landform model in the box. Make sure that it sits flat on the bottom of the box.
2. Mark the side of the box in centimeter units with a grease pencil, starting at the bottom of the box. This will indicate your contour interval. The water line, or level, represents an isoline because it connects points on the landform model that have the same elevation.
3. Attach the acetate sheet to the top of the box with tape so that the sheet is on top of the lid. Do not tape the cover to the box it self as the lid will be removed throughout the lab.
4. Fill the box with water up to the one centimeter mark. Put the lid on the box. Look straight down from above the box and trace the line where the water meets the landform model onto the top of the box. This line represents the 1 cm contour line. See Figure 2.

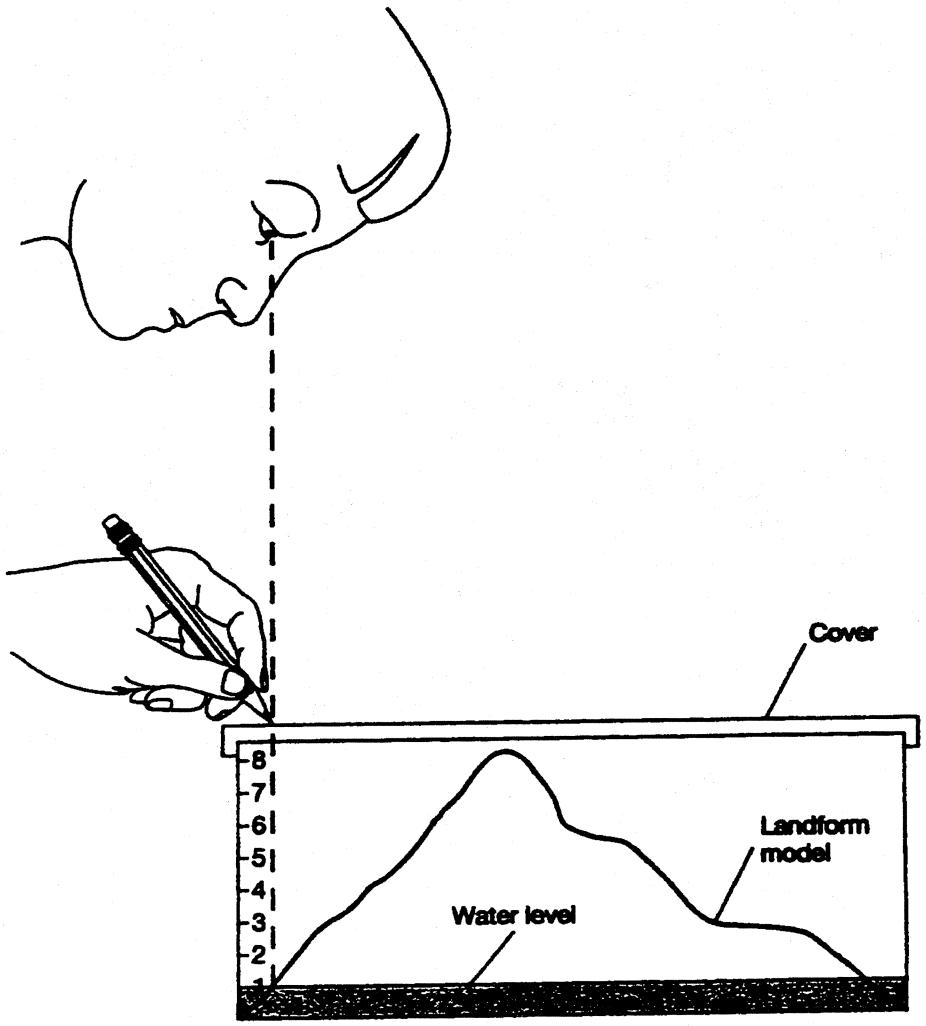


Figure 2

Name:_____ Name:_____

5. Remove the lid and fill the box to the next centimeter mark. Replace the lid and trace the new water line as you did in step 4 Remember contour lines should not cross. Repeat this provedure centimeter by centimeter untill you have come as cloase as possible to the top of the landform model. At this point you will have completed a contour map of the landfrom model. See Figure 3.

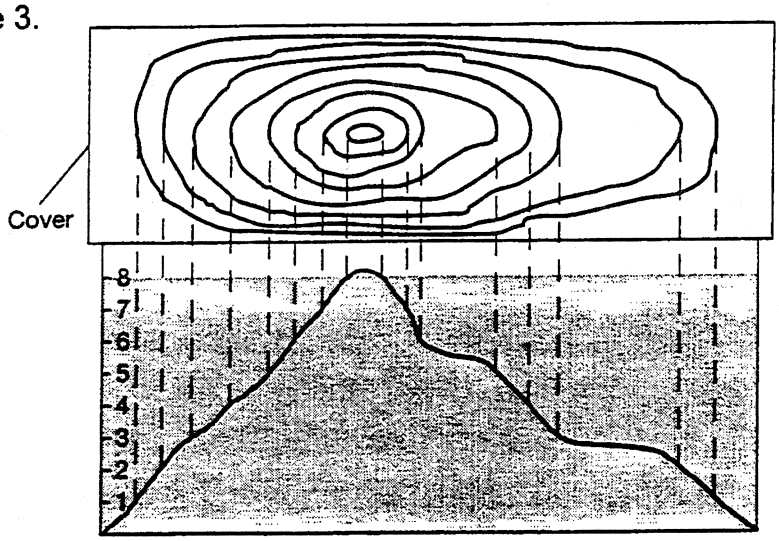


Figure 3

Conclusion

1 After you finished, dump out the water and remove the acetate sheet form the lid. Trace the lines on the acetate sheet onto a piece of plain paper This sheet will represent a map of the landform.
2. Label the depth (in centimeters) on each of the lines on your map.
3. Clean off the acetate sheet with a paper towel and return it to the teacher
4 How does a mountain appear on a contour map?

5. What is the contour interval of this map?

6. What is the highest possible elevation on this map (in centimeters)?

7 Why are the lines closer together in some areas of the map?

8. What is true of the elevation of two different points on the same contour line?

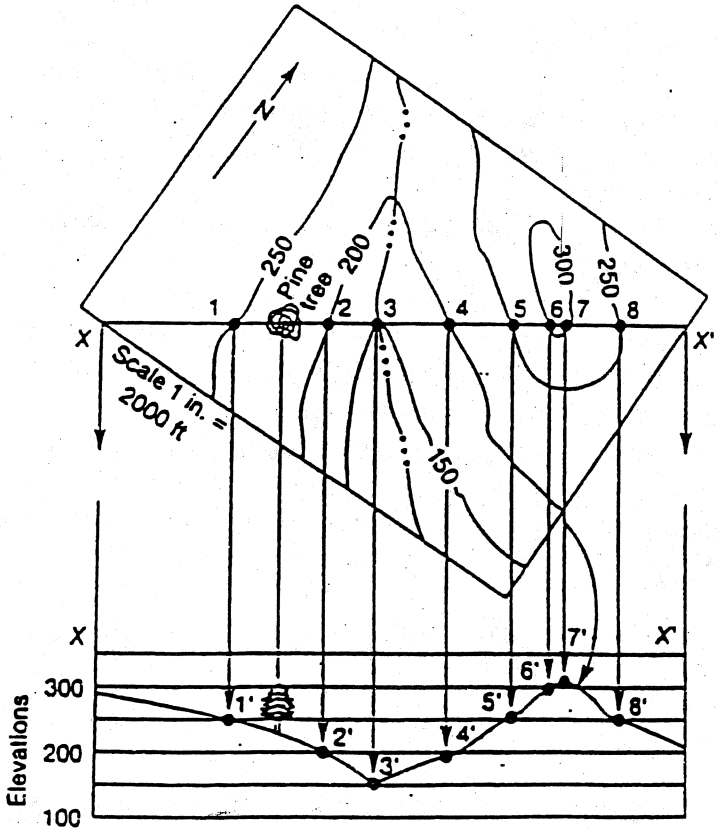
TOPOGRAPHIC MAP STUDIES - PROFILES

Purpose: To draw profiles (cross-sections) from topographic maps.

Introduction: Topographic maps show both natural features and the work of humans. Agricultural, architectural and transportation-system expansion in response to a growing Earth population has greatly changed the nature of the Earth's surface. Topographic maps tell a cultural as well as a geological story.

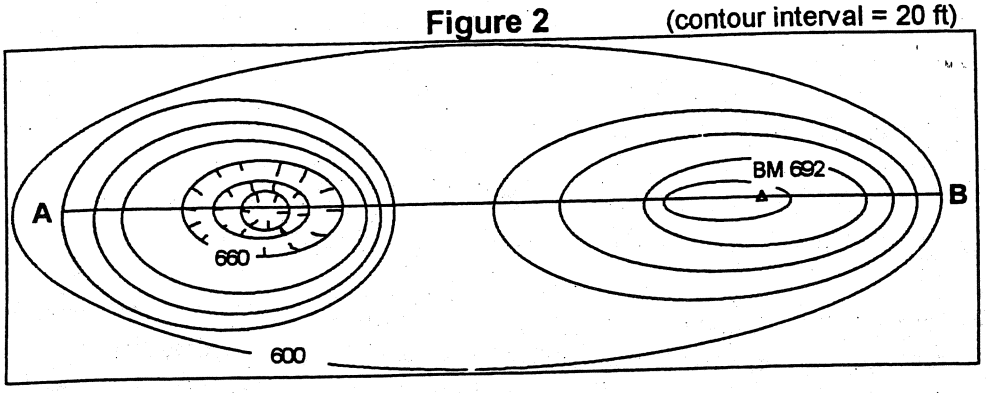
One important kind of interpretation made from topographic maps is the cross section or profile. Line segment XX' in Figure 1 below is called a cross-section line or a traverse. The two parts of Figure 1 show how a profile is taken from a cross-section line.

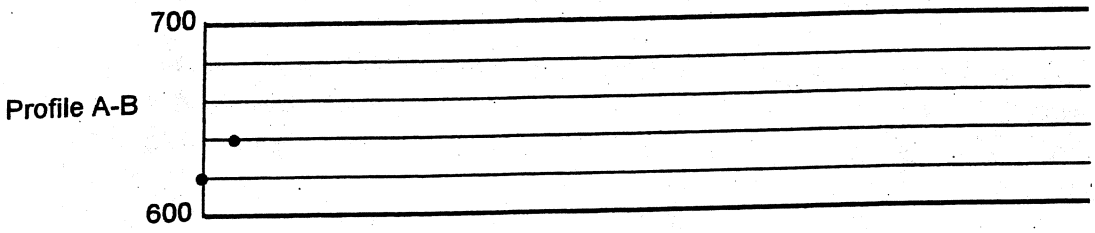
Figure 1



Other features shown by contour lines are depressions or openings in the Earth's surface. Contour lines with hachures, or short lines drawn at right angles to the contour, are known as depression contours. See the north-west section of the map in Figure 2 for an example of hachures. After the first depression contour, the decrease in elevation is measured using the same contour interval that is used for the regular contour lines.

Figure 2 (contour interval = 20 ft)





Method:

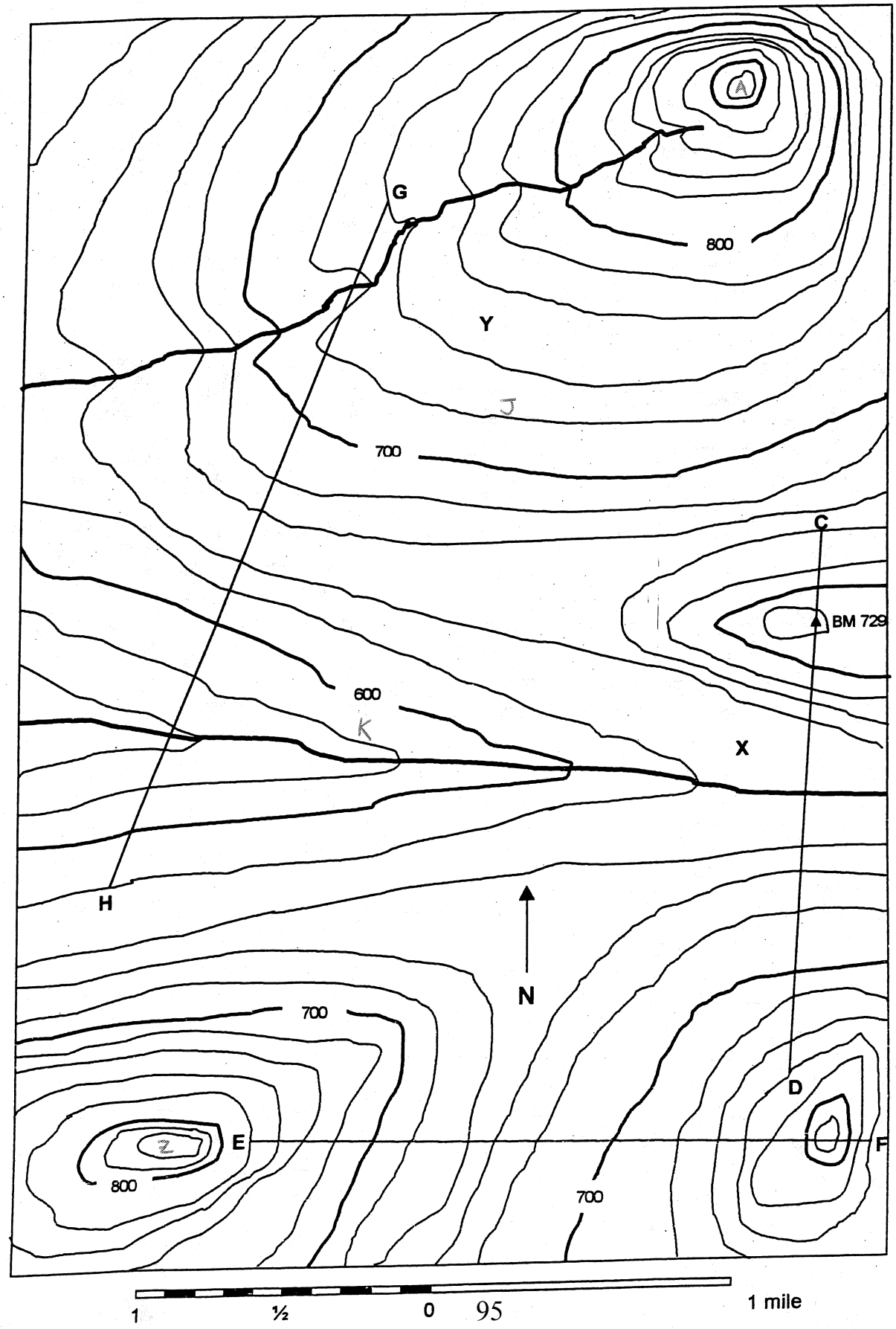
1. Complete the topographic cross-section for line A-B in Figure 2. Use the cross-section grid provided below the map and follow these steps:
   a. Place a separate piece of paper with its straight-edge along line A-B on the map.
   b. Holding the paper still, mark the paper where the contour lines on the map intersect line A-B.
   c. Write the value of the contour line below marks representing labeled contour lines (every 100ft for this map) AND whenever the contours change direction. Mark the position of a river or stream with an "X" and that of a bench mark with a "▲".
   d. Line the paper up with the cross-section grid and, moving the paper up and down the grid, plot each contour line value.
   e. Connect the plotted points with a smooth line to produce the cross-section.

*** Before continuing, have your lab instructor check your work above. ***

2. Reproduce the corrected profile for A-B on your answer sheet.

3. Complete the topographic cross-sections for C-D, E-F and G-H on Figure 3 using the same steps as above.

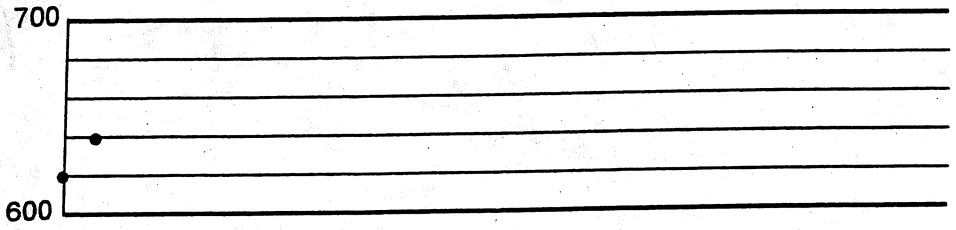
Figure 3



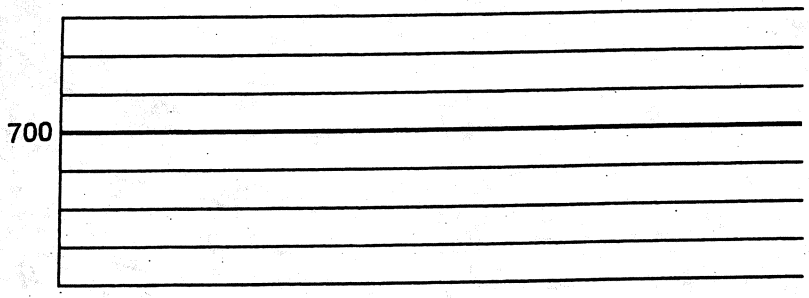
REGENTS EARTH SCIENCE: Exp# 4 Name_____

TOPOGRAPHIC MAP STUDIES – PROFILES

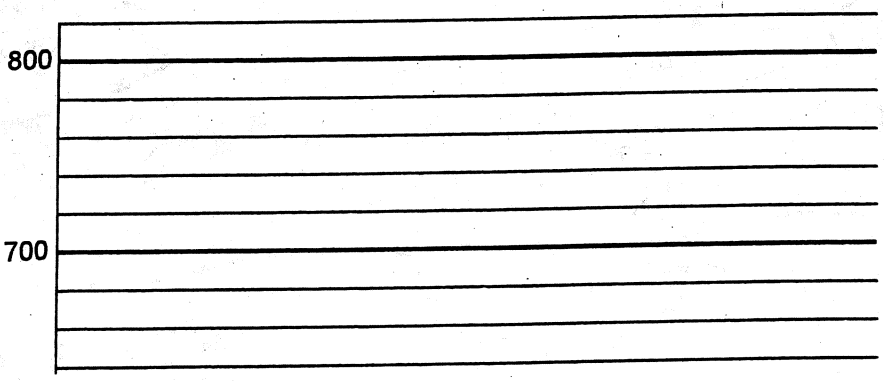
Profile A-B



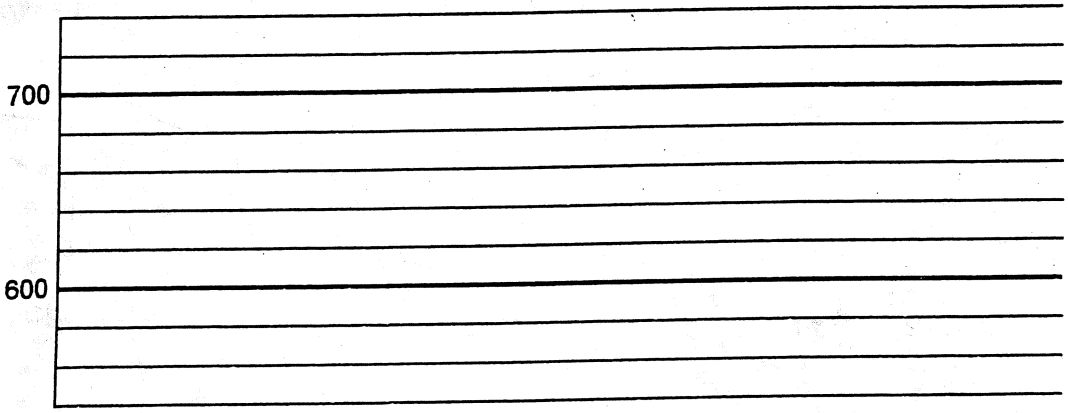
Profile C-D



Profile E-F



Profile G-H



Questions: Answer all questions in COMPLETE SENTENCES!

1. What is the possible range of values for the location marked point X in figure 3?

2. In which direction is the river near point X flowing? List 3 ways you can determine the direction a river is flowing.

3. What is the maximum elevation of hill Z?

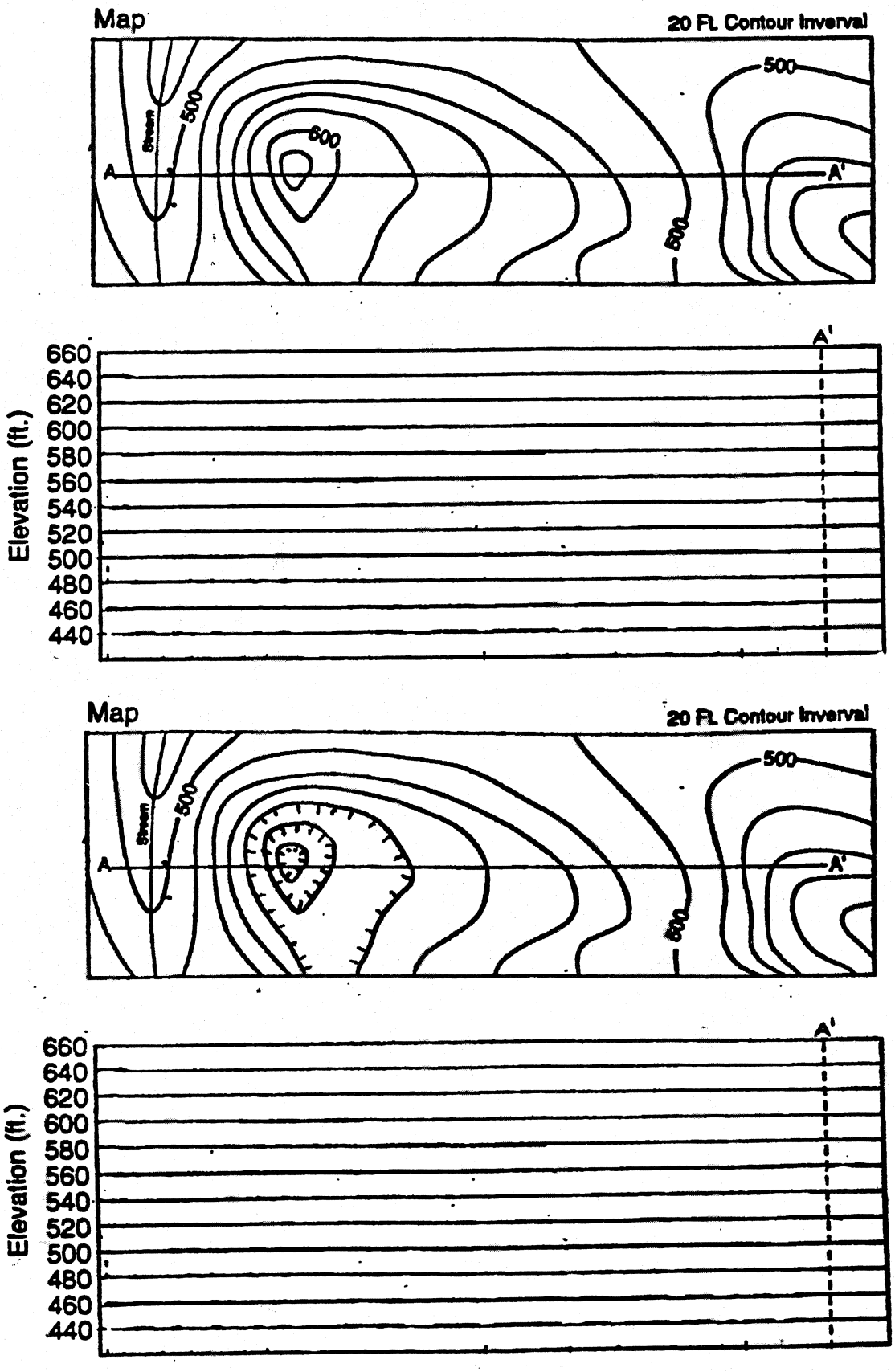
4. What is the distance from point X to Y to the nearest 10^{th} of a kilometer?

5. Which side of hill A is the steepest? Explain how your answer.

6. Calculate the gradient from point J to K include units in your answer.

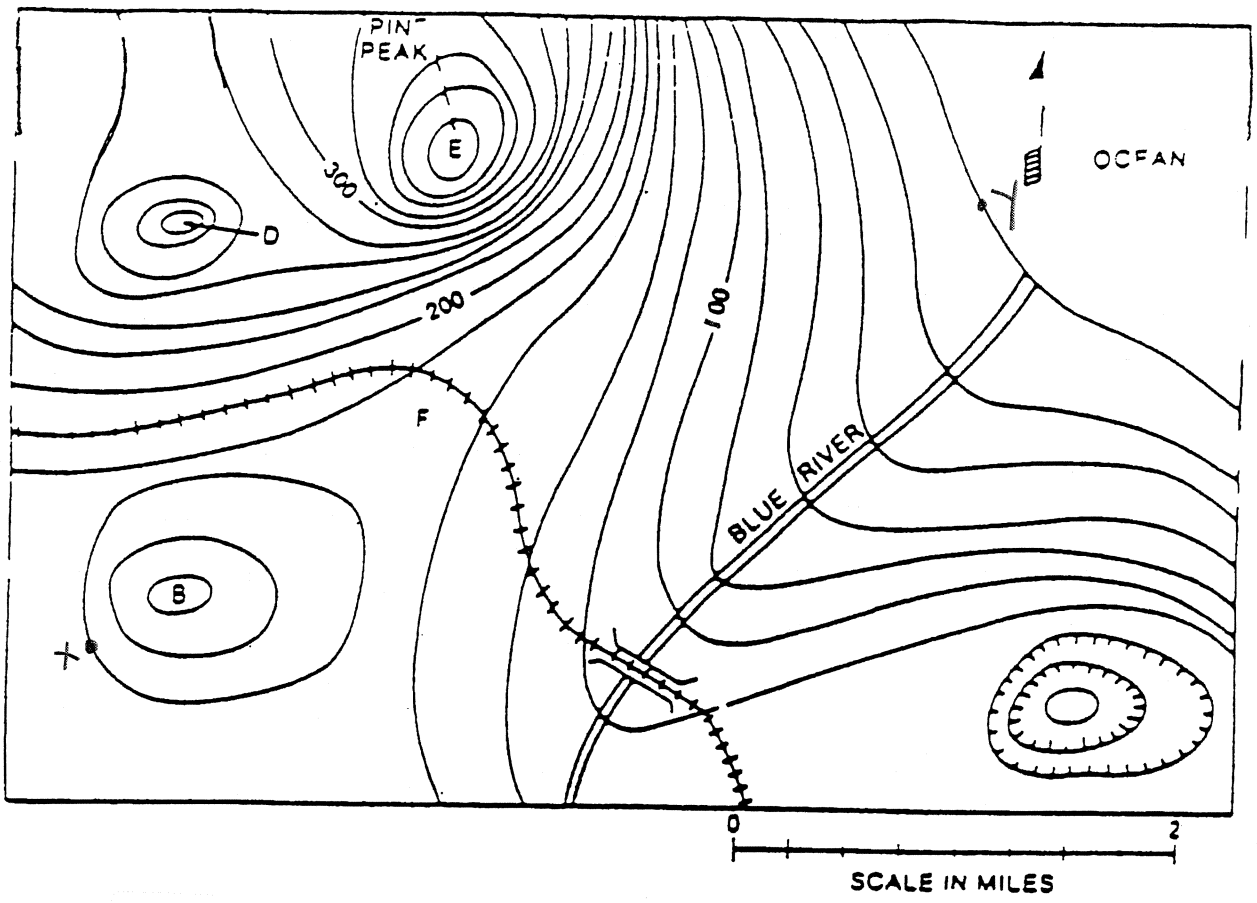
Name: _____ Date: _____

Draw a topographic profile for line A –A'



Name _____ Date _____

CONTOUR MAP EXERCISE



Name _____ Date _____

Contour Map Exercise

Refer to the map in Figure 6—5 to answer the following questions.

1 What is the contour interval? _____

2. What is meant by a contour line?

_____

3. What is the maximum elevation at letter A? _____

4 What special feature occurs in the neighborhood of letter A?

_____

5. What is the elevation of the highest possible point on the map? _____

6. What is the elevation at the closest contour line to the bridge? _____

7 How many miles of railroad track show on the map? _____

8. In what direction does the Blue River flow? _____

9. Other than the presence of the ocean, how can you tell the direction the river flows?

_____

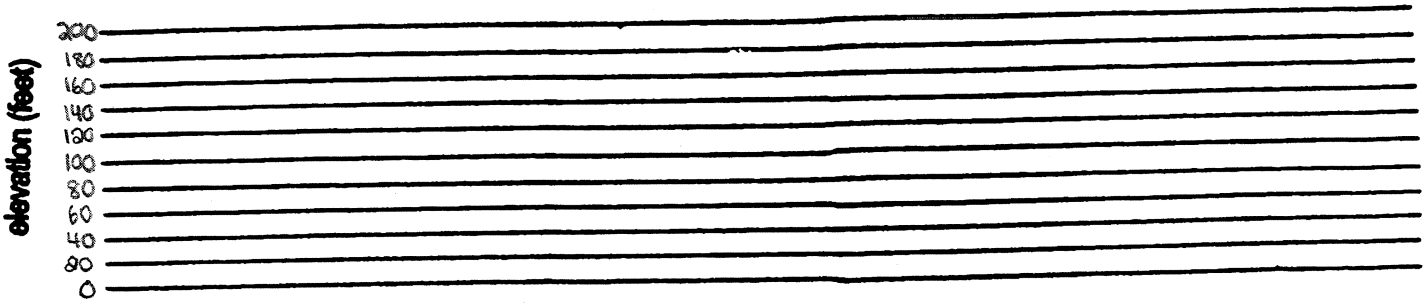
10. On which side would you find the steepest slope of Pine Peak? _____

11 How can you tell which slope is steepest on the map? _____

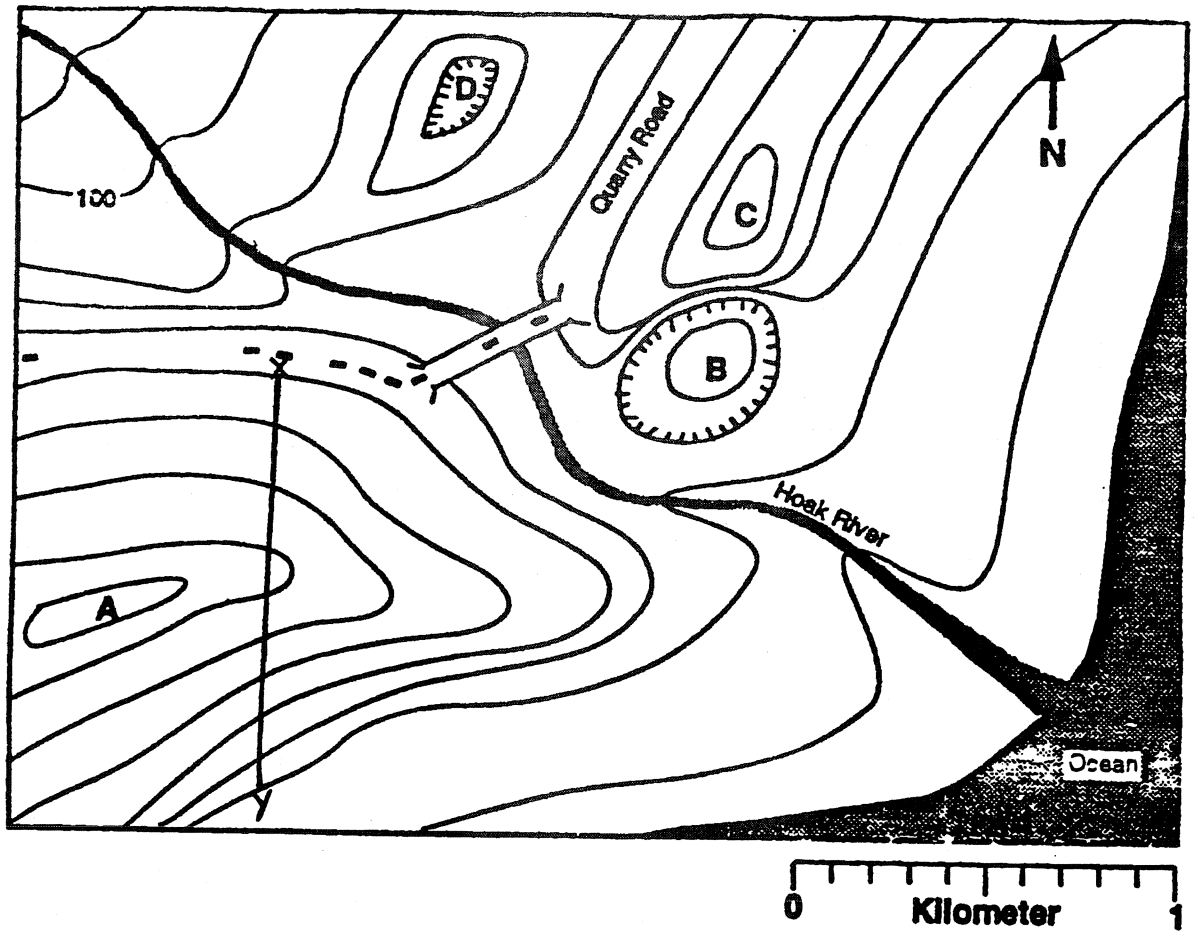
12. What is the elevation of Point F? _____

13. What is the lowest elevation on the map? _____

Draw a line connecting points X and Y Then draw a profile along this line.



Name:_____ Name:_____



Using your knowledge of topographic contour maps, answer the questions based on the above map.

1 What is the contour interval? _____ meters

2. What is the **maximum** elevation of point A? _____ meters

3. What is the elevation of the contour line surrounding point B? _____ meters

4 What is the **minimum** elevation of point D? _____ meters

5. Estimate the height of the Quarry Road Bridge above the Hoak River? _____ meters

6. Which side of hill A is steepest? _____

7 In what direction is the Hoak River flowing? _____

Name:_____ Name:_____

8. Explain three different methods that you can use to determine which way the Hoak River flows:
   a. _____

   _____

   b _____

   _____

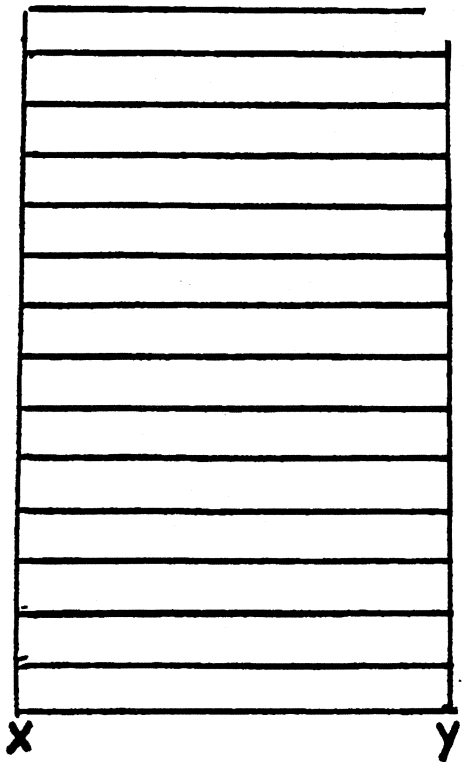
   c. _____

   _____

9. What is the total length of Quarry Road shown on the map? _____ Kilometers

10. What is the gradient of the Hoak River from the 100 meter contour line to the ocean? (Show all work)

11 Construct a topographic profile along line X – Y



Name:_____ Date:_____

Review: Shape of Earth and Locations on Earth

1 What is the true shape of the Earth?

2. When drawn to scale, what would the Earth appear as?

3. Compare the equatorial circumference with the polar circumference?

4 Where on Earth would you weigh the least? Why?

5. What is the relationship between an observer's latitude and the altitude of Polaris?

6. Where on Earth must an observer stand in order to see Polaris at their zenith?

7 As a person travels North of the Equator what happens to the altitude of Polaris?

8. As a person travels West across New York State, what happens to the altitude of Polaris?

9 What is the time difference between observers at 75°W and 45°W longitude?

10. If the time at 30°W is 1p.m., what time would it be at 15°E?

11 How many degrees of longitude equal three hours?

12. What is the latitude and longitude (to the nearest minute) of Mt. Marcy?

13. What is the latitude and longitude (to the nearest minute) of Ithaca?

Name _____ Date _____

Topic 2 Review Sheet

1) What is the shape of the Earth?

2) Describe the shape of the Earth?

3) Compare the equatorial circumference with the polar circumference

4) What is the best evidence of the shape of the Earth?

5) How do gravity measurements help us explain the shape of the Earth?

6) Where does a person weigh more, at the poles or at the equator? Why?

7) Name all the layers of the atmosphere.

8) What happens to temperature as you increase altitude in the atmosphere?

9) What happens to air pressure and water vapor as you increase altitude in the atmosphere?

10) List the differences between the lithosphere, hydrosphere and atmosphere?

11) What is the most abundant element by mass in the troposphere?

12) What is the most abundant element by volume in the Earth's crust?

13) What is the most abundant element by mass in the Earth's crust?

14) What is the relationship between latitude and Polaris?

15) List the latitude and longitude of the following locations to the nearest minute:

Elmira _____ Ithaca _____

_____ _____

Mt Marcy _____ Old Forge _____

_____ _____

16) As a person travel North of the Equator what happens to altitude of Polaris?

17) While traveling, when does the altitude of Polaris remain the same?

18) How many degrees are found between each line of longitude?

Name _____ Date _____

19) What do contour lines connect?

20) What is a benchmark?

21) What is the formula for gradient?

22) List three ways to determine the direction that a stream is flowing.

Name:_____ Date:_____

Earth in the Universe
Topic 3 Vocabulary

Asteroid. _____

_____

Big Bang theory· _____

_____

Celestial object: _____

_____

Comet: _____

_____

Doppler effect: _____

_____

Eccentricity· _____

_____

Ellipse: _____

_____

Focus: _____

_____

Galaxy· _____

_____

Gravitation: _____

_____

Name:_____ Date:_____

Impact event: _____

_____

Inertia. _____

_____

Jovian planet: _____

_____

Luminosity: _____

_____

Me or: _____

_____

Milky Way Galaxy: _____

_____

Nuclear fusion: _____

_____

Red shift: _____

_____

Revolution: _____

_____

Rotation: _____

_____

Name:_____ Date:_____

Solar System. _____

_____

Star: _____

_____

Terrestrial planet: _____

_____

Universe: _____ _____

_____

Name:_____ Date:_____

The Solar System

1 What is one of the focal points for each planet's elliptical orbit?

2. What is the name of the galaxy that out solar system belongs to?

3. Which planet is closest to the sun?

4 Which planet has the longest period of revolution?

5. What is the relationship between distance from the sun and a planet's period of revolution?

6. How many days does it take Mercury to make one revolution around the sun?

7 Which planet has the longest period of rotation?

8. Which planet rotates fastest?

9 Which planet's orbit is most eccentric?

10. Which planet has the most circular orbit?

11 Which planet is the largest?

12. Which planet is four times larger than Earth?

13. Which planet is the most dense?

14 Which planet could float in water?

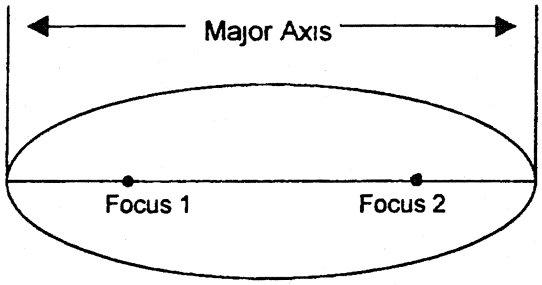
15. Which planet has the most satellites?

Name:_____ Date:_____

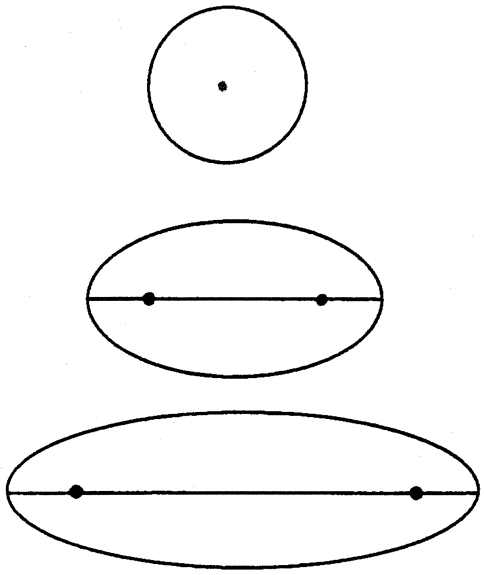
Eccentricity

Eccentricity $= \frac{\text{distance between the foci}}{\text{length of the major axis}}$

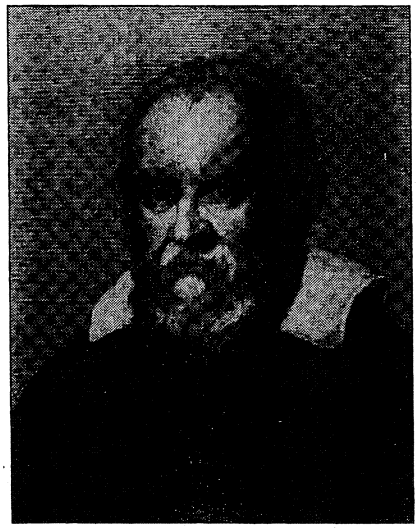
As the distance between the foci _____ the eccentricity _____



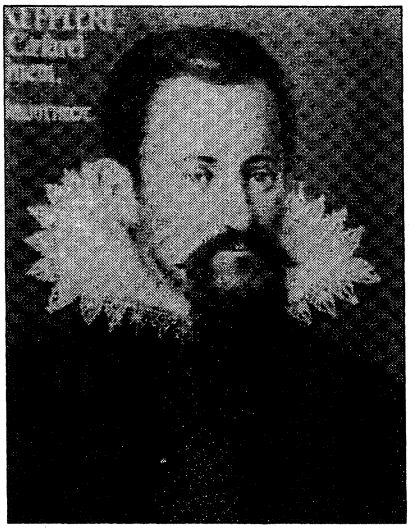
Calculate the Eccentricity of the following ellipses: (show all work)



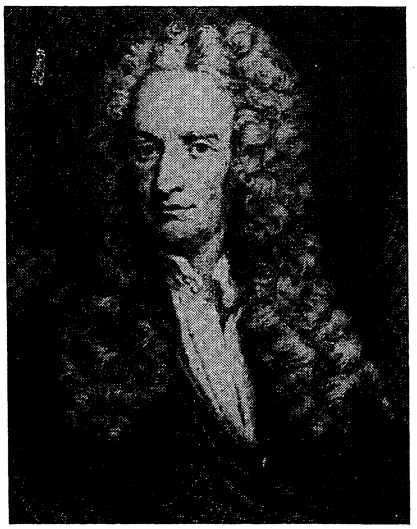
Around the Sun



Galileo



Kepler



Newton

Background Information

By the year 1543, when the astronomer Copernicus published *De Revolutionibus*, major progress had been made in accurately describing the solar system. Copernicus wrote ". . . the sun rules the family of planets as they circle around him." From this point on, the heliocentric, or sun-centered, model of the solar system prevailed. Several years after the death of Copernicus, the German astronomer and mathematician Johannes Kepler used observations made by a Danish astronomer, Tycho Brahe, to more accurately describe planetary orbits.

Brahe's observations of Mars allowed Kepler to determine that the planetary orbits were elliptical, not round as described by earlier astronomers. It was at this point that Kepler published two laws of planetary motion. His first law established that the orbits of planets are ellipses, with the sun as one of two foci, the other focus being a theoretical point in space. See Figure 1 for an example of an ellipse.

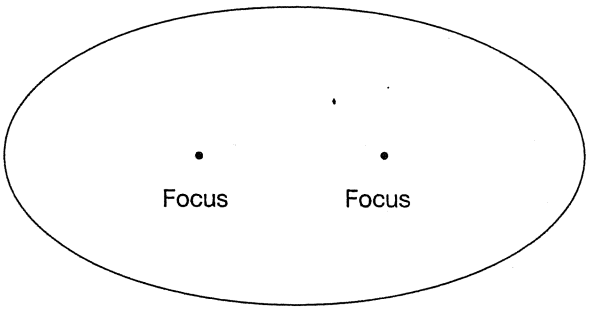


Figure 1

Kepler's second law states that the orbital speed of the planets increases as they get closer to the sun and decreases proportionally as they get farther away. Figure 2 shows the effect of the sun on the orbital speed of the planets. The planet Mars takes the same amount of time to travel from point *A* to point *B* as it does to travel from point *C* to point *D*. The distance *AB* is much greater than the distance *CD*, so the orbital speed between points *A* and *B* is greater than the orbital speed between points *C* and *D*.

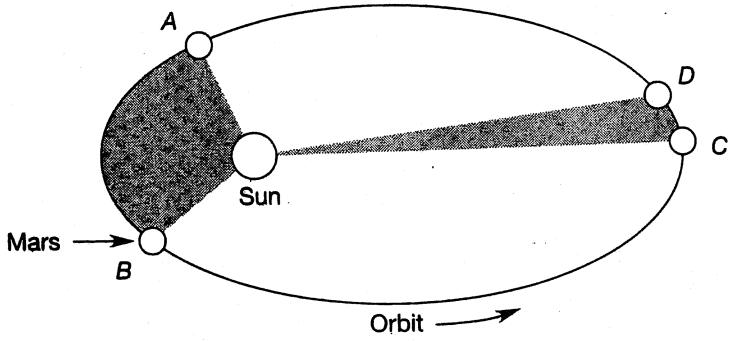


Figure 2

Kepler's third law showed the mathematical relationship between the distance of a planet from the sun and its period of revolution. Planets closer to the sun have a shorter period of revolution, or year, than those farther away. This situation causes planets to appear to wander when viewed from Earth. Some of the time they appear to have a backward, or retrograde, motion. In fact, the word *planet* is derived from the Greek word for "wander." See Figure 3 for an illustration of retrograde motion.

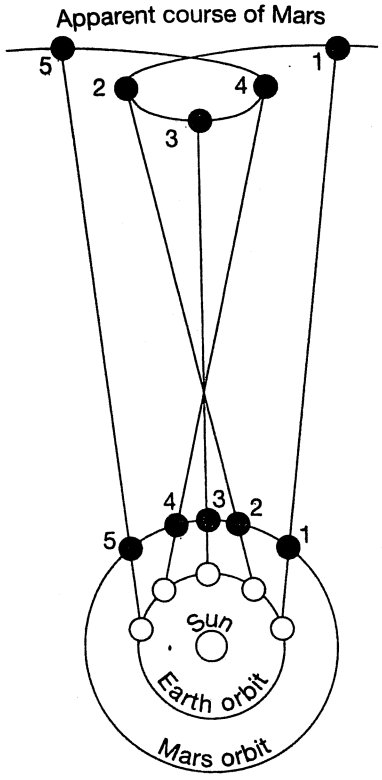


Figure 3

Name _____ Class _____ Date _____

The lower portion of Figure 3 shows the relative positions of Mars and Earth in their orbits. The upper portion of the diagram shows the successive positions of Mars as seen from Earth when viewed over a period of time. Because the Earth orbits the sun faster than Mars, Mars appears to move backward at positions 3 and 4 and then appears to move forward again to position 5.

Both Kepler and his contemporary, Galileo, were excommunicated from the Church for defying Church doctrine with their nondivine descriptions of the solar system. Though gravity had yet to be described by Newton, Kepler's references to magnetism indicate that perhaps he was close to the discovery of yet another major law of physics. Isaac Newton's later description of the force he called gravity and his laws of motion combined to explain the behavior of bodies in the solar system and eventually in the universe. Figure 4 shows how forces (gravity) and motion (inertia) interact to produce orbits.

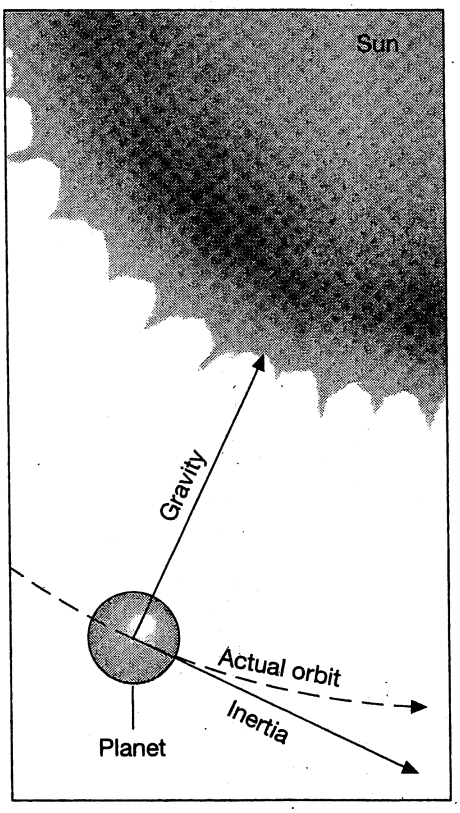


Figure 4

In this investigation you will draw a series of ellipses and relate their characteristics to actual orbits found in the solar system.

Problem

How can the shape of orbits be described?

How does the shape of the Earth's orbit compare with the orbits of other planets in the solar system?

Materials *(per group)*

pencil
50-cm length of string
2 thumbtacks or pushpins
thick piece of cardboard, 32 cm × 38 cm
tape
centimeter ruler

Procedure

1. Form a loop by tying the ends of a piece of string together. The loop should be 11 cm long when pulled tight.
2. Remove page 83 from this book. Place this sheet on the cardboard so that points *A* through *F* are visible.
3. Put the tacks into points *A* and *B*. Place the loop around both tacks. Pull the loop tight with a pencil as shown in Figure 5.

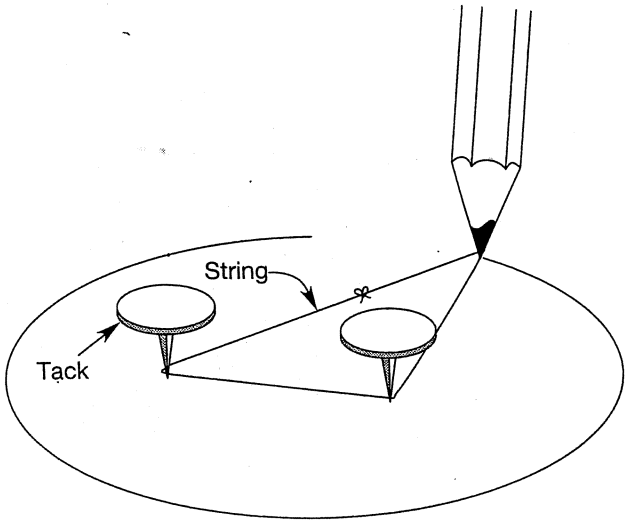


Figure 5

4. Keeping the loop pulled tight with the pencil, complete the ellipse as shown in Figure 5. The thumbtacks represent the foci for the ellipse you have just drawn. Label this ellipse *AB*.
5. Repeat this procedure with the tacks placed in points *C* and *D*. Place the loop around the tacks at points *C* and *D* and draw the ellipse. Label the ellipse *CD*.
6. Draw and label ellipse *EF* using the same procedure.
7. Two measurements, the length of the major axis and the focal distance, will allow you to determine the eccentricity, or elongation, of an ellipse. See Figure 6.

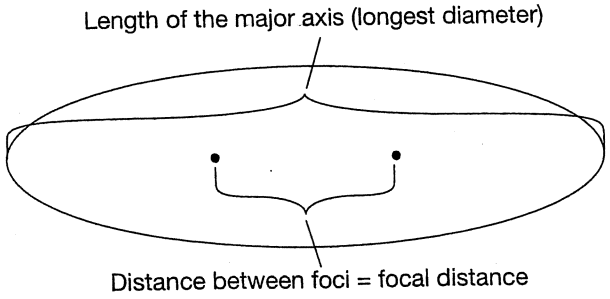


Figure 6


D
F
B
A
E
C

Analysis and Conclusions:

1. Complete the chart below:

	Focal distance to the nearest 10^{th} of a cm	**Length of major axis to the nearest 10^{th} of a cm**	**Eccentricity to the nearest 1000^{th}**
Ellipse AB			
Ellipse CD			
Ellipse EF			

2. What is the relationship between focal distance and eccentricity of an ellipse?

3. Which of the three orbits you drew has the greatest eccentricity? Explain your answer.

4. Using the following Data, calculate the eccentricity of the Earth's orbit to the nearest thousandth:
   Major axis = 298,000,000 km
   Focal distance = 4,800,000 km

   Eccentricity of Earth's orbit: _____

5. The Data Table below lists information about the orbits of the other planets:

Planet	Eccentricity	Earth's eccentricity in comparison to Planet's
Mercury	0.206	
Venus	0.007	
Mars	0.093	
Jupiter	0.048	
Saturn	0.056	
Uranus	0.047	
Neptune	0.008	

6. In the chart above write **MORE** if Earth is more eccentric than the planet or **LESS** if Earth is less eccentric than the planet.

7. Which planet has the most eccentric orbit? The least eccentric orbit?

8. Circle focal point A and label it the sun. On the ellipse drawn for foci AB, place and X on the orbit where an object would have its greatest orbital velocity.

9. State the relationship between distance from the sun and orbital velocity. Explain why this relationship exists.

Name _____Date_____

Topic 3 Review

1 What is a Universe?

2. Explain the Big Bang Theory

3. List 2 pieces of evidence for the big bang theory

4 Compare and contrast the red and blue shift.

5. What is a galaxy?

6. How can we classify stars?

7 What is the name and shape of your galaxy?

Name _____Date_____

8. How is energy produced in the sun? Briefly explain the process.

9. Briefly describe the origin of a star

10. What is an asteroid? Where are they found?

11 What is a comet?

12. What is a meteoroid?

13. Explain what an impact event is, and what do they look like?

14 What major effect does a planets distance from the sun have on its characteristics?

Name _____Date_____

15. What do the terrestrial planets have in common?

_____
_____
_____

16. What do the Jovian planets have in common?

_____
_____
_____

17 Compare and contrast rotation and revolution.

_____
_____
_____
_____
_____
_____

18. One period of rotation would be_____

19. One period of revolution would be _____

20. The oval shape of the Earth's orbit is called a/an _____

21 What is a foci? What are the foci for our orbit?

_____
_____
_____

22. Write the formula for eccentricity

23. Find the eccentricity for the following: distance between foci 1.3cm, length of major axis is 2.7 cm.

Name _____Date_____

24 What would happen if the foci were far apart?

_____
_____
_____

25. What would happen if the foci are closer together?

_____
_____
_____

26. When is perihelion?

_____
_____
_____

27 When is aphelion?

_____
_____
_____

28. Explain how gravity works, and what affects it.

_____
_____
_____

29. What happens to gravity between 2 planets when they move apart?

_____
_____
_____

30. Explain how the period of rotation is related to the distance from the sun.

_____
_____
_____

Name:_____ Date:_____

Motions of Earth, Moon, and Sun
Topic 4 Vocabulary

Axis of rotation. _____

_____

Constellation. _____

_____

Coriolis Effect: _____

_____

Eclipse. _____

_____

Foucault pendulum: _____

_____

Geocentric model: _____

_____

Heliocentric model: _____

_____

Phases of the moon: _____

_____

Local time: _____

_____

Tides: _____

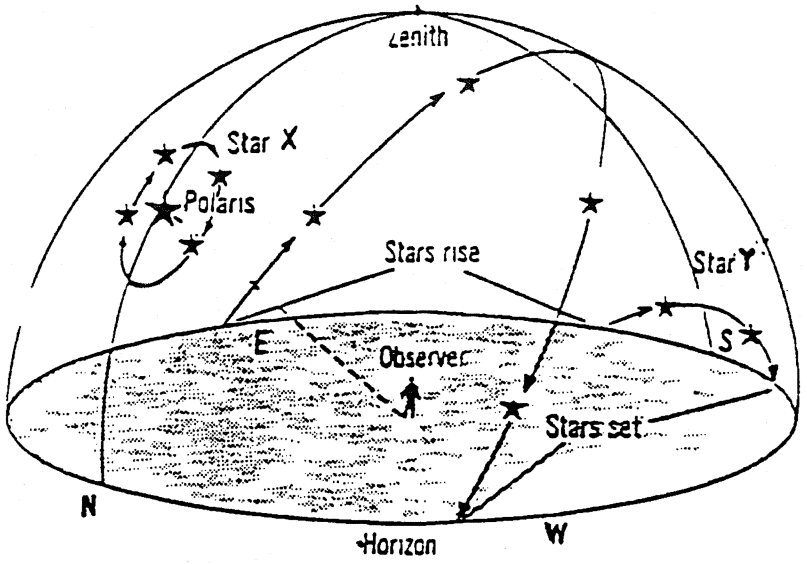
_____

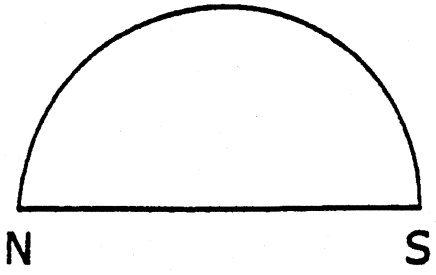
Time zones: _____

Name:_____ Date:_____

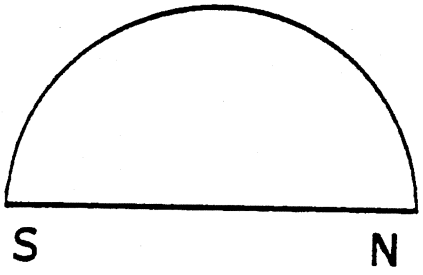
Motion of the Stars

Draw the star trails for an observer looking north, east, west, and south

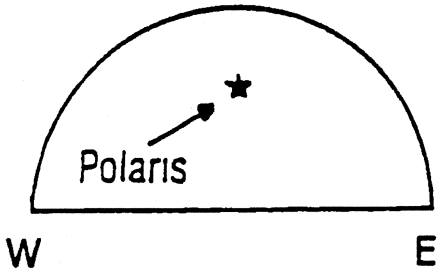




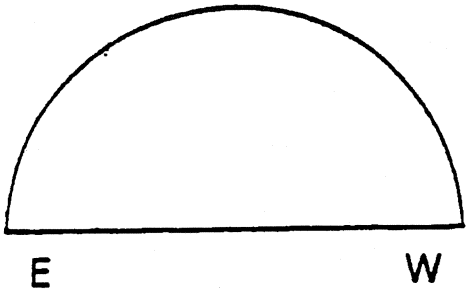
LOOKING EAST



LOOKING WEST



LOOKING NORTH



LOOKING SOUTH

Name: _____ Date: _____

The Sun's Path Lab

Introduction:

As you know the sun rises in the East and sets in the West. Simply put the sun appears to move in an arch westward across the sky What you may not know is that this path is not identical from one day to the next. The sun does not always rise exactly East and set exactly West. The aspects of the sun's path that change from one season to the next are: **the points of sunrise and sunset, the length of the path, the number of daylight hours, and the altitude of the solar noon.** Solar noon occurs when the sun crosses the observer's celestial meridian. At this time the sun is precisely halfway in its journey from sunrise to sunset and is as high in the sky as it will get for that day

Objectives:

After completing this activity you should be able to:

1 Describe the shape of the sun's path in the sky
2. Relate the length of the sun's path to the number of daylight hours.
3. Identify the time of the year when the sun's path is longest.
4. Identify the time of the year when the sun's path is shortest.
5. Identify the time of the year when the sun rises farthest North of East.
6. Identify the time of the year when the sun rises farthest South of East.
7 Describe the pattern of change shown by the altitude of the noon sun over the course of a year
8. Determine accurately the angle between the sun's position at two points along its path.

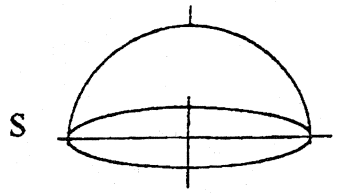
Prior Knowledge:

1 The sun rises in the East and sets in the West
2. The sun appears to move across the sky at a constant rate of 15°/hr
3. The observer is located at the point where the North-South line crosses the East-West line.
4. The clear plastic hemisphere represents the dome of the sky

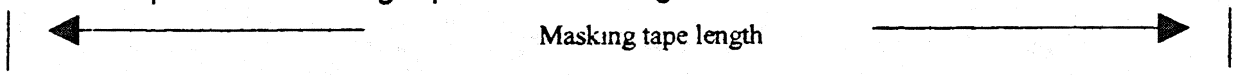
Name: _____ Date: _____

Directions.

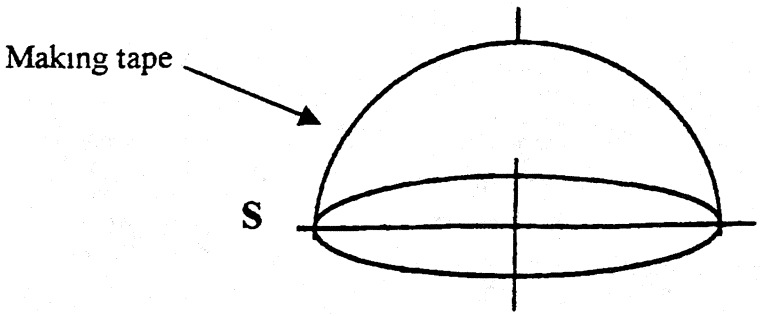
1 Find the point on one of the lines labeled 9 a.m.



2. Tear off a piece of masking tape about as long as the line below



3. Carefully stick a piece of masking tape on the outside of the plastic hemisphere following the sun's path as shown below



4 Mark the 9 a.m. position on the tape. Remembering that the sun moves 15°/hr along its path, determine the number of degrees the sun will move from 9 a.m. to 1 p.m. Enter this value on the line below.

_____ degrees

5. Using the external protractor provided, measure this number of degrees (along the sun's path) from the 9 a.m. position and make a mark on the making tape. Label the mark 1 p.m.

6. Carefully remove the masking tape and stick it in the space provided below.

(Place masking tape here)

7 Measure the distance between the 9 a.m. and the 1 p.m. marks to the nearest tenth of a centimeter and write the answer in the space below.

_____ centimeters

Name: _____ Date: _____

Questions:

1 What term would apply to the point directly above the observer's head?

2. For our location in New York, about how high above the northern horizon would the North Star be located?

3. What is solar noon?

4 The lettered lines represent the path of the sun in the sky on the winter solstice, vernal equinox, summer solstice, and autumnal equinox. Which line represents the

Vernal Equinox _____
Summer Solstice _____
Autumnal Equinox _____
Winter Solstice _____

5. When the sun is highest in the sky (halfway between sunrise and sunset), it is local solar noon. Measuring as carefully as possible from the southern horizon, how high in degrees is the noon time sun on the following dates?

Vernal Equinox _____
Summer Solstice _____
Autumnal Equinox _____
Winter Solstice _____

6. This model is for the New York area. Is the sun ever at the observer's zenith for an observer in New York?

7 In what part of the sky (North, East, West, or South) is the sun located at noon?

8. Where does the sun rise and set on each of the following dates?

	Rise	Set
September 23	_____	_____
December 21	_____	_____
March 21	_____	_____
June 21	_____	_____

Name: _____ Date: _____

9 Measuring carefully in degrees, what is the approximate length of the path of the sun on:

September 23 _____
December 21 _____
March 21 _____
June 21 _____

10. Recalling that the sun moves 15°/hr along its path, approximately how many hours of daylight are there on each of the following dates:

September 23 _____
December 21 _____
March 21 _____
June 21 _____

Conclusion:
What are the four aspects of the sun's path that change from season to season?

Name: _____ Date: _____

LAB – Apparent Size of the Sun

Lab Skills and Objectives

- To construct a graph of solar apparent diameter data
- To interpret the graph in terms of Earth's distance from the sun
- To compare the graph with Earth s seasonal changes

Materials

- Sharp pencil
- Sheet of graph paper

Data Table

Date	Apparent Diameter	Date	Apparent Diameter
Jan1	32' 32"	Jul 10	31 28"
Jan 10	32' 32"	Jul 20	31 29"
Jan 20	32' 31	Jul 30	31 31
Jan 30	32' 28"	Aug 10	31 34"
Feb 10	32' 25"	Aug 20	31 37"
Feb 20	32' 21	Aug 30	31 41
Mar 1	32' 17"	Sep 10	31 46"
Mar 10	32' 12"	Sep 20	31 51
Mar 20	32' 07"	Sep 30	31 57"
Mar 30	32' 02"	Oct 10	32' 02"
Apr 10	31 56"	Oct 20	32' 08"
Apr 20	31 50"	Oct 30	32' 13"
Apr 30	31 45"	Nov 10	32' 18"
May 10	31' 41	Nov 20	32' 23"
May 20	31 37"	Nov 30	32' 26"
May 30	31' 33"	Dec 10	32' 29"
Jun 10	31' 30"	Dec 20	32' 31"
Jun 20	31' 29"	Dec 30	32' 32"
Jun 30	31' 28"		

Procedure

1 The data given is the apparent diameter of the sun as it appears from Earth. Since the apparent diameter of the sun is less that 1 it is measured in minutes (') and seconds ("). There are 60 minutes in a degree and 60 seconds in a minute.
2. To begin your graph, take a sheet of graph paper and turn it so that its longest dimension is horizontal. Label the vertical axis Apparent Diameter and mark the appropriate scale. The vertical axis should extend from 31 20" to 32' 40" Label the horizontal axis Date and mark the appropriate scale.
3. Label the seasons on your graph according to the dates for the start of each season.
4. Using the data in the table, plot the apparent diameter of the sun for each of the dates listed. Draw a smooth curve through the plotted points.
5. Answer the questions in the Analysis and Conclusions section.

Name: _____ Date: _____

Analysis and Conclusions

Answer the following questions in complete sentences based on the graph and your knowledge of Earth Science.

1 In general, how is the apparent size of an object affected by its distance from an observer? Does an object appear larger when the observer is closer or father away from it?

2. From your graph, in which season is the sun's apparent diameter largest? Will the Earth be closer to or farther from the sun at that time?

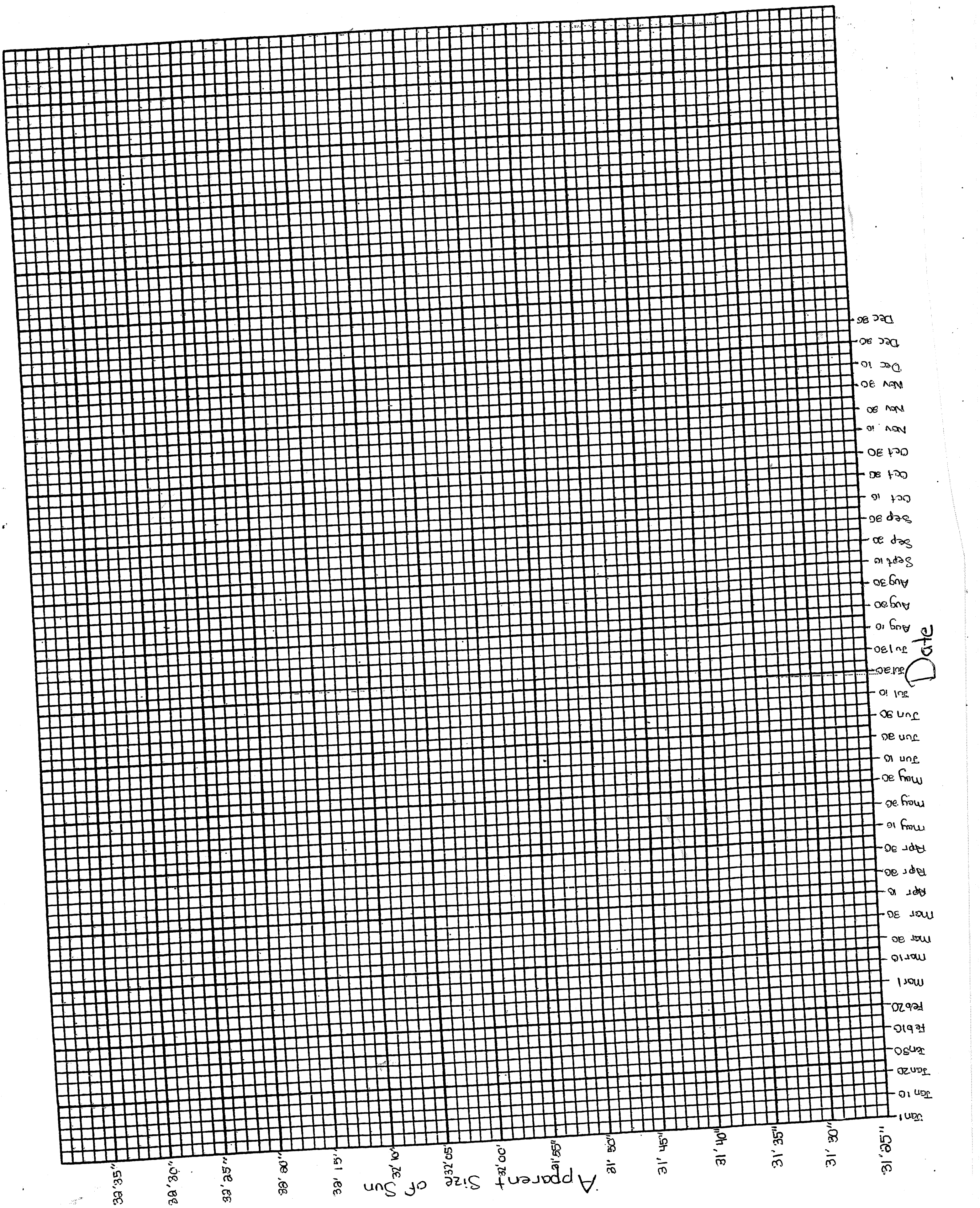
3. In which season is the sun's apparent diameter smallest? Will the Earth be closer to or farther from the sun at that time?

4. Based upon your answers to questions 1-3, explain how you know that distance from the sun is not a cause of seasons.

5. What is aphelion? From your graph, determine between which dates Earth is at aphelion?

6. What is perihelion? From you graph, determine between which dates Earth is at perihelion?

7 Compare your answers to questions 5 and 6 with the dates of aphelion and perihelion. How do they compare?
Aphelion July 4
Perihelion January 2


Date
Jan 1
Jan 10
Jan 20
Jan 30
Feb 10
Feb 20
Mar 1
Mar 10
Mar 20
Mar 30
Apr 10
Apr 20
Apr 30
May 10
May 20
May 30
Jun 10
Jun 20
Jun 30
Jul 10
Jul 20
Jul 30
Aug 10
Aug 20
Aug 30
Sept 10
Sep 20
Sep 30
Oct 10
Oct 20
Oct 30
Nov 10
Nov 20
Nov 30
Dec 10
Dec 20
Dec 30
Apparent Size of Sun
31'25"
31'30"
31'35"
31'40"
31'45"
31'50"
31'55"
32'00"
32'05"
32'10"
32'15"
32'20"
32'25"
32'30"
32'35"

Name: _____ Date: _____

LAB – Altitude of the Sun

Lab Skills and Objectives

- To construct a graph showing the Altitude of the sun for 3 given dates
- To compare the changes in the sun s altitude with the Earth s seasonal changes

Materials

- Pencil
- Graph paper

All data is for Lawrence, New York 73° 44' W 40° 37' N

December 21 2000

Time	Altitude (°)
07:00	3.4
08:00	6.3
09:00	14.4
10:00	20.8
11:00	24.8
12:00	26.0
13:00	24.1
14:00	19.5
15:00	12.7
16:00	4.3
17:00	2.6

March 21, 2000

Time	Altitude (°)
06:00	2.9
07:00	14.0
08:00	24.8
09:00	34.7
10:00	43.0
11:00	48.4
12:00	49.7
13:00	46.6
14:00	39.8
15:00	30.8
16:00	20.4
17:00	9.3
18:00	2.1

Name: _____ Date: _____

June 21, 2000

Time	Altitude (°)
05:00	5.2
06:00	15.7
07:00	26.7
08:00	38.0
09:00	49.3
10:00	60.1
11:00	69 1
12:00	72.8
13:00	68.3
14:00	59 0
15:00	48.1
16:00	36.8
17:00	25.5
18:00	14.5
19:00	4.2

Procedure

1 The data given is the altitude of the sun on 3 given dates. From this data you will create a graph showing the altitude of the sun for the 3 given dates through out the day

2. On the same piece of graph paper plot the altitude of the sun verses the time of day for the three given dates. Clearly title the graph and create a color key showing the date that is being represented by each line. On your graph paper label the horizontal (x) axis **Time** and mark the appropriate scale. Label the vertical (y) axis **Altitude of Sun** and mark the appropriate scale. Using the data table, plot the data. Draw a smooth curve through the plotted points

3. Answer the questions in the Analysis section.

Name: _____ Date: _____

Analysis

Answer the following questions in complete sentences based on the graph and your knowledge of Earth science

1 What is the significance of the three days used in this lab?

2. How many hours of daylight did Lawrence receive for the following dates:
   December 21
   March 21
   June 21

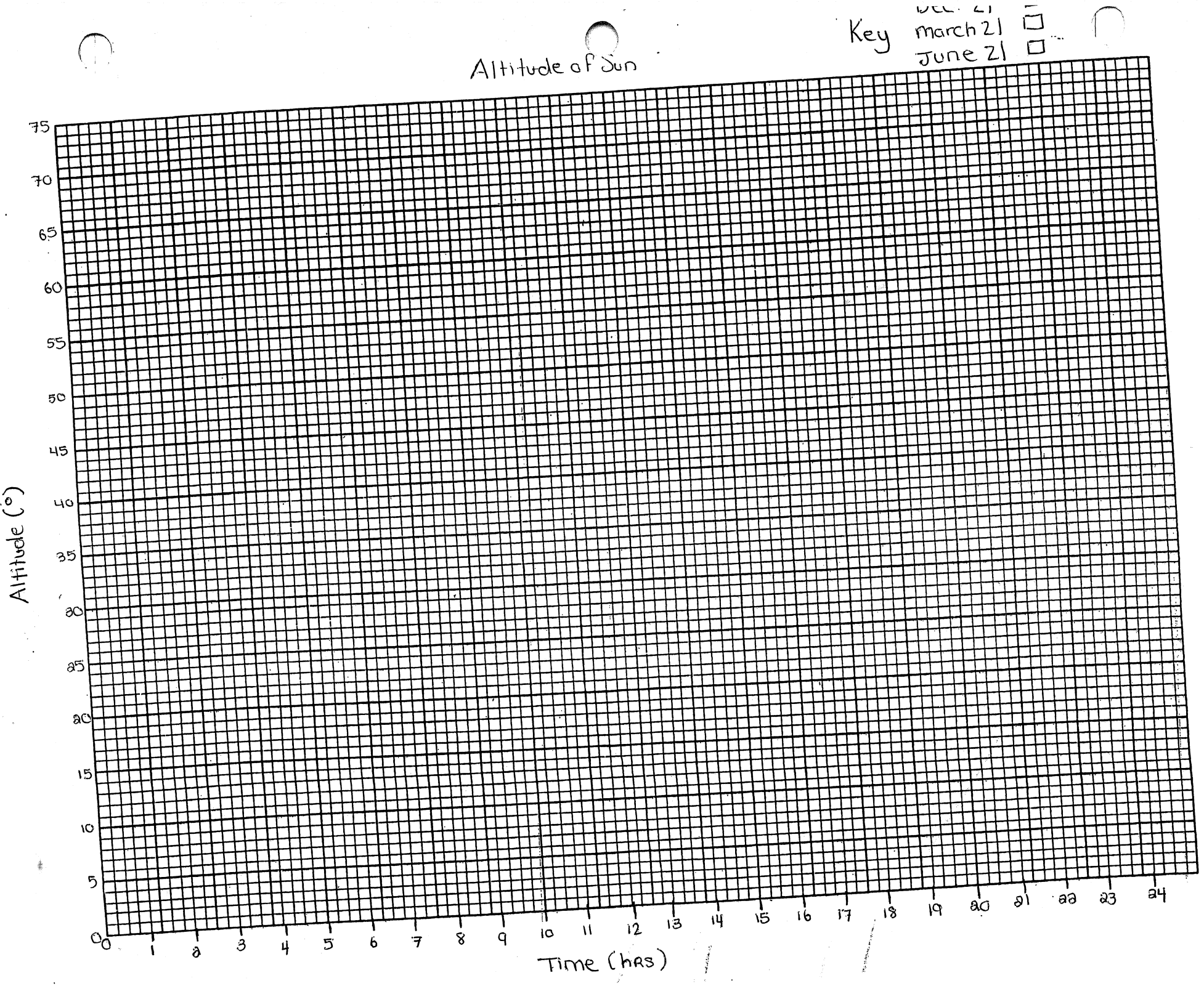
3. What was the highest altitude of the sun for the following dates:
   December 21
   March 21
   June 21

4 In which compass direction did the sun rise and set for the following dates:

	Rise	Set
December 21		
March 21		
June 21		

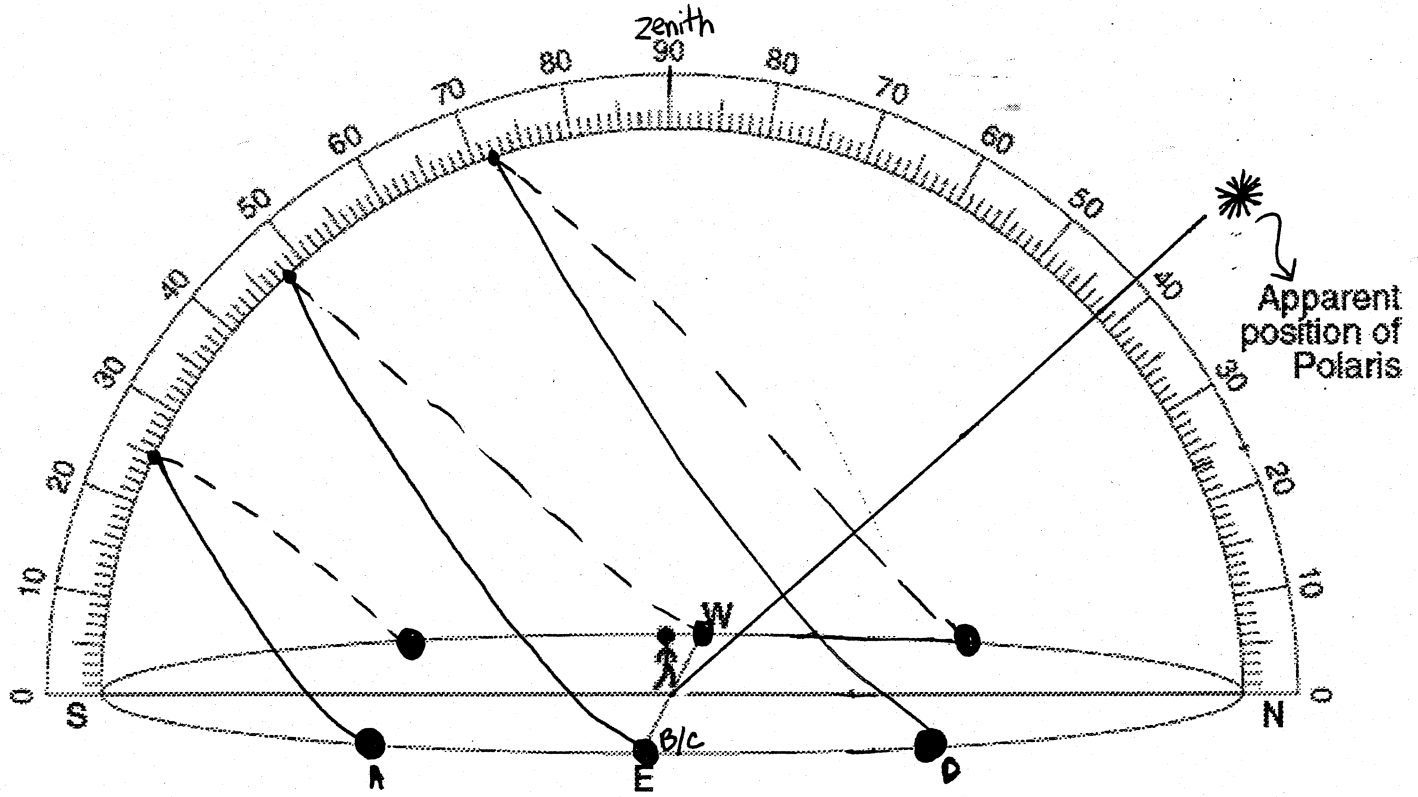
5. According to your graphs, during which month would your noon time shadow be the longest? Shortest?

6. According to your graph for March 21 at what time would an observers shadow be the shortest?


Altitude of Sun
Key
March 21
June 21
Altitude (°)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hrs)

Name_____ Date_____

Sun's Apparent Path



Changes in the sun's path for 42° N Latitude

Season	Date	Location of Sunrise	Location of Sunset	Length of Sun's Path (degrees)	Number of Daylight Hours	Height of the Noon Sun

Name:_____ Date:_____

Foucault Pendulum

Diagram I
(side view)

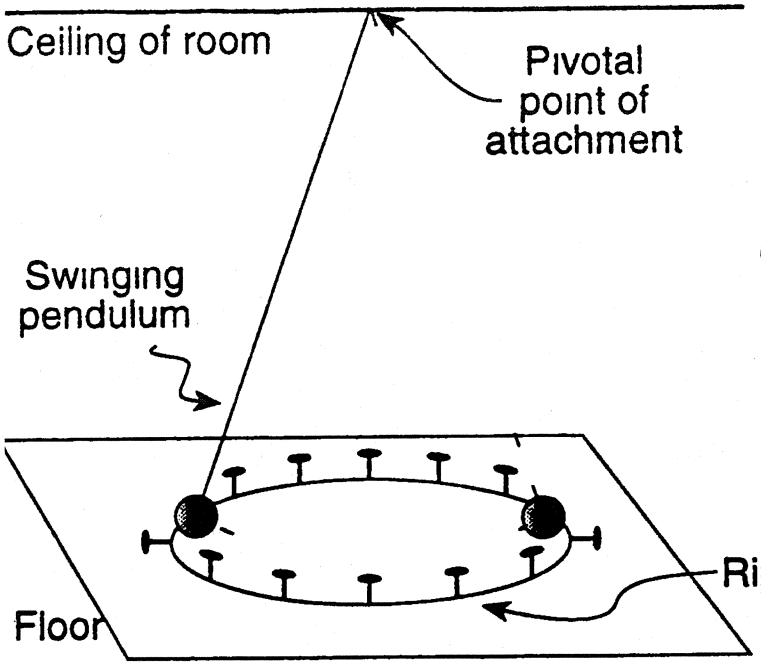
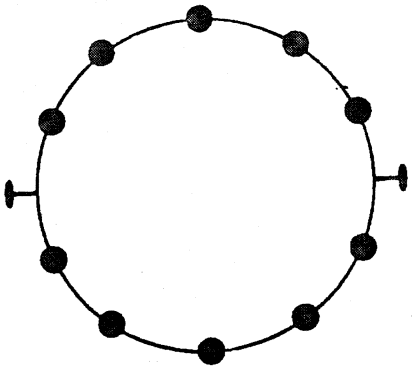
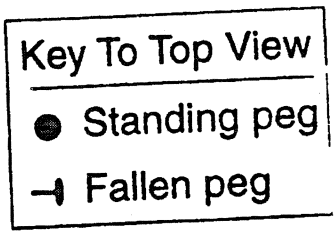
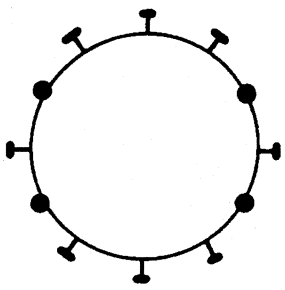


Diagram II
(top view)

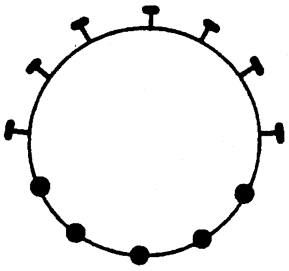




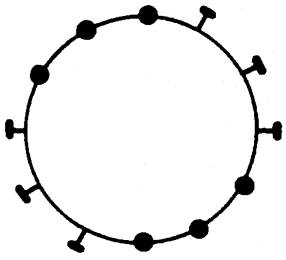
1 Diagram II shows two pegs tipped over by the swinging pendulum at he beginning of the demonstration. Which diagram shows the pattern of standing pegs and fallen pegs after several hours?



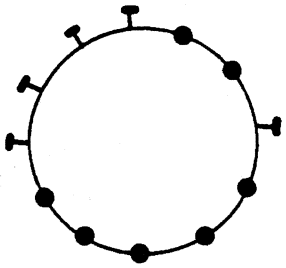
(1)



(2)



(3)



(4)

2. The Foucault pendulum provides evidence that the Earth
   (1) rotates on its axis
   (2) revolves around the sun
   (3) has an elliptical orbit
   (4) has an orbiting moon

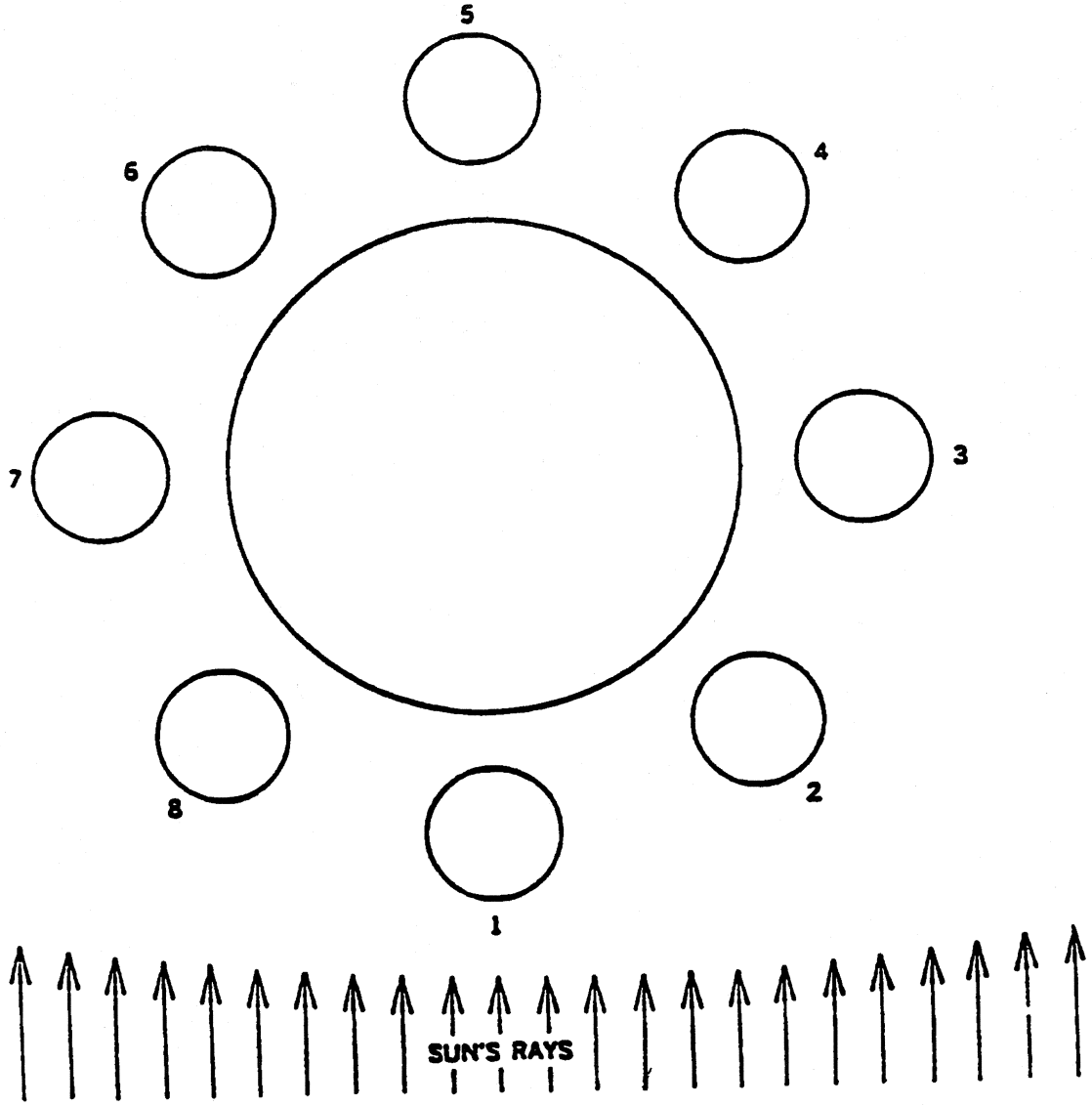
3. Which of the following cannot be explained by the geocentric model of the solar system?
   (1) the daily path of the stars around Polaris
   (2) The daily path of the sun through the sky
   (3) Changes in the angular diameters of the planets
   (4) The circular motion of a freely swinging pendulum

Name:_____ Date:_____

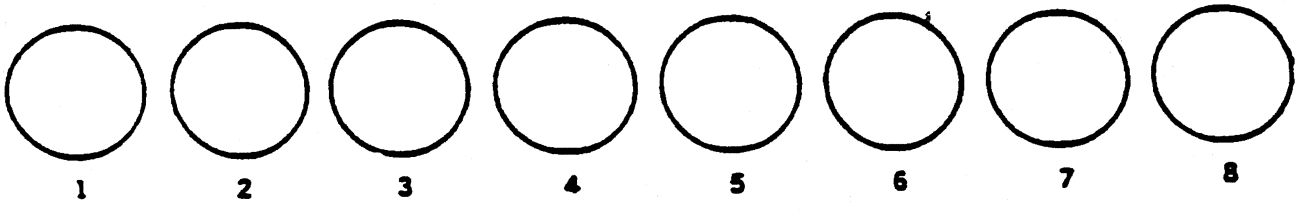
Phases of the Moon

The phases of the moon are caused by the _____ of the moon. Half of the moon is receiving light from the sun at any given time but an observer on Earth sees varying amounts of this lighted half as the moon moves through its orbit.

The moon orbiting Earth as viewed from space



Phases of the moon as viewed from Earth



Name _____ Date _____

Lunar Phase Lab

Read your lab and answer the following questions. Make sure to read the procedure.

1. What type of shadow did Aristotle notice on the moon during a lunar eclipse?
2. What is the moon's maria?
3. What will you examine in this investigation?
4. Read the procedure section, What does figure 1 show?
5. Why don't we have solar and lunar eclipses every month?
6. Make sure to label the locations or phases at which solar and lunar eclipses occur on the lunar-cycle diagram in figure 2.
7. What will you do with the pictures of the moon phases after you cut them out?
8. How much of the moon is always illuminated by the sun?
9. What causes the rise and fall of the ocean tides each day?
10. What happens to gravitational attraction as the distance between 2 objects decreases?
11. What else other than distance causes an increase in gravity?
12. What is another name for very high tides?
13. What type of tides occurs at first and last quarter phases?
14. Draw the position of the Earth, sun, and moon during a lunar eclipse.

15. Draw the position of the Earth, sun, and moon during a solar eclipse.

Name _____ Class _____ Date _____

Lunar Cycles

Background Information

Humans have been observing and predicting the appearance of the nearby moon since the dawn of civilization. Because of the disappearance of the moon and sun during eclipses, our large natural satellite created a place for itself in the folklore and religion of many cultures. Aristotle noted the curved shadow cast by the Earth on the surface of the moon during lunar eclipses. From this observation he correctly inferred a spherical shape for the Earth, which would be necessary to cast such a shadow. Galileo showed the battered, irregular surface of the moon in his drawings, made with the aid of his telescope. Gradually, the properties of the moon became better known as technology came to the aid of selenography (the systematic study of the moon, named for the Greek moon goddess Selene). When American astronauts landed on the moon in 1969, the moon's maria, or dark plains, were found to be large outpourings of lava that make up one-sixth of the moon's surface area.

In this investigation you will examine how the gravitational relationship and the effects of the relative motions of the Earth, moon, and sun combine to produce lunar phases, tidal effects, and eclipses of the sun and moon.

Problem

How do the Earth, moon, and sun interact to produce phases, eclipses, and tides?

Materials *(per class)*

globe and light source or planetarium model
scissors
clear tape
astronomy almanac (optional)

Procedure

1. Figure 1 shows the relative positions of the sun, Earth, and moon during solar and lunar eclipses. Solar and lunar eclipses do not occur every month because the plane of the moon's orbit is inclined, or tilted, in relation to the plane of the Earth's orbit. Note that for a total eclipse to occur, the location affected by the eclipse must fall within the umbra. Label the locations or phases at which solar and lunar eclipses occur on the lunar-cycle diagram in Figure 2.

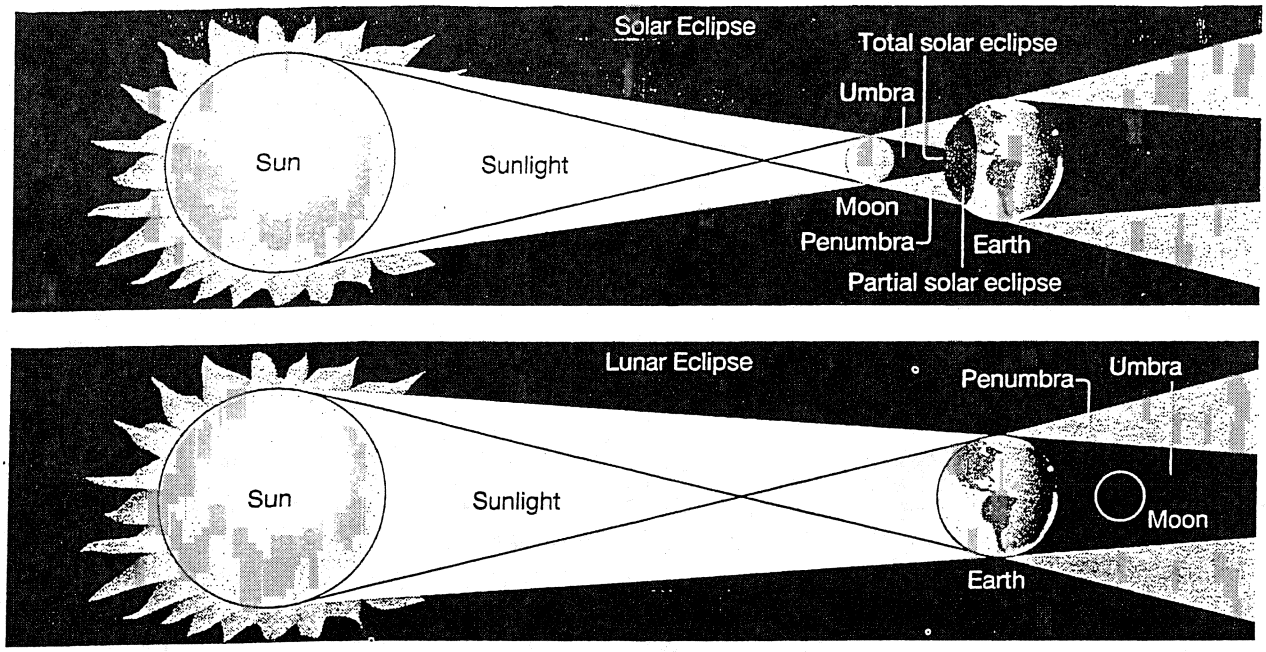


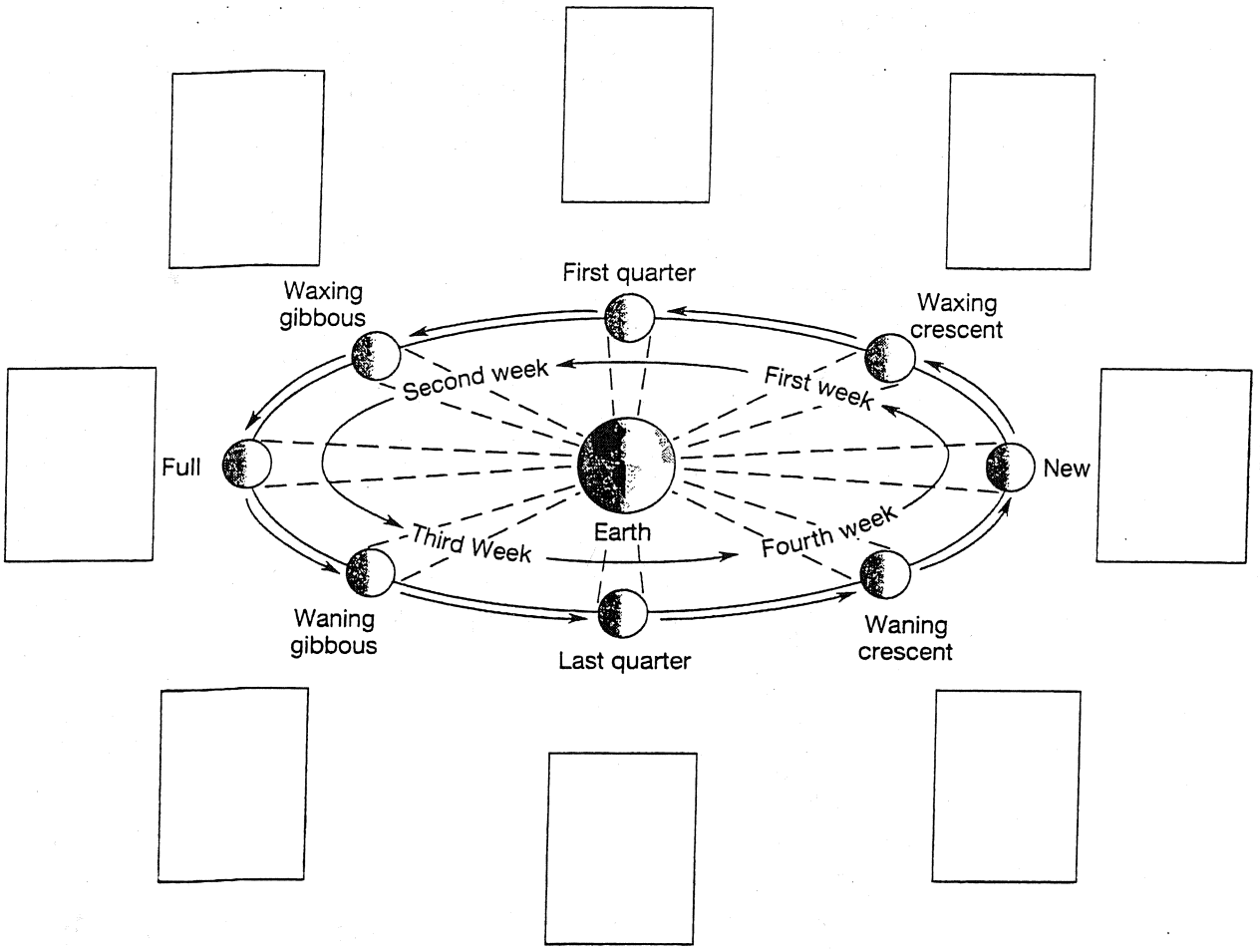
Figure 1

2. Carefully observe the demonstration of the phases of the moon provided by your teacher. Note the relative positions of the Earth and sun at the various phase positions.

3. Using scissors, cut out the lunar-phase photographs along the dashed lines. **CAUTION:** *Be careful when using scissors or any sharp instruments.* The photographs are located at the bottom of Figure 2. These photos show how the moon appears, as seen from Earth, at each of the lunar-phase positions in the lunar-cycle diagram.

4. Tape each photograph in the proper box or position in the lunar-cycle diagram. Try to imagine yourself at the center of the diagram looking out toward the moon's orbit, keeping in mind the location of the sun. One-half of the moon is illuminated by the sun at all times. The reason that we see lunar phases is that the amount of the illuminated portion of the moon that we can see from Earth at any given time varies during the lunar cycle. It is interesting to note that we always see the same side of the moon. This is a result of the fact that the moon rotates on its axis at the same rate that it revolves around the Earth. This is true of many other natural satellites in the solar system.

Name _____ Class _____ Date _____



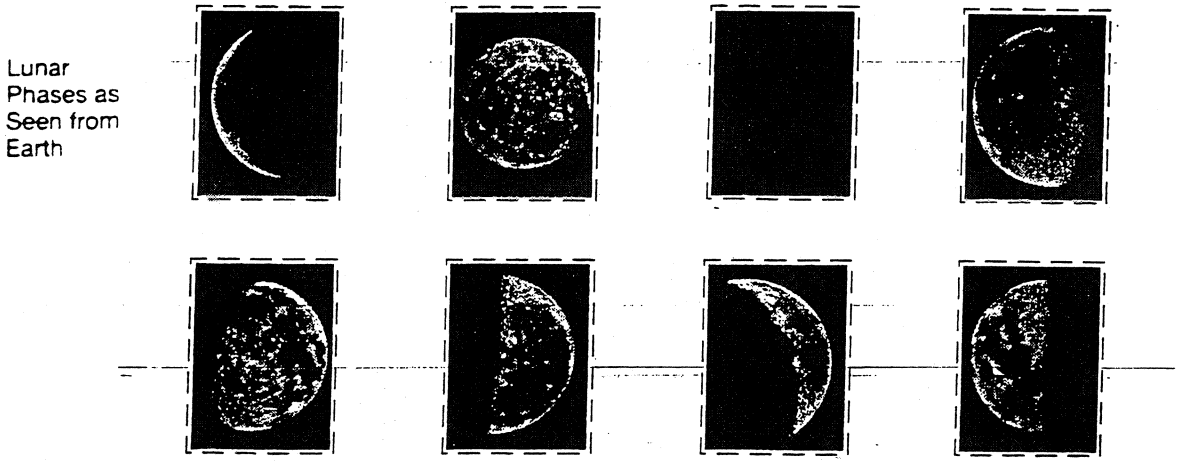


Figure 2. Lunar Cycles

Name _____ Class _____ Date _____

5. The ocean tides that rise and fall each day are another result of the interactions of the Earth, moon, and sun as they move in their respective orbits. The sun, the planets, and their satellites exert gravitational or attractive forces, to varying degrees, on each other. Because gravity increases with a decrease in distance, the side of the Earth near the moon is pulled more than the center or the far side of the Earth. The result is a high tide on the side of the Earth facing the moon, as well as a high tide on the opposite side of the Earth. Gravity also increases with an increase in mass. Because of its smaller mass, the moon's gravity is only one-sixth Earth's gravity.

   Although the sun has a very large mass, its great distance from the Earth-moon system makes it a minor player, in the short term, in the gravitational tug-of-war. However, when the sun, moon, and Earth are aligned, or in a straight line, as at new or full phases, extra-high spring tides occur. When the moon is at first and last quarter with the sun not pulling "in line," lower high tides called neap tides occur.

   Figure 3 shows why Los Angeles experiences a high tide, a low tide, and another high tide during a 12-hour period. At the same time, the moon is moving in its orbit. As a result, tides occur slightly later each day. On the lunar-cycle diagram in Figure 2, label the locations or phases at which spring and neap tides occur.

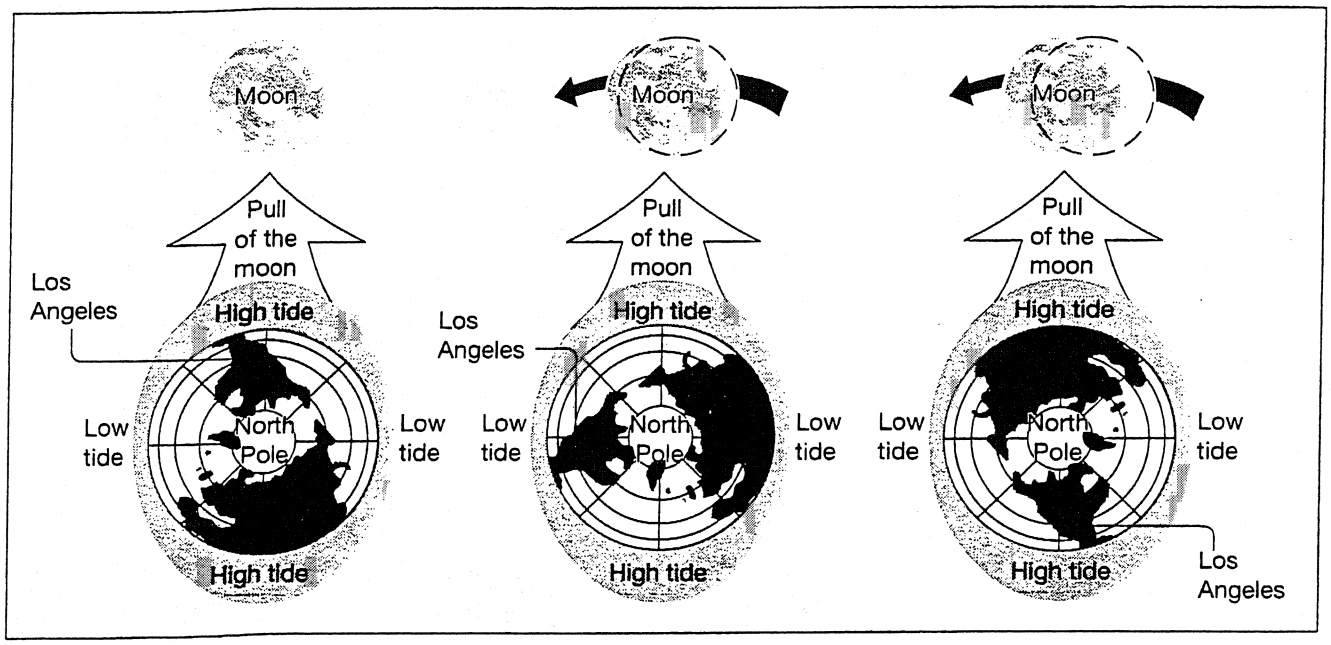


Figure 3

Analysis and Conclusions

1. During which phases does the moon seem to be "growing" larger, or waxing? During which phases is it getting smaller, or waning?

2. Where do you have to be located on Earth to view a total solar eclipse? Where would you see a partial solar eclipse?

3. What is the present phase of the moon? What will it be one week from today?

4. Which motion of the moon, rotation on its axis or revolution around the Earth, causes a cycle of phases to be seen from Earth?

Name _____ Class _____ Date _____

5. The angular diameter of the moon, or its apparent width measured in degrees when observed from Earth, varies during each cycle. What does this indicate about the shape of the moon's orbit?

_____

_____

_____

_____

Going Further

What are some of the consequences of the tidal effects that vary during the lunar cycle? How would life on Earth be different if we did not have a moon orbiting the Earth?

Name: Date:

Lab Activity – Altitude of the Moon

Date	Moon Phase	Maximum Altitude of Moon (°)		Date	Moon Phase	Maximum Altitude of Moon (°)
Jan 4	New Moon	25.9		July 7	Waxing Quarter	39.9
Jan 13	Waxing Quarter	62.9		July 14	Full Moon	28.3
Jan19	Full Moon	72.0		July 22	Waning Quarter	61.9
Jan 26	Waning Quarter	34.8		July 29	New Moon	69.1
Feb 3	New Moon	33.1		Aug 5	Waxing Quarter	32.2
Feb 11	Waxing Quarter	69.9		Aug 13	Full Moon	37.4
Feb 18	Full Moon	60.2		Aug 21	Waning Quarter	71.4
Feb 25	Waning Quarter	26.5		Aug 28	New Moon	56.0
Mar 4	New Moon	45.3		Sep 3	Waxing Quarter	27.6
Mar 12	Waxing Quarter	74.5		Sep 12	Full Moon	50.0
Mar 18	Full Moon	50.7		Sep 19	Waning Quarter	73.6
Mar 26	Waning Quarter	26.6		Sep 26	New Moon	46.6
Apr 3	New Moon	58.9		Oct 3	Waxing Quarter	27.4
Apr 10	Waxing Quarter	71.6		Oct 11	Full Moon	58.2
Apr17	Full Moon	36.1		Oct 19	Waning Quarter	68.8
Apr 24	Waning Quarter	30.6		Oct 25	New Moon	37.9
May 2	New Moon	66.5		Nov 2	Waxing Quarter	34.6
May 9	Waxing Quarter	64.6		Nov 10	Full Moon	68.9
May 16	Full Moon	29.6		Nov 17	Waning Quarter	61.1
May 24	Waning Quarter	41.1		Nov 24	New Moon	28.4
Jun1	New Moon	73.7		Dec 2	Waxing Quarter	45.9
Jun 7	Waxing Quarter	55.2		Dec 9	Full Moon	72.6
Jun 15	Full Moon	26.0		Dec 16	Waning Quarter	51.6
Jun 23	Waning Quarter	54.0		Dec 22	New Moon	27.3
Jun 30	New Moon	73.4				

Procedure

1. Turn the graph paper so that its longest dimension is horizontal. Label the x-axis Date. Label each of the dates listed in the data table above and indicate the month below the numbers for each month. Label the y-axis Altitude (degrees). The vertical axis should extend from 0 to 90 degrees.
2. Plot the maximum altitude of the moon for each of the dates in the Data Table. Use a plus sign (+) for a new moon, a dot (·) for the quarter phases, and a circled dot (o) for each full moon.
3. Connect all of the plotted moon data sequentially to form a smooth, wavelike curve.
4. Answer the questions in Analysis and Conclusions.

Analysis and Conclusions (answer in complete sentences)

1. Based upon the pattern on your graph, what is the most likely date of the first full moon in the next year?

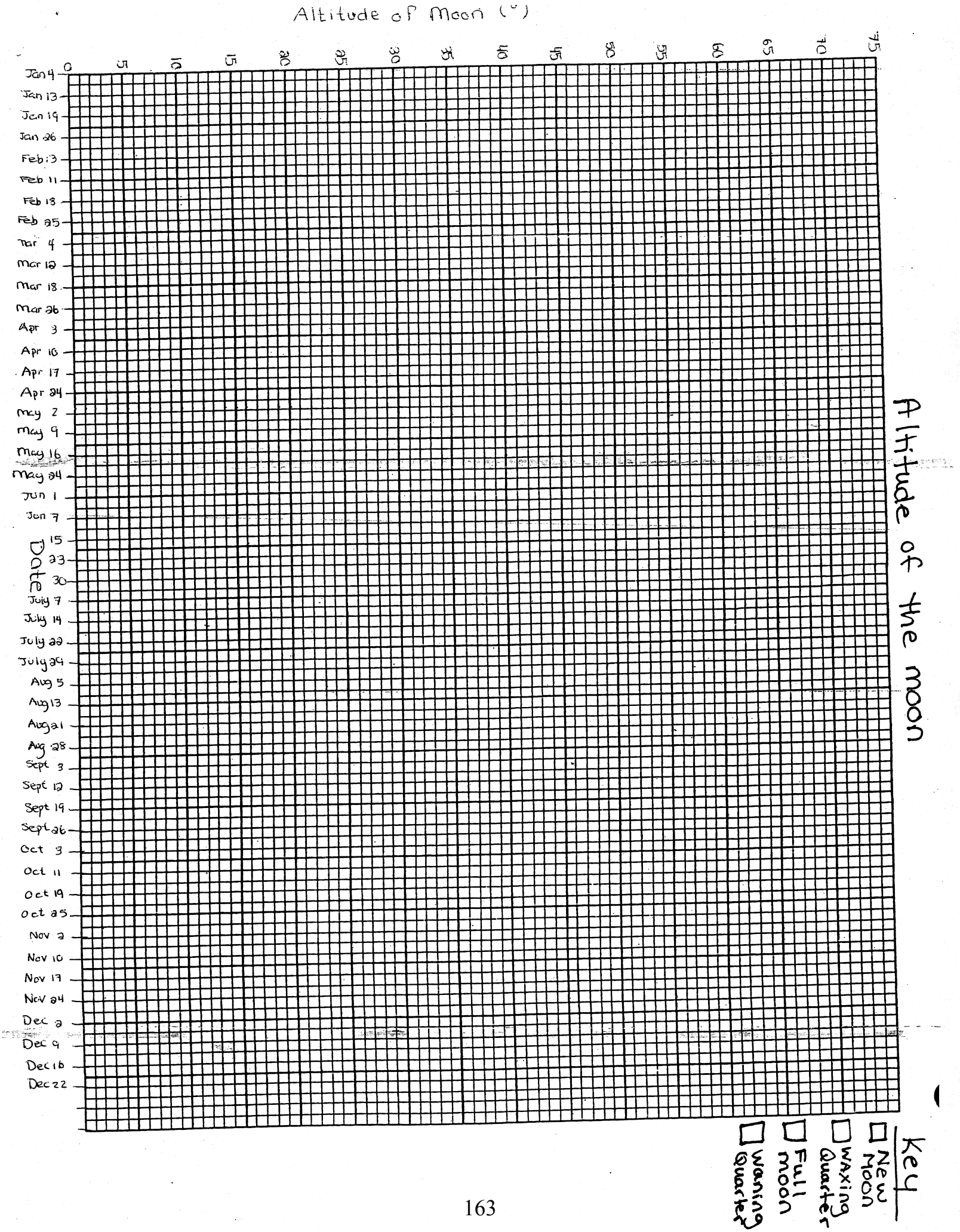
2. What is the relationship between the occurrence of the Full moon and the date for each month?

3. During which month is the full moon highest in the sky? Lowest in the sky?

4. Recall that the full moon is always on the opposite side of Earth from the sun. In June, Earth's Northern Hemisphere is tipped toward the sun and away form the moon. What effect does Earth's tip have on the altitude of the moon?

5. Look at the altitude of the moon in December. Based on your results, predict how Earth's Northern Hemisphere is tipped relative to the sun and the full moon in December. What season begins in the Northern Hemisphere in December?

6. Why do we see different phases of the moon? Are the phases of the moon cyclic or non-cyclic? How long does it take to complete one complete cycle of the phases of the moon?


Altitude of Moon (°)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Jan 4
Jan 13
Jan 19
Jan 26
Feb 3
Feb 11
Feb 18
Feb 25
Mar 4
Mar 10
Mar 18
Mar 26
Apr 3
Apr 10
Apr 17
Apr 24
May 2
May 9
May 16
May 24
Jun 1
Jun 7
15
23
30
July 7
July 14
July 22
July 29
Aug 5
Aug 13
Aug 21
Aug 28
Sept 3
Sept 12
Sept 19
Sept 26
Oct 3
Oct 11
Oct 19
Oct 25
Nov 2
Nov 10
Nov 17
Nov 24
Dec 2
Dec 9
Dec 16
Dec 22
Date
Altitude of the moon
Key
New Moon
Waxing Quarter
Full moon
Waning Quarter

Name _____Date_____

Topic 4 Review Sheet

1 What does apparent mean?

_____
_____
_____

2. Most objects in the sky appear to rise in the _____

3. Most objects in the sky appear to set in the _____

4 Stars appear to move at a constant rate of _____ per hour

5. During what season is the apparent path of the sun longest?

_____
_____
_____

6. During what season is the apparent path of the sun the shortest?

_____
_____
_____

7 Where does the sun rise on June 21? Where are the direct rays?

_____
_____
_____

8. Where does the sun rise on December 21? Where are the direct rays?

_____
_____
_____

9. Where does the sun rise on March 21 and September 21? Where are the direct rays?

_____
_____
_____

Name _____Date_____

10. What is solar noon?

_____
_____
_____

11 What is a zenith?

_____
_____
_____

12. Draw the dome diagram below.

13. Explain the geocentric model.

_____
_____
_____

14 Explain the heliocentric model.

_____
_____
_____

15. Which do they use today and why?

_____
_____
_____

16. What is an axis?

_____
_____
_____

Name _____Date_____

17 How many degrees is the Earth tilted?

_____
_____
_____

18. What are two things that give evidence that the Earth rotates?

_____
_____
_____

19. Describe the Coriolis effect.

_____
_____
_____

20. Describe the Foucault Pendulum.

_____
_____
_____

21 Local time is based on _____

22. Places on the same NS line have _____

23. What are time zones?

_____
_____
_____

24 Why do we see the phases of the moon?

_____
_____
_____

25. How many days does it take the moon to rotate around the sun?

_____
_____
_____

Name _____Date_____

26. Draw the phases of the moon.

27 What are tides? What are they caused by?

_____

_____

_____

28. The time between 2 high tides is _____

29. What is an eclipse?

_____

_____

_____

30. What is an umbra?

_____

_____

_____

31 What is penumbra?

_____

_____

_____

32. Draw a lunar eclipse.

33. Draw a solar eclipse.

Name:_____ Date:_____

Energy in Earth Processes
Topic 5 Vocabulary

Calorie: _____

_____

Condensation: _____

_____

Conduction: _____

_____

Convection: _____

_____

Crystallization: _____

_____

Electromagnetic energy: _____

_____

Electromagnetic spectrum: _____

_____

Energy: _____

_____

Heat energy: _____

_____

Mechanical energy: _____

_____

Name:_____ Date:_____

Nuclear decay: _____

_____

Radiation: _____

_____

Solidification. _____

Specific heat: _____

_____

Temperature: _____

_____

Vaporization: _____

_____

Wavelength: _____

_____

Name _____ Date _____

Energy Worksheet

Directions:
Read pages 70-71 in your review book and answer the following questions.

1 Define:

Energy _____

Electromagnetic Energy _____

Absolute Zero _____

Wavelength _____

Electromagnetic Spectrum _____

Refracted _____

Reflected _____

Scattered _____

Transmitted _____

Absorbed _____

2. List all the types of wavelengths on the electromagnetic spectrum from shortest to longest wavelength.

3. Which has a higher frequency and gives off more energy· Gamma rays or Radio waves?

Name _____ Date _____

4. List all the colors in the visible light region.

5. What happens to the distance between wavelengths as you go from gamma rays to radio waves?

6. What causes waves to get refracted?

Name _____ Date _____

Energy Absorption Lab

Objective: The student will describe how surface characteristics affect energy absorption.

Materials:

Black and silver cans with lids and thermometers
Heat lamp
Meterstick
Clock
Safety goggles

Procedure:

1 Put your safety goggles on.

2. Arrange the cans so that they are 25cm away from the heat lamp.

3. Read the temperature in degrees Celsius for both cans.. Record this in the 0 time spot in the data table.

4. Turn the heat lamp on. Record the temperature readings for both cans every minute for 10 minutes. Record these readings in the data table under the section Lamp On.

5. After 10 minutes, turn the lamp off, and continue to read the temperature every minute for each can. Record these on the Data table under Lamp off.

6. Graph your data on the graph paper Plot your temperatures for both cans on the same axis. Plot the time on the X axis.

Name _____ Date _____

Data Table

Lamp On

Time	0	1	2	3	4	5	6	7	8	9	10
Light can											
Dark Can											

Lamp off

Time	11	12	13	14	15	16	17	18	19	20
Light Can										
Dark Can										

Analysis and Conclusion

Answer each question in complete sentences on the answer sheet.

1 What is the only factor that varied in the experiment?

2. Which can absorbed energy at the greatest rate?

3. Which can reradiated energy at the greatest rate? Give evidence as shown on your graph.

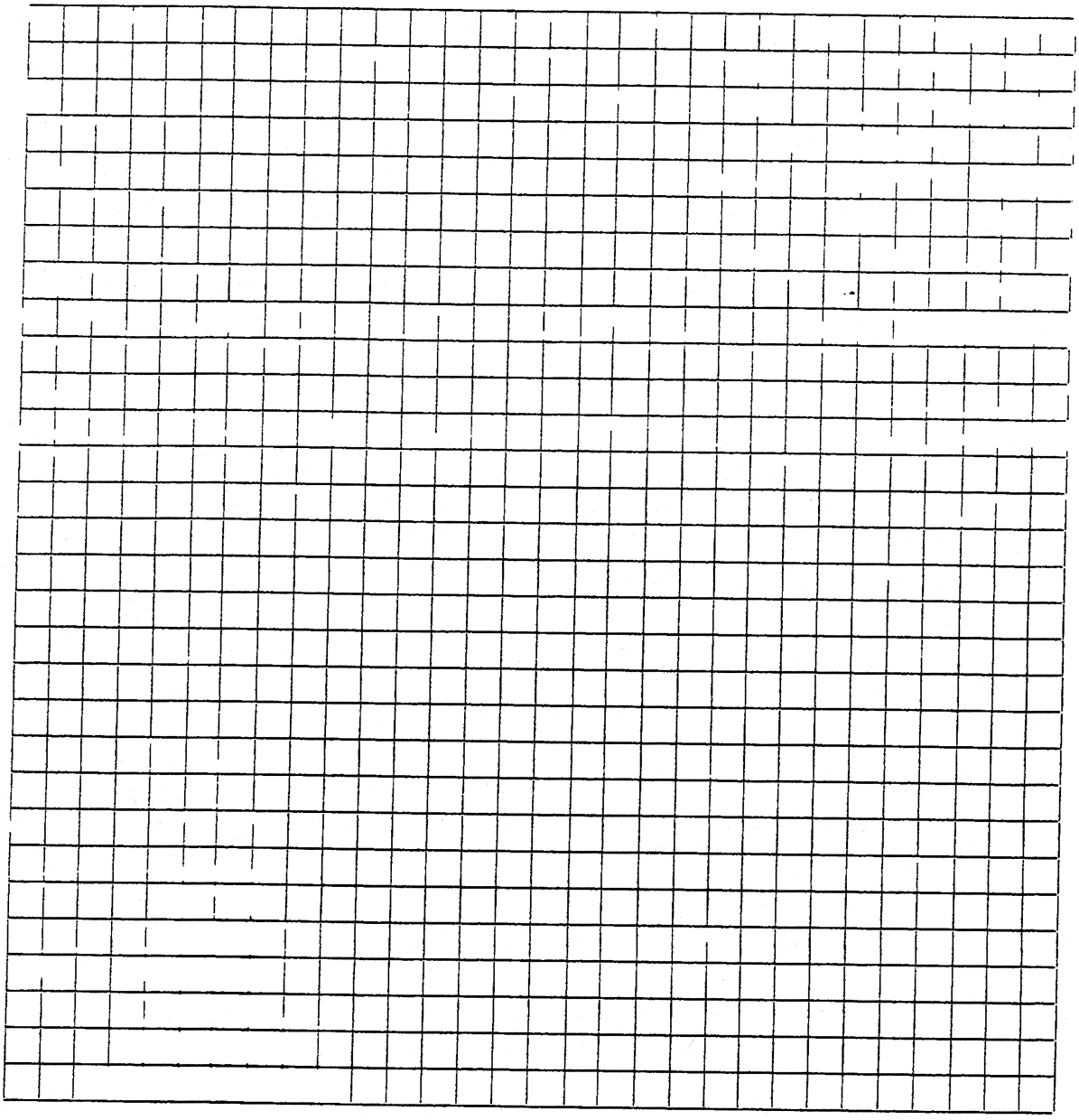
4. What type of heat transfer carried the heat energy from the light bulb to the can?

5. How do wavelengths of energy absorbed by the cans differ from those given off by the cans?

6. If you were going to put a new roof on your house and you lived in Alaska, what color might you choose? Why?

7 If you were going to put a new roof on your house and you lived in Florida, what color might you choose and why?

Name _____ Date _____



Name _____ Date _____

Answer Sheet for Energy Absorption Lab

1 _____

2. _____

3. _____

4. _____

5. _____

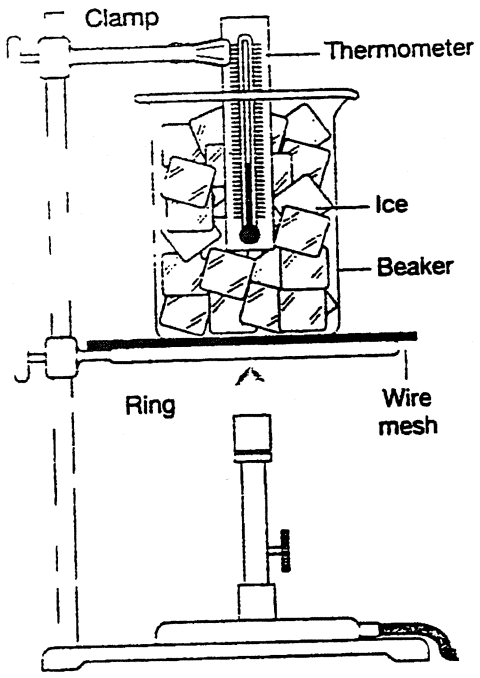
6. _____

7 _____

Name_____ Date_____

Latent Heat

The ice in the beaker below was heated for 25 minutes and the temperature was recorded in degrees Celsius every minute. The results are shown in the table below.



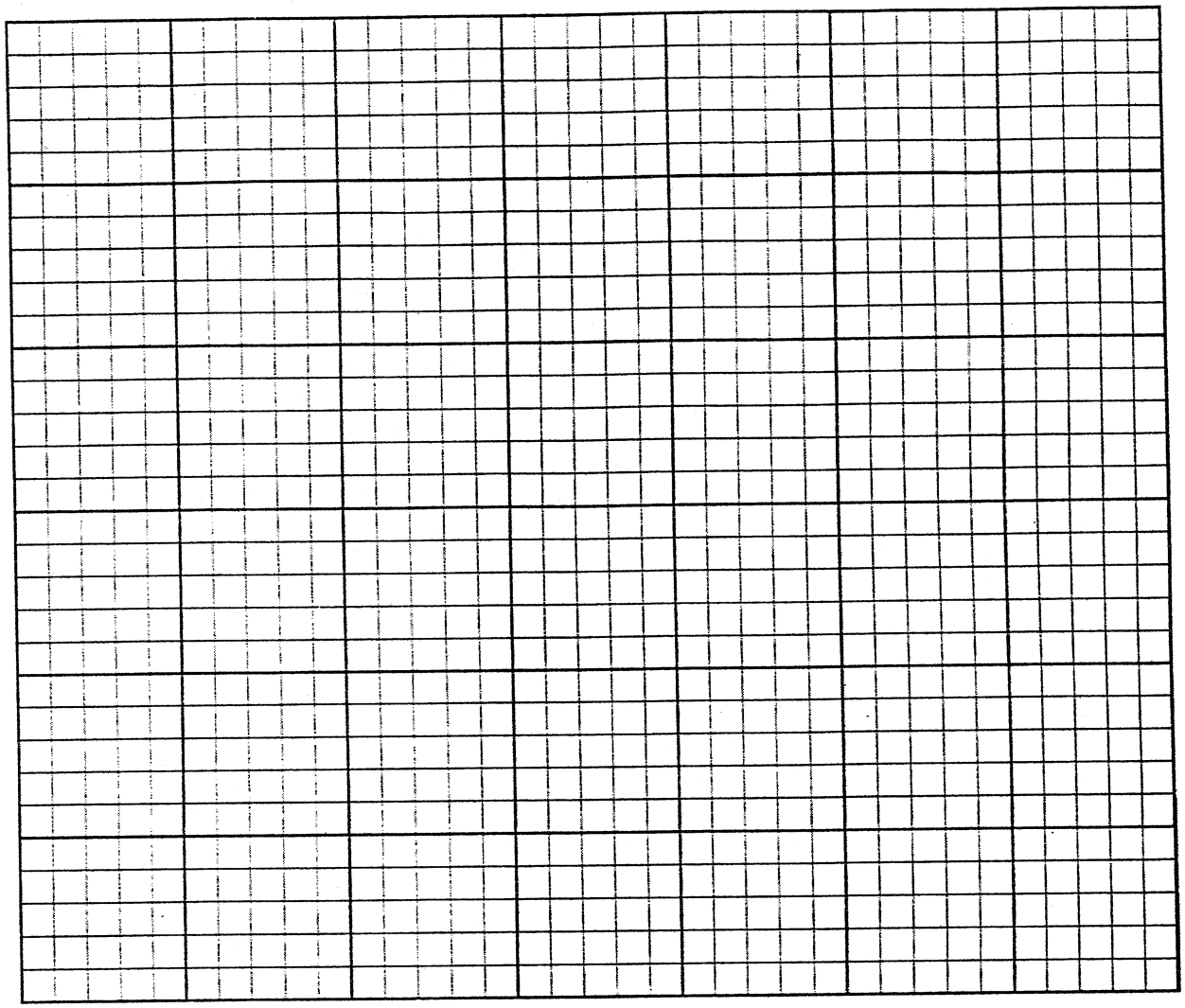
Time (min)	0	1	2	3	4	5	6	7	8	9	10
Temp. (°C)	100	-75	-50	-25	0	0	0	0	25	50	75

Time (min)	11	12	13	14	15	16	17	18	19	20	21
Temp. (°C)	100	100	100	100	100	100	100	100	100	100	100

Time (min)	22	23	24	25
Temp. (°C)	125	150	175	200

Name_____ Date_____

Graph the temperature readings on the graph below showing the time on the x-axis and temperature on the y-axis. Label the graph where the water would be in the liquid, solid, and gas phase. Label the phase changes that are taking place, which are represented by the horizontal portions of the graph.



Name_____ Date_____

Answer the following questions based on the graph and your knowledge of Earth Science.

1 Describe the following phase changes:
   a. Freezing- _____
   b. Melting- _____
   c. Vaporization- _____
   d. Condensation- _____

2. Which phase change requires the most amount of energy to be releases?

3. According to the graph, which phase change takes the longest amount of time to complete?

4. What does the term Latent Heat mean?

5. Calculate the rate of change during the first four minutes. (Show all work)

   Was the rate of change constant through out the entire experiment?

6. What are the specific heat values for the following substances?
   Ice _____ Water Vapor _____
   Water _____ Lead _____

Given equal masses of these four substances and equal heat input, which material would show the greatest temperature increase? Why?

Name:_____ Date:_____

Insolation and the Seasons
Topic 6 Vocabulary

Angle of incidence _____

_____

Deforestation: _____

_____

El Nino: _____

_____

Global warming: _____

_____

Greenhouse gases: _____

_____

Ice ages. _____

_____

Insolation: _____

_____

Ozone: _____

_____

Heat budget: _____

_____

Sunspot: _____

_____

Transpiration: _____

_____

Name:_____ Name:_____

The Ozone Hole: What Made It?

Concentrated in the Earth's stratosphere (a layer of atmosphere that extends from 10-50 km above Earth s surface) is a layer of ozone Something is punch9ing a hole through that ozone layer But why should anyone care? And what is ozone anyway?

Ozone is a form of oxygen. But unlike oxygen you breathe, which consists of two atoms of oxygen bonded together a molecule of ozone consists of three atoms of oxygen. This oxygen triplet possesses a unique and important property It absorbs ultraviolet (UV) radiation from the sun. UV radiation can kill living things. If can also cause skin cancer in humans.

For a number of years, scientists had known that substances called chlorofluorocarbons (CFCs) were at least partly responsible for destroying the ozone layer This meant that humans were also responsible. That's because CFCs are chemicals we use as coolants in refrigerators and air conditioners. They were also used in various kinds of aer sol cans.

When CFC's escape into the air they rise into the stratosphere where they can survive for 50 to 100 years. During that time, the CFCs break up, releasing free chlorine. The ghly reactive chlorine atoms can do two things. They can react with ozone – thinning out the ozone layer – to form a new compound called chlorine monoxide (CLO) or they can react with nitrogen – leaving the ozone layer in one piece.

Although 80 percent of the stratosphere consists of nitrogen, the reaction with nitrogen does not happen enough. So why doesn't the nitrogen hold on to the chlorine? That's the question many scientists tried to answer Researchers investigated strange clouds found in the stratosphere. These clouds were thin and so spread out that they were invisible tot he unaided eye. What were they make of?

These unseeable clouds contained a mixture of water and nitric acid (HNO_3)! The nitrogen that might otherwise have neutralized the chlorine set loose from CFCs was already tied up, which left the chlorine free to break up ozone molecules.

There is a general agreement, however that is we did not pump CFCs into the atmosphere, no harm would come to the ozone layer So the ultimate responsibility rests with us, not the clouds above our heads.

Questions

1 The stratosphere extends above Earth's surface from
a. 0 – 10 km b. 10 – 20 km c. 10 – 50 km d. 10 – 100 km

2. The ozone layer absorbs
a. ultraviolet radiation
b. nitrogen
c. CFCs
d. water

3. CFCs are used in all the following devices except
a. refrigerators
b. televisions
c. aerosol cans
d. air conditioners

4. How many oxygen molecules are bonded together in ozone?

5. Describe how nitrogen might protect the ozone layer and why its effect is limited.

Name _____ Date _____

LAB

Carbon Dioxide and Global Warming

Is the threat of global warming myth or fact? Many observers look alarmingly to the 1980's—a decade of unprecedented warmth—to confirm their fears that global warning is real. Yet a short-term trend such as this can mean very little. What about global temperatures over the long term? As it turns out, long-term studies verify that global temperatures have indeed been increasing, although sporadically since the turn of the century

What's causing global temperatures to rise? Many environmental scientists point to the increasing atmospheric concentrations of greenhouse gases—carbon dioxide (Ca_2), water vapor (H_20), methane (NIH_4), nitrous oxide (N_20), ozone (03), and the chlorofluorocarbons (CFC's). A clear historical link has been established between CO_2 concentrations and global temperature change. By analyzing tiny bubbles of air trapped in ice core samples, scientists have learned that, in the past, when atmospheric CO_2 concentrations increased, so did global temperatures. Periods of markedly low CO_2 concentrations correspond to periods of extreme cold, i.e., the ice ages.

In this lab, you will investigate both short-term and long-term trends in concentrations of CO_2 in the atmosphere and identify some of the causes *and* effects of global warming.

Lab Skills and Objectives:

1 To graph changes in atmospheric CO_2 concentration and to interpret the graph.

2. To correlate trends in CO_2 concentrations with future climate change.

Materials: Pencil

Procedure

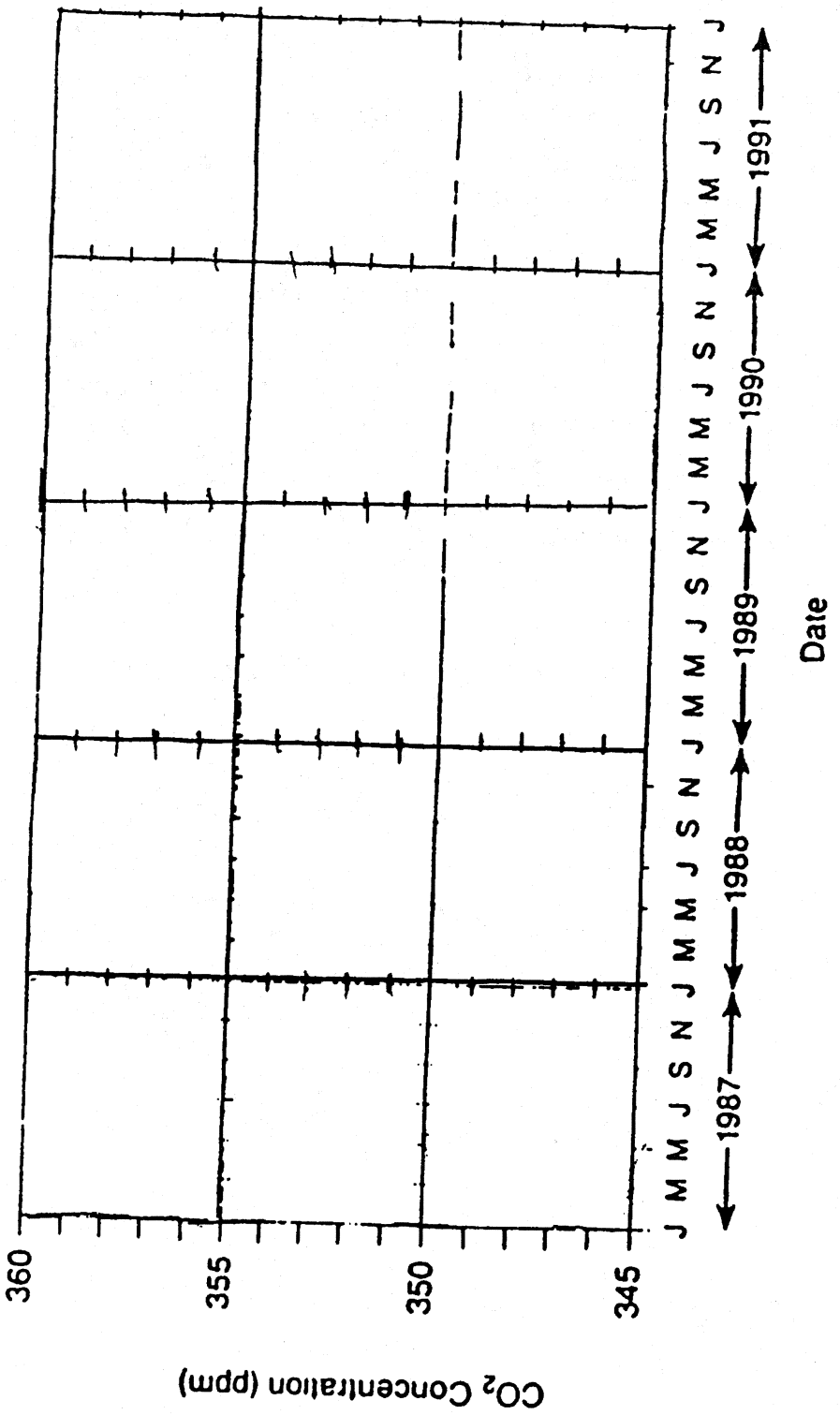
1 The data in Figure 31 1 are CO_2 concentrations in parts per million (ppm) from 1987—1991 Use the data to plot CO_2 concentrations as a function of date on the graph grid provided in Figure 31.2. Draw a smooth curve between your data points.

Carbon Dioxide Concentrations (PPM)

	Date	1987	1988	1989	1990	1991
	Jan	348.2	3502	352.7	353.7	354.6
	Mar	349.6	352.1	353.7	355.6	357 1
	May	351.9	354.2	355.1	357.1	359.0
	Jul	349.8	352.6	353.8	354.5	3561
	Sep	346.4	348.8	349.8	351.0	352.2
	Nov	347.7	350.1	351.3	352.7	

Figure 31.1

Name _____ Date _____


CO2 Concentration (ppm)
360
355
350
345
J M M J S N J M M J S N J M M J S N J M M J S N J
1987
1988
1989
1990
1991
Date

Name _____ Date _____

Analysis and Conclusion **Answer the following in complete sentences.**

1 What two patterns of change in carbon dioxide concentrations are evident from your graph? During which month of each year were the carbon dioxide concentration the highest? The lowest?

2. Based on what you know about the relationship between photosynthesis and CO_2. explain why CO_2 concentrations cycle throughout the year

3. Based on what you know about the relationship between the burning of fossil fuels (coal, oil, gasoline) and $C0_1$, what else accounts for the cyclic nature of CO_2 concentrations throughout the year?

4 What effect is the destruction of forests likely to have on atmospheric carbon dioxide concentrations? Explain your answer

5. What are two ways that the rate of change in atmospheric carbon dioxide concentration could he reduced?

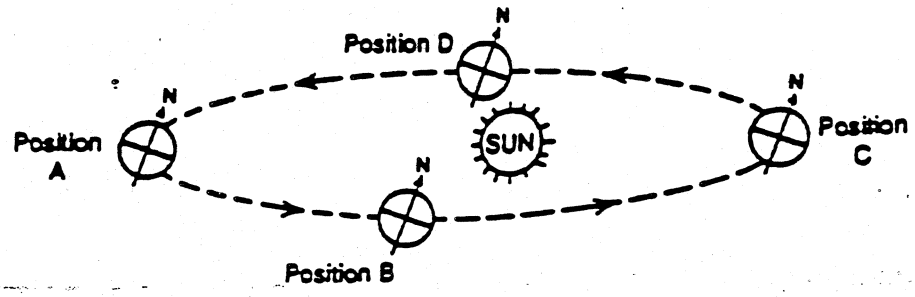
6. If, as predicted. increased Concentrations of CO~ in the atmosphere lead to global warming, what might happen to the polar icecaps? Sea level? Coastal communities?

Name _____ Date _____

Revolution and the Seasons

Base your answers to the questions on the diagram below that shows the Earth in 4 different positions in its orbit around the sun. Each position represents the beginning of a season.

The diagram below represents four positions of the Earth as it revolves around the Sun.



(NOT DRAWN TO SCALE)

1) Complete the chart below

Position	Date	Season in New York	Location where the sun shines directly	Number of daylight hours in New York
A				
B				
C				
D				

2) How much is the axis of the Earth tilted? _____

3) At which position is the Earth actually closest to the sun? _____

4) What season is it in the Northern Hemisphere when the Earth is closest to the sun?

_____

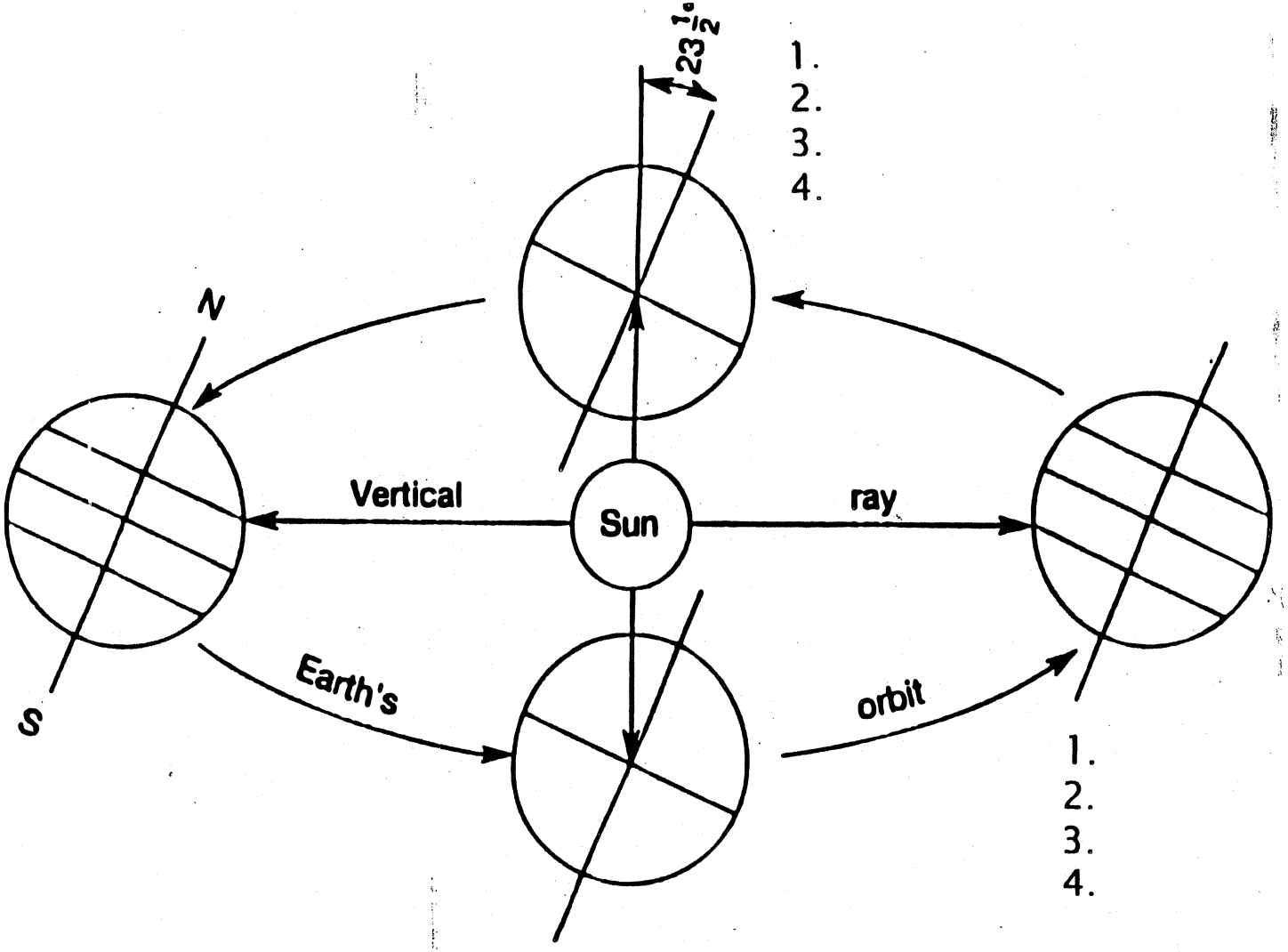
5) In the space below explain why the seasons are opposite in the Southern Hemisphere.

EARTH'S SEASONS

For each model of the earth below indicate the following for the Northern hemisphere:

1. Season
2. Date
3. Location of the direct ray of the sun
4. Number of daylight hours

1.
2.
3.
4.



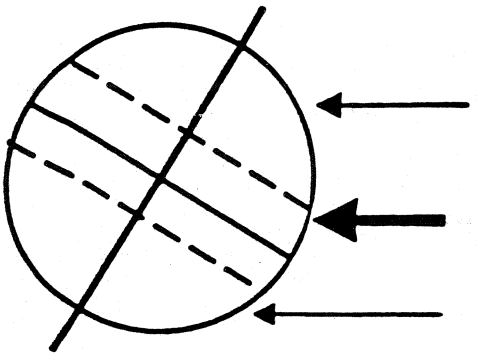
1.
2.
3.
4.

1.
2.
3.
4.

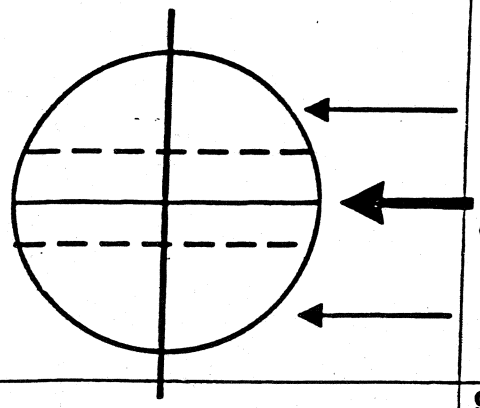
1.
2.
3.
4.

Name _____ Date _____

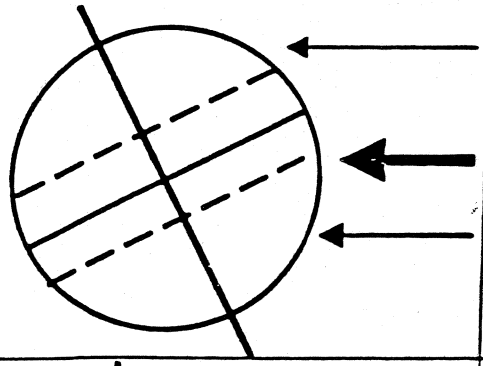
Earth's Tilt and the Seasons



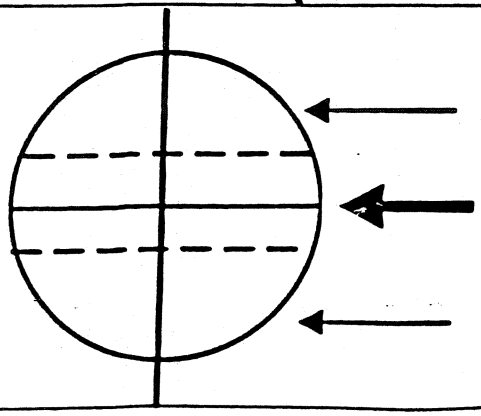
1) Date _____
2) Season in NY. _____
3) Location where the sun's rays are shining directly. _____
4) Relative Length of daylight in New York State. _____



5) Date _____
6) Season in NY. _____
7) Location where the sun's rays are shining directly. _____
8) Relative Length of daylight in New York State. _____



9) Date _____
10) Season in NY. _____
11) Location where the sun's rays are shining directly. _____
12) Relative Length of daylight in New York State. _____



13) Date _____
14) Season in NY. _____
15) Location where the sun's rays are shining directly. _____
16) Relative Length of daylight in New York State. _____

Season	Date	Location of the Sun's Direct Rays (Latitude)	Name of the Latitude Line	Number of Daylight hours	Number of Nighttime hours
				90°N- 40°N- 0°-**12** 40°S- 90°S-	90°N- 40°N- 0°- 40°S- 90°S- **0**
	3/21			90°N- 40°N- 0°- 40°S- 90°S-	90°N- 40°N- 0°- 40°S- 90°S-
		23 ½ °N	Tropic Of Cancer	90°N- 40°N- 0°- 40°S- 90°S-	90°N- 40°N- 0°- **12** 40°S- 90°S-
Autumnal Equinox (Fall)				90°N- 40°N- 0°- 40°S- 90°S-	90°N- 40°N- 0°- 40°S- 90°S-

Name _____ Date _____

Lab The Seasons

Purpose: To become familiar with the positions of the earth during the four seasons.

Materials: Yellow pencil.

PROCEDURE.

1 On the diagram in the OBSERVATION section of this exercise label the following Lines on *EACH* of the drawings of the earth:

1 The Equator

2. The Arctic Circle

3. The Antarctic Circle

4. The Tropic of Cancer

5. The Tropic of Capricorn

2. Show which earth position represents the summer and winter solstices, and the vernal and autumnal equinoxes.

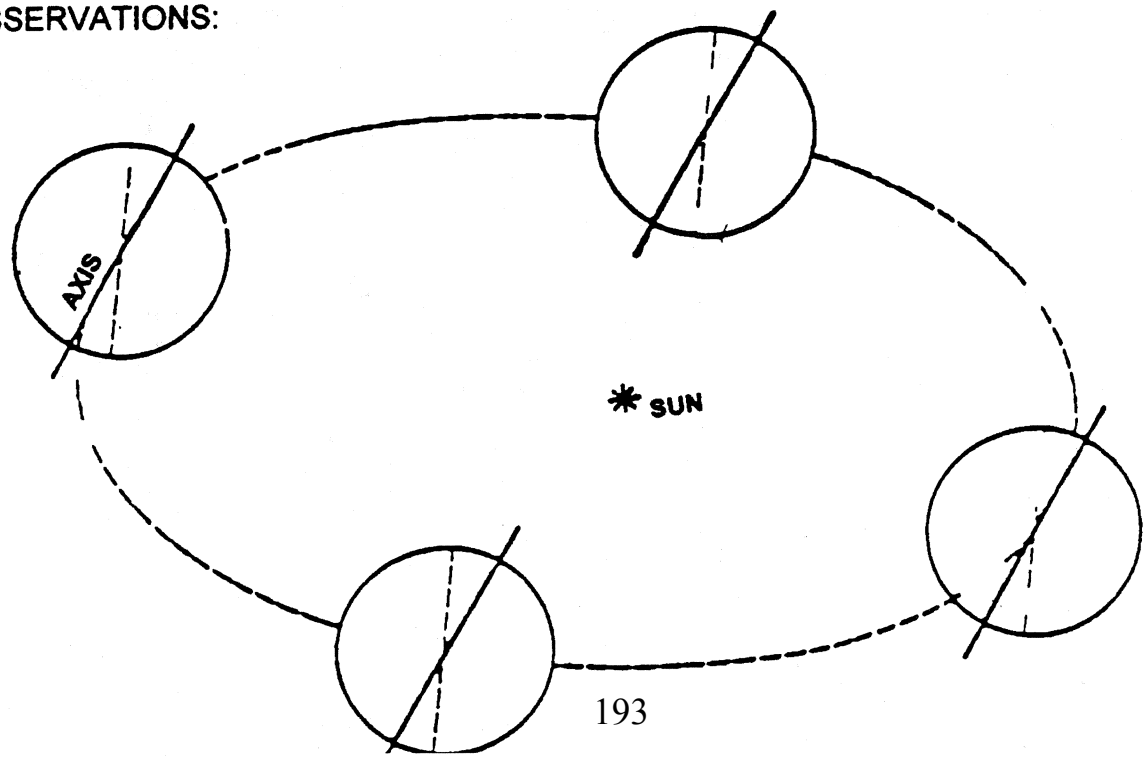
3. Indicate the dates of each of the positions labeled above.

4 Color the part of the earth that is lit by sunlight, in each of the positions, with the yellow pencil

5. Use arrows to show the direction of the earth's <u>revolution</u>

6. Use arrows to show the direction of the earth's <u>rotation</u>.

OBSERVATIONS:



Name _____ Date _____

CONCLUSIONS:

1 What is the shape of the earth's Orbit?

2. Describe the direction of the earth's revolution?

3. Where does the vertical ray of the sun strike the earth on June 21?

4. How much of the Antarctic Circle is in darkness on June 21?

5. How much of the Equator has daylight on June 21?

6. About how long is the day and night in New York City on June 21?

7 Where does the vertical ray of the sun strike the earth on December 21?

8. What would be the effect on the seasons if the angle of insolation of the earth increased to more than 23.5 ?

9. What would be the effect on the seasons if the axis were perpendicular to the plane of the earth's orbit?

10. Why do the Seasons change?

11 How does distance between the Earth and the sun affect seasons?

Name _____ Date _____

Orbits and Seasons Lab

Objective: The student will gain an understanding of how the Earth's orbit and motions are related to seasons by completing this activity

Procedure:

1 Label the date for each of the Earth positions in Figure 1

2. Label the location of aphelion and perihelion on Figure 1

3. In the spaces below, write the Latitude of the vertical rays of the sun on the following dates:

   June 21 _____
   December 21 _____
   September 21 _____
   March 21 _____

4. In the space below draw and label the Sun, Earth's orbit, and Earth on June 21 Label the axis and equator on the diagram.

5. In the space below draw and label the Sun, Earth's orbit and Earth on June 21 as it appeared 11 000 years ago. The Summer solstice occurred at perihelion 11 000 years ago. Label the axis and equator on the diagram.

Name _____ Date _____

Analysis and Conclusion Questions.
Answer each question in complete sentences on the answer sheet.

1 Compare the diagrams you drew in procedure 4 and 5 above. What effect do you think the change in Earth's position in the orbit would have had on the ice sheets in the Northern Hemisphere? Explain your answer

2. How does the duration of Insolation change between December 21 and June 21 for a location at 40 N latitude?

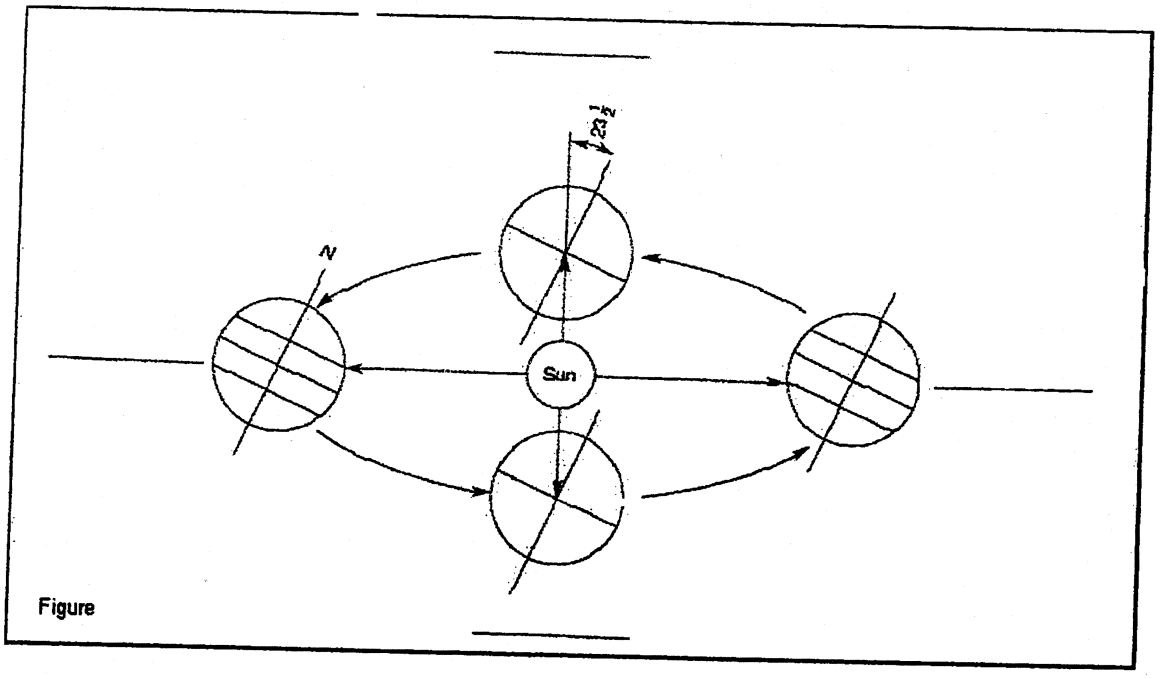
3. List the number of daylight hours on March 21 for the following locations:
   0 Latitude
   40 N Latitude
   90 S Latitude

4. Where would the most intense area of heating be on the surface of the Earth? Explain why

5. There is a certain location in the United States that is referred to as the "Land of the Midnight Sun"? Where, when and why would this take place?

Name _____ Date _____

Answer sheet for Orbits and Seasons Lab



Figure

1 _____

2. _____

3. _____

4. _____

Name _____ Date _____

5. _____
_____
_____
_____

Name:_____ Date:_____

Seasons Wheel Lab

Use your seasons wheel to answer the following questions:

Turn the wheel to the equinox position:

1 At what latitude is the vertical ray of the sun directly over head? _____

2. How many hours of daylight will 43° N receive? _____

3. How many hours of daylight will 0° (equator receive)? _____

4 Compare the duration of insolation at 90° N and 90° S _____

Turn the wheel to the Summer Solstice position:

5. At what latitude is the vertical ray of the sun directly over head? _____

6. How many hours of daylight will 43° N receive? _____

7 What latitude has the longest duration of insolation? _____

8. What latitude has the shortest duration of insolation? _____

Turn the wheel to the Winter Solstice position:

9. At what latitude is the vertical ray of the sun directly over head? _____

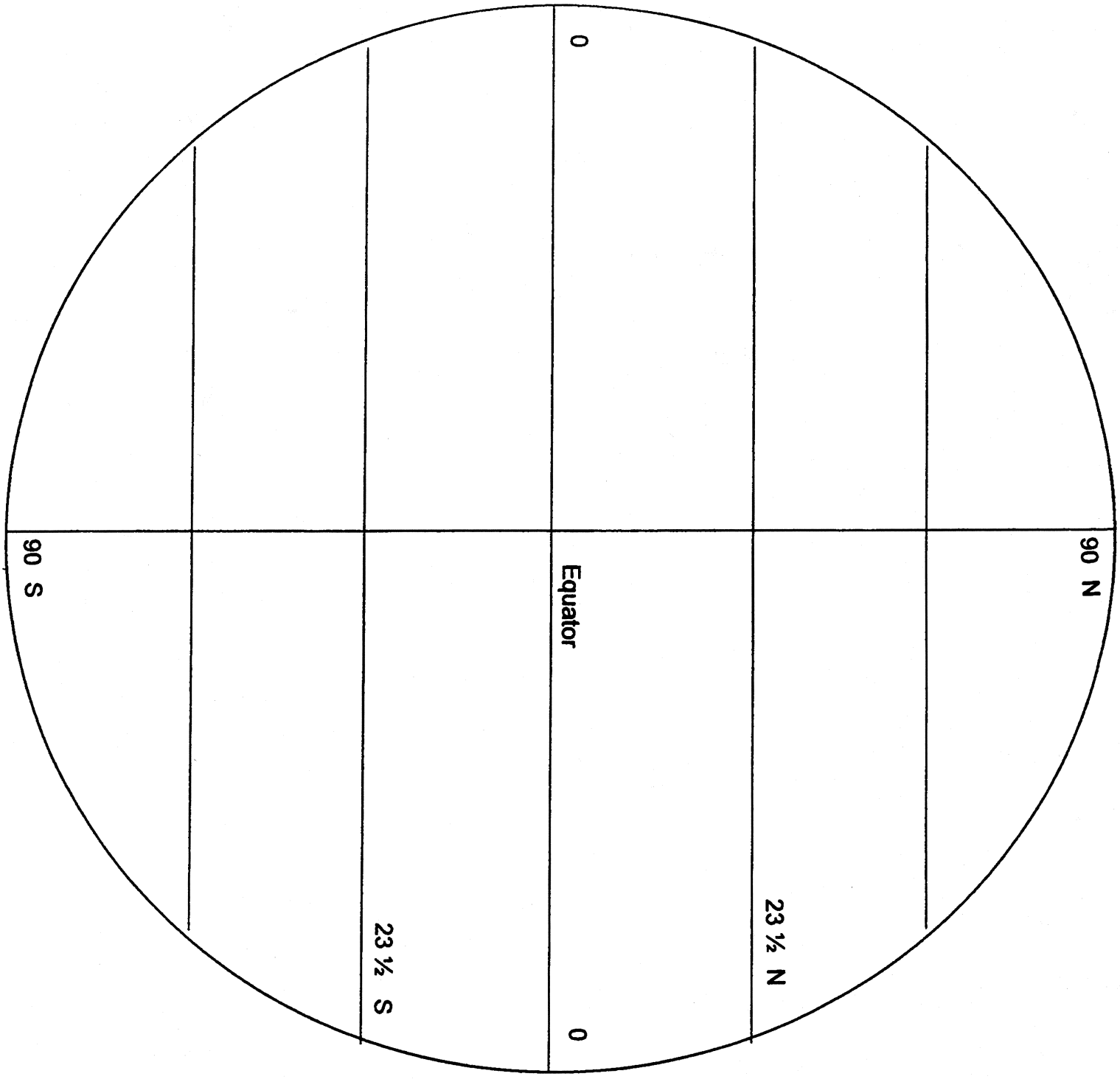
10. How many hours of daylight will 43° N receive? _____

11 What latitude has the longest duration of insolation? _____

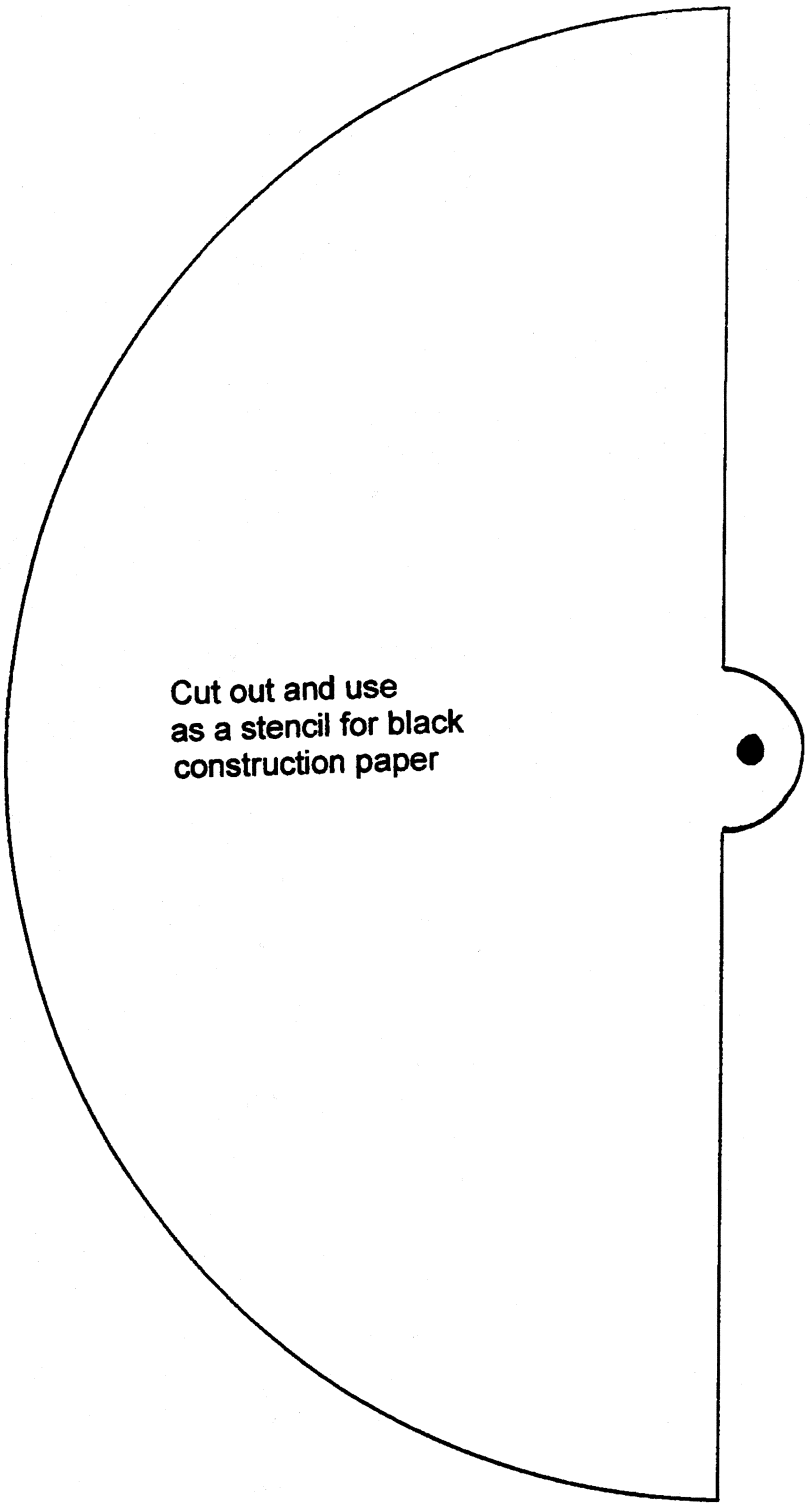
12. What latitude has the shortest duration of insolation? _____

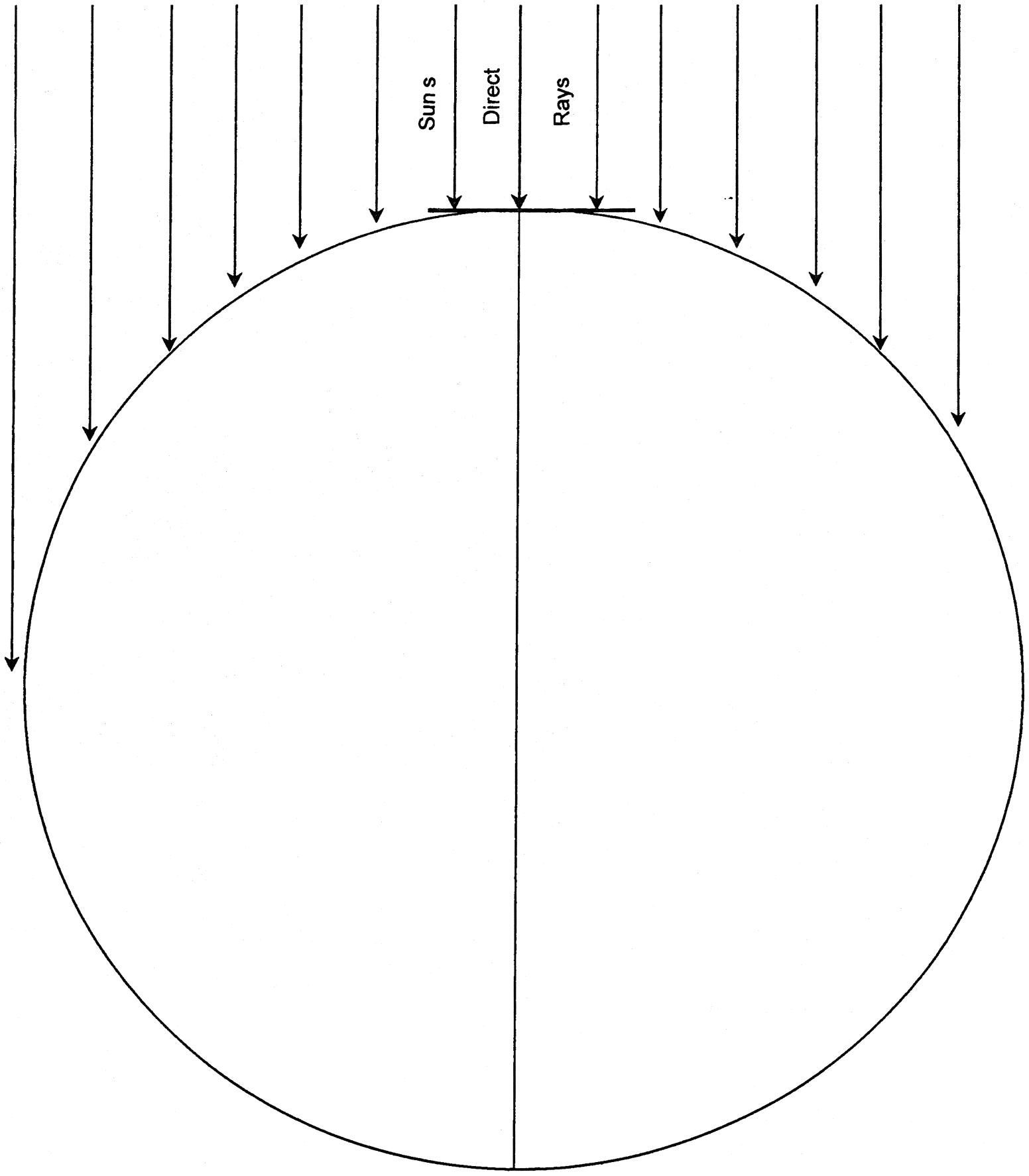
Name"_____ Date:_____

Cut out circle



Name:_____ Date:_____




Sun s
Direct
Rays

Name _____ Date _____

Review Sheet: Insolation

1) How does living near body of water affect your seasons?

2) Who will be warmer in winter someone living near the ocean, or someone living far from the ocean?

3) What is the relationship between clouds and insolation during the day?

4) What is the relationship between clouds and insolation during the night?

5) Which two gases absorb infrared rays?

6) List three factors that could happen to the Earth if there were an increase in the amount of Carbon Dioxide.

7) Did you know that the core of a glacier can give you information about the climate conditions of the past? Well it can!!!!!

8) Where is the sun always located in the sky?

9) As the angle of the sun increases, what happens to the intensity of insolation?

10) As the angle of insolation decreases, what happens to the intensity of insolation?

11) Which latitudes have the lowest angle of insolation?

12) Which latitudes have the longest duration of insolation?

13) What are the two coldest time of the day?

14) What is the warmest time of the day?

15) At what time of the day is Earth in radiative balance?

16) How come New York is warmest in July when the angle of insolation is greatest in June?

17) How come a black top surface will heat faster than a white sandy beach?

18) How come the ground heats faster than the ocean?

19) List two reasons why the Poles are the coldest regions.

20) When is the warmest time of the year in New York?

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Reference Tables for Physical Setting/EARTH SCIENCE

Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$^{14}C \rightarrow {}^{14}N$	5.7×10^3
Potassium-40	$^{40}K \rightarrow {}^{40}Ar$, $^{40}K \rightarrow {}^{40}Ca$	1.3×10^9
Uranium-238	$^{238}U \rightarrow {}^{206}Pb$	4.5×10^9
Rubidium-87	$^{87}Rb \rightarrow {}^{87}Sr$	4.9×10^{10}

Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

Equations

$$\text{Eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

$$\text{Gradient} = \frac{\text{change in field value}}{\text{distance}}$$

$$\text{Rate of change} = \frac{\text{change in value}}{\text{time}}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Properties of Water

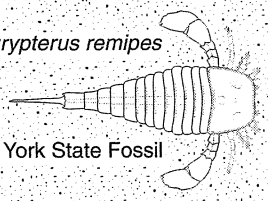
Heat energy gained during melting	334 J/g
Heat energy released during freezing	334 J/g
Heat energy gained during vaporization	2260 J/g
Heat energy released during condensation	2260 J/g
Density at 3.98°C	1.0 g/mL

Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

2010 EDITION

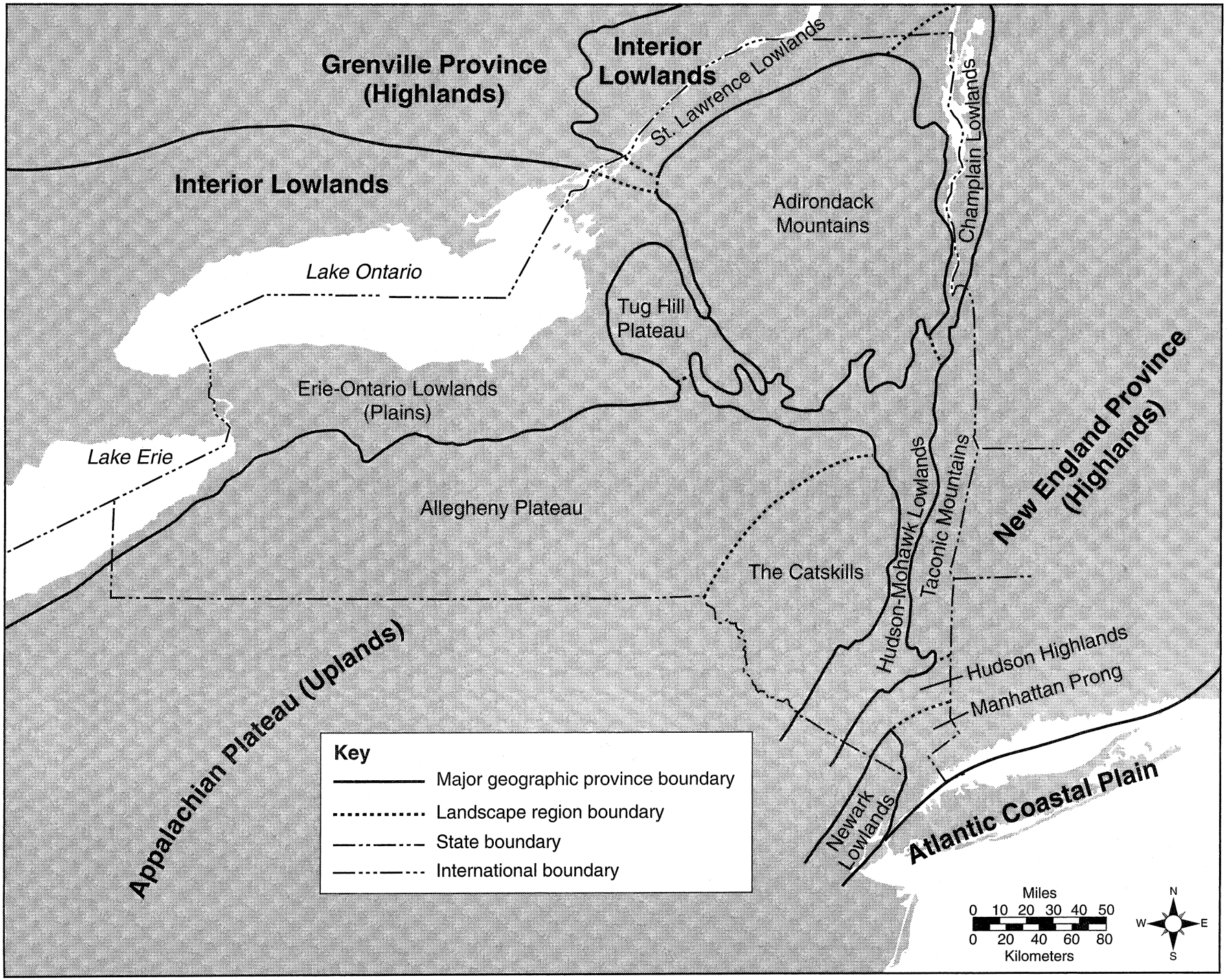
This edition of the Earth Science Reference Tables should be used in the classroom beginning in the 2009–2010 school year. The first examination for which these tables will be used is the January 2010 Regents Examination in Physical Setting/Earth Science.



Eurypterus remipes

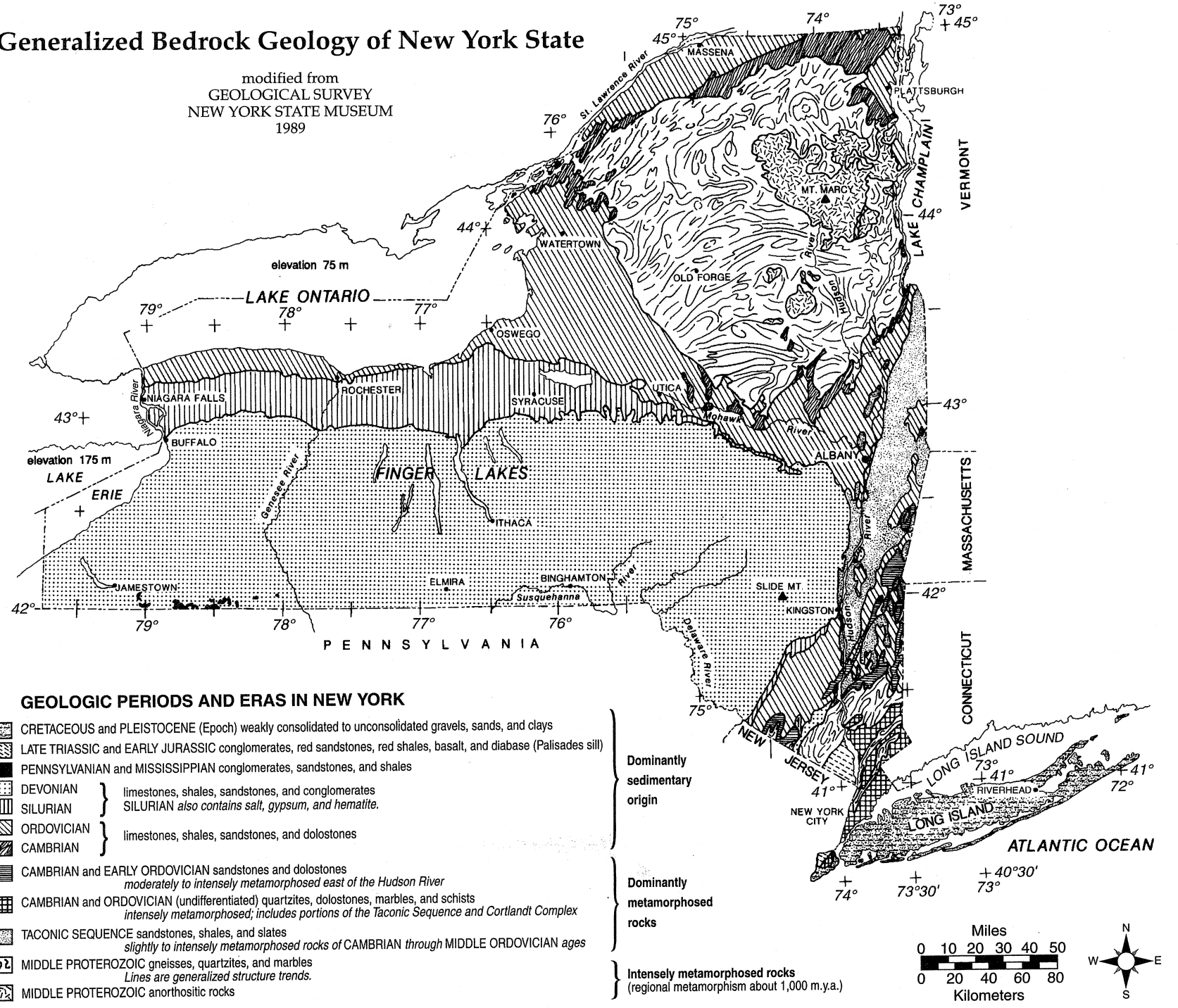
New York State Fossil

Generalized Landscape Regions of New York State



Generalized Bedrock Geology of New York State

modified from
GEOLOGICAL SURVEY
NEW YORK STATE MUSEUM
1989



GEOLOGIC PERIODS AND ERAS IN NEW YORK

Dominantly sedimentary origin

- CRETACEOUS and PLEISTOCENE (Epoch) weakly consolidated to unconsolidated gravels, sands, and clays
- LATE TRIASSIC and EARLY JURASSIC conglomerates, red sandstones, red shales, basalt, and diabase (Palisades sill)
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, and shales
- DEVONIAN, SILURIAN — limestones, shales, sandstones, and conglomerates; SILURIAN *also contains salt, gypsum, and hematite.*
- ORDOVICIAN, CAMBRIAN — limestones, shales, sandstones, and dolostones

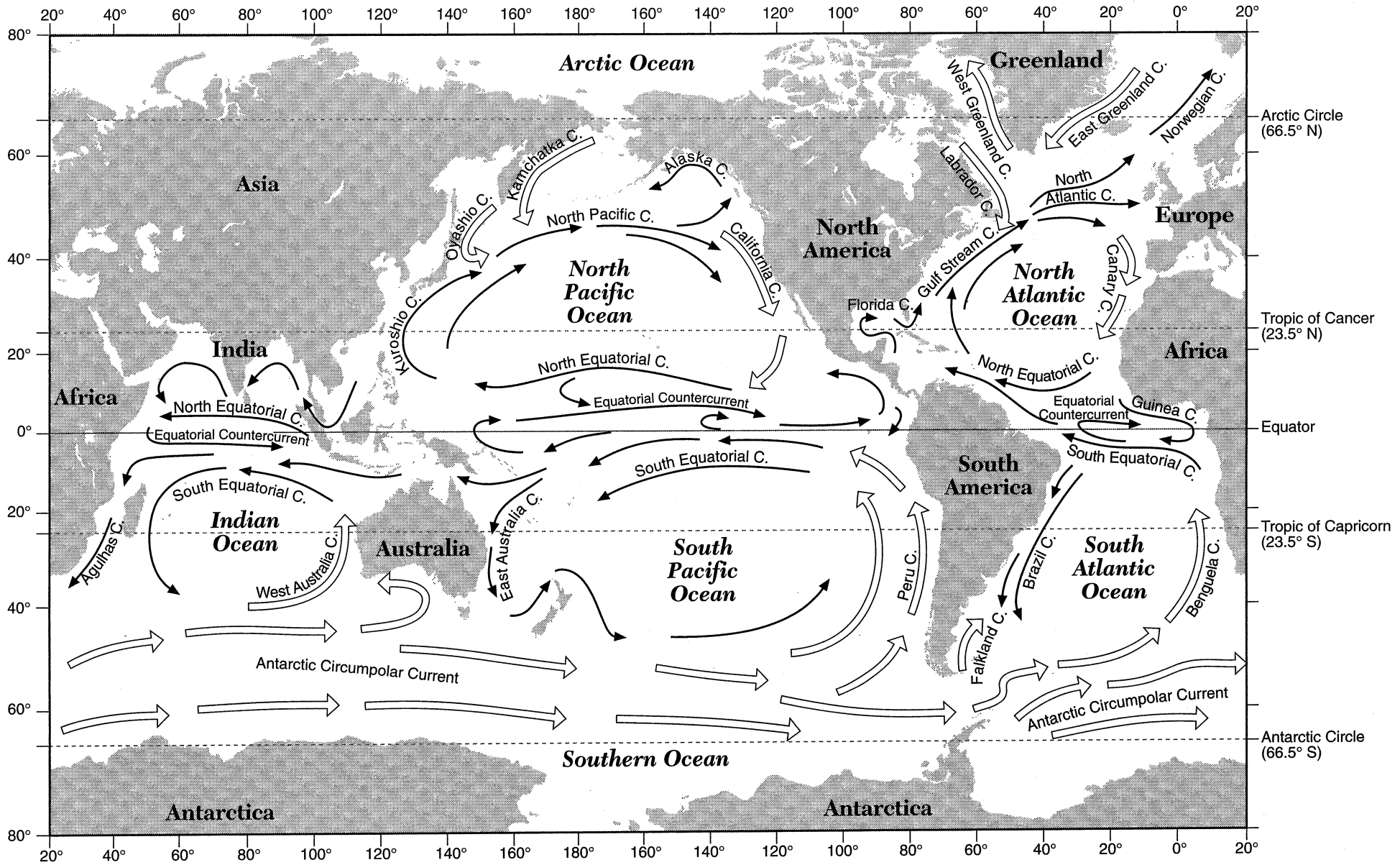
Dominantly metamorphosed rocks

- CAMBRIAN and EARLY ORDOVICIAN sandstones and dolostones
  moderately to intensely metamorphosed east of the Hudson River
- CAMBRIAN and ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, and schists
  intensely metamorphosed; includes portions of the Taconic Sequence and Cortlandt Complex
- TACONIC SEQUENCE sandstones, shales, and slates
  slightly to intensely metamorphosed rocks of CAMBRIAN *through* MIDDLE ORDOVICIAN *ages*

Intensely metamorphosed rocks (regional metamorphism about 1,000 m.y.a.)

- MIDDLE PROTEROZOIC gneisses, quartzites, and marbles
  Lines are generalized structure trends.
- MIDDLE PROTEROZOIC anorthositic rocks

Surface Ocean Currents

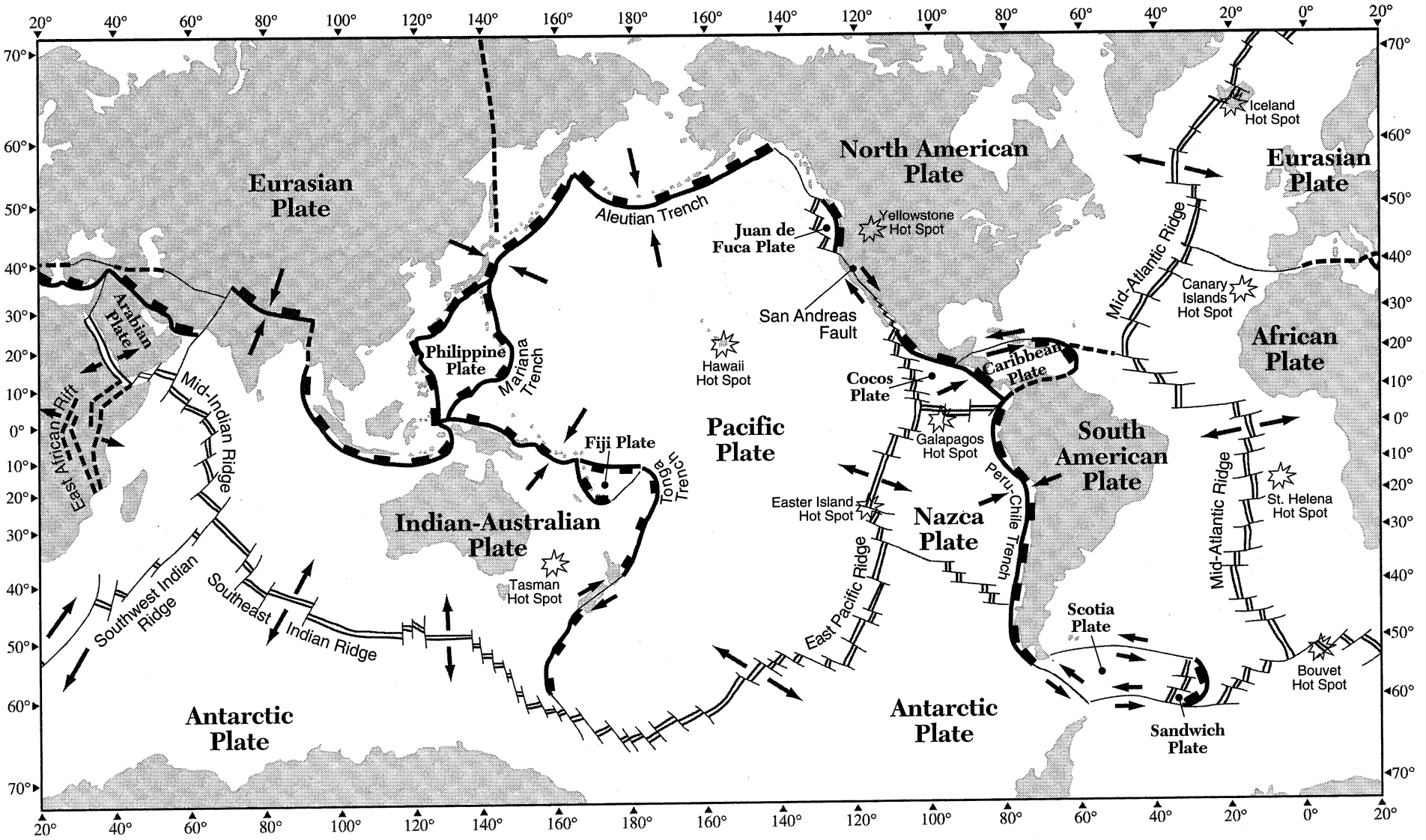


NOTE: Not all surface ocean currents are shown.

Key

- Warm currents
- Cool currents

Tectonic Plates

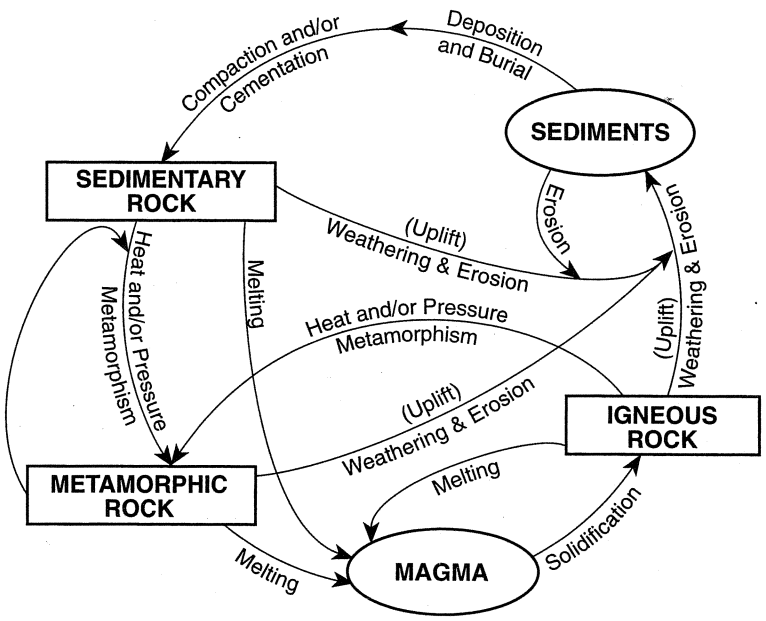


Key

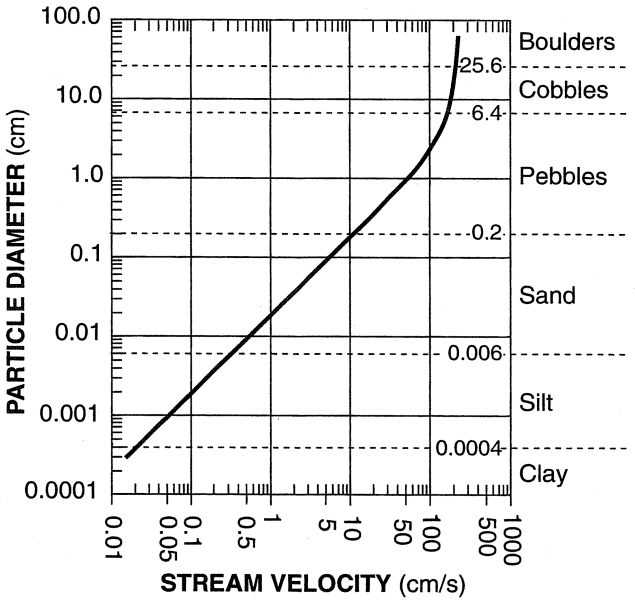
- Relative motion at plate boundary
- Transform plate boundary (transform fault)
- Divergent plate boundary (usually broken by transform faults along mid-ocean ridges)
- overriding plate / subducting plate — Convergent plate boundary (subduction zone)
- Complex or uncertain plate boundary
- Mantle hot spot

NOTE: Not all mantle hot spots, plates, and boundaries are shown.

Rock Cycle in Earth's Crust



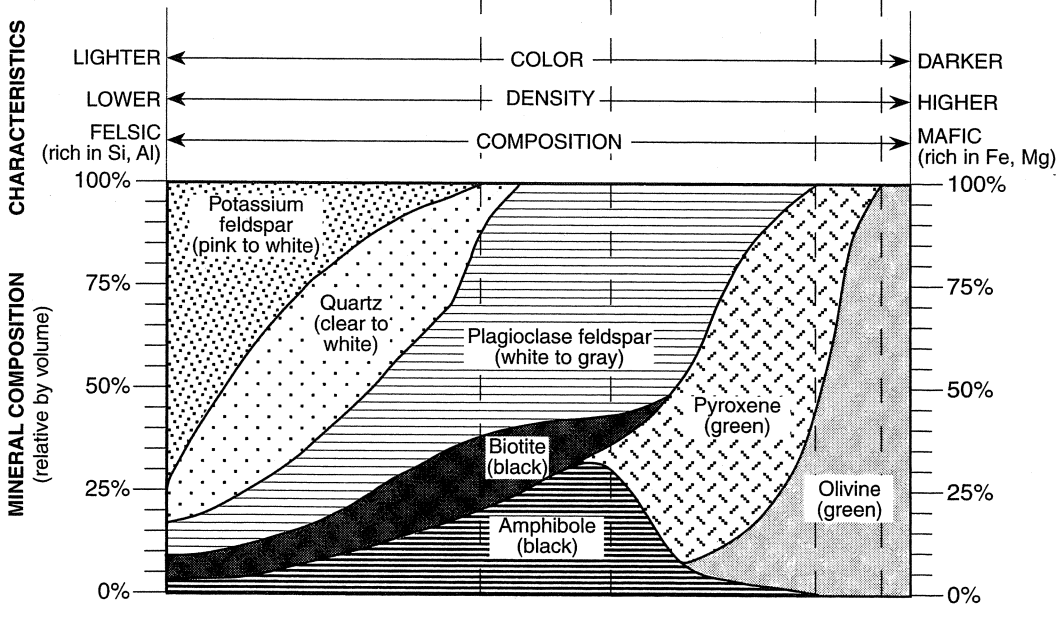
Relationship of Transported Particle Size to Water Velocity



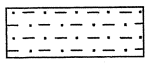
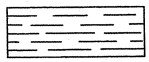
This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

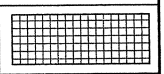
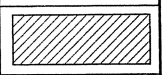
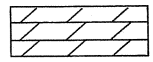
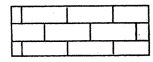
Scheme for Igneous Rock Identification

IGNEOUS ROCKS							CRYSTAL SIZE	TEXTURE	
ENVIRONMENT OF FORMATION	EXTRUSIVE (Volcanic)	Obsidian (usually appears black)		Basaltic glass			non-crystalline	Glassy	Non-vesicular
		Pumice		Scoria					Vesicular (gas pockets)
		Vesicular rhyolite	Vesicular andesite	Vesicular basalt			less than 1 mm	Fine	
		Rhyolite	Andesite	Basalt					Non-vesicular
	INTRUSIVE (Plutonic)			Diabase					
		Granite	Diorite	Gabbro	Peridotite	Dunite	1 mm to 10 mm	Coarse	
		Pegmatite					10 mm or larger	Very coarse	

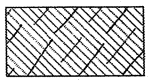
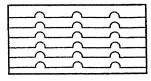
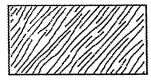
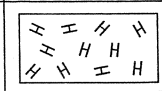
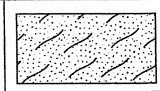
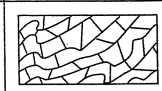
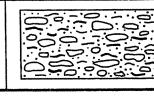


Scheme for Sedimentary Rock Identification

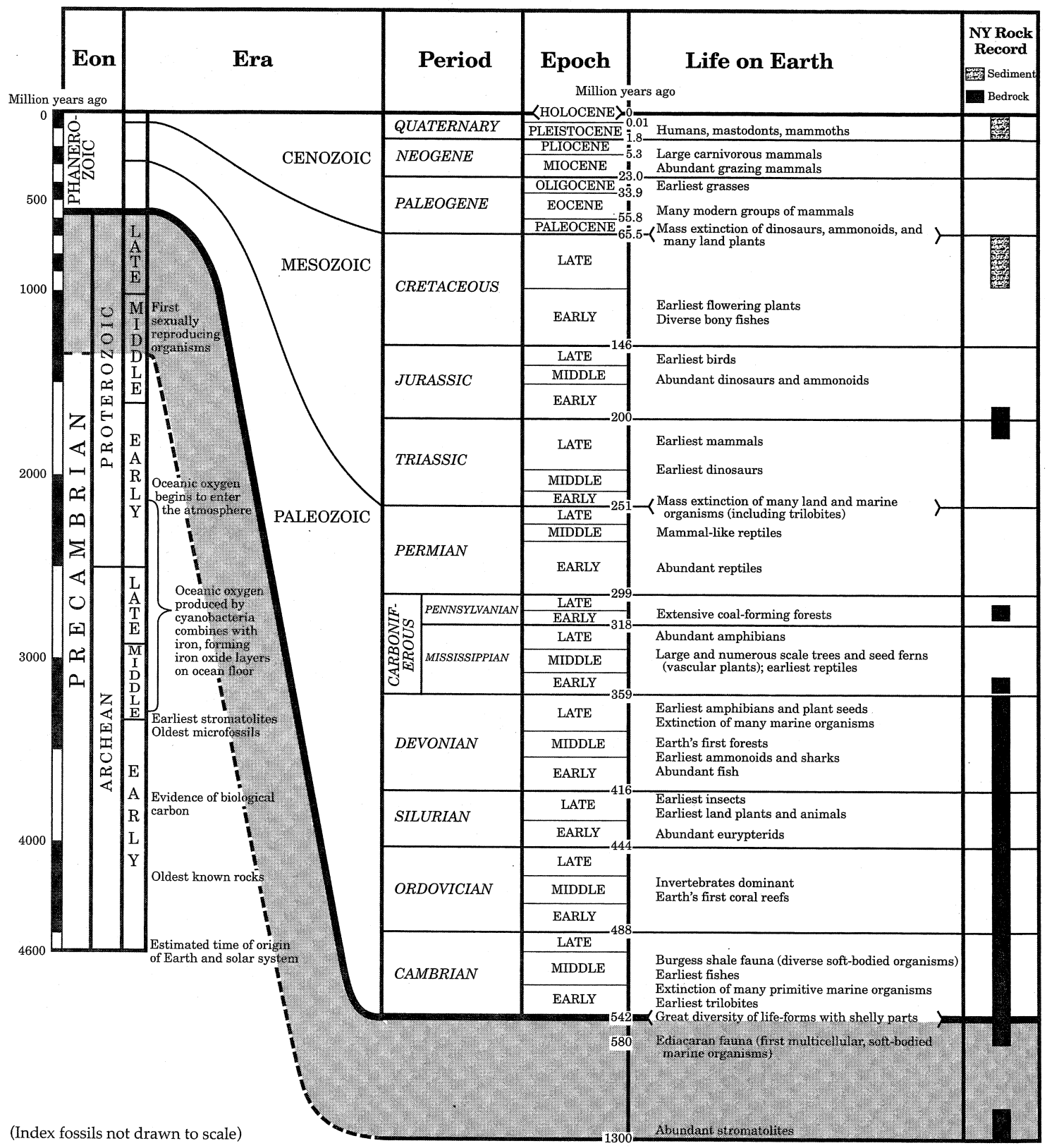
INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

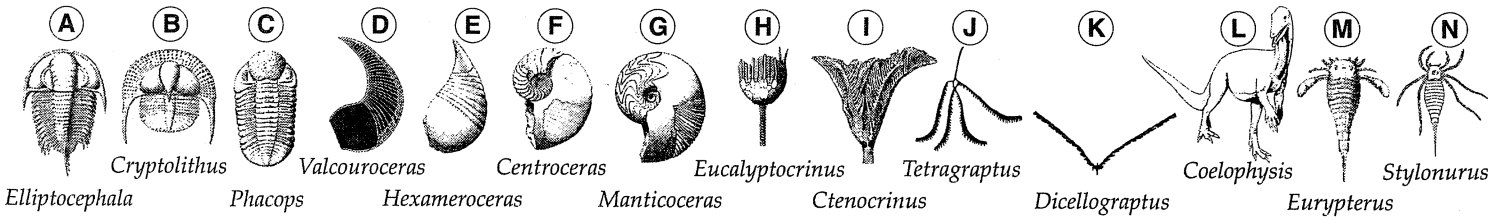
Scheme for Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	MINERAL ALIGNMENT	Fine	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional (Heat and pressure increases)	Low-grade metamorphism of shale	**Slate**	
		Fine to medium			Foliation surfaces shiny from microscopic mica crystals	**Phyllite**	
					Platy mica crystals visible from metamorphism of clay or feldspars	**Schist**	
	BAND-ING	Medium to coarse			High-grade metamorphism; mineral types segregated into bands	**Gneiss**	
NONFOLIATED		Fine	Carbon	Regional	Metamorphism of bituminous coal	**Anthracite coal**	
		Fine	Various minerals	Contact (heat)	Various rocks changed by heat from nearby magma/lava	**Hornfels**	
		Fine to coarse	Quartz	Regional or contact	Metamorphism of quartz sandstone	**Quartzite**	
			Calcite and/or dolomite		Metamorphism of limestone or dolostone	**Marble**	
		Coarse	Various minerals		Pebbles may be distorted or stretched	**Metaconglomerate**	

GEOLOGIC HISTORY



(Index fossils not drawn to scale)



OF NEW YORK STATE

Time Distribution of Fossils (including important fossils of New York)

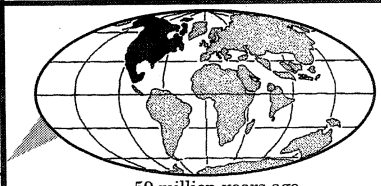
The center of each lettered circle indicates the approximate time of existence of a specific index fossil (e.g. Fossil (A) lived at the end of the Early Cambrian).

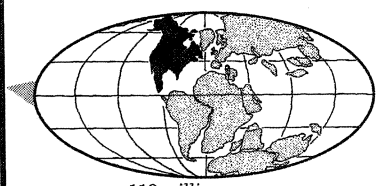
TRILOBITES, NAUTILOIDS, AMMONOIDS, CRINOIDS, GRAPTOLITES, DINOSAURS, MAMMALS, EURYPTERIDS, VASCULAR PLANTS, PLACODERM FISH, BIRDS, CORALS, GASTROPODS, BRACHIOPODS

Important Geologic Events in New York

- Advance and retreat of last continental ice
- Sands and clays underlying Long Island and Staten Island deposited on margin of Atlantic Ocean
- Dome-like uplift of Adirondack region begins
- Initial opening of Atlantic Ocean
  North America and Africa separate
  ⟨ Intrusion of Palisades sill ⟩
  Pangaea begins to break up
- **Alleghenian orogeny** caused by collision of North America and Africa along transform margin, forming Pangaea
- Catskill delta forms
  Erosion of Acadian Mountains
  Acadian orogeny caused by collision of North America and Avalon and closing of remaining part of Iapetus Ocean
- Salt and gypsum deposited in evaporite basins
- Erosion of Taconic Mountains; Queenston delta forms
  Taconian orogeny caused by closing of western part of Iapetus Ocean and collision between North America and volcanic island arc
- Widespread deposition over most of New York along edge of Iapetus Ocean
- Rifting and initial opening of Iapetus Ocean
- Erosion of Grenville Mountains
- **Grenville orogeny:** metamorphism of bedrock now exposed in the Adirondacks and Hudson Highlands

Inferred Positions of Earth's Landmasses


59 million years ago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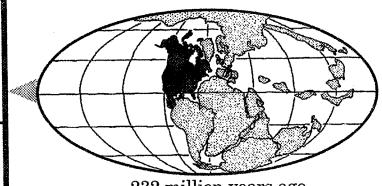
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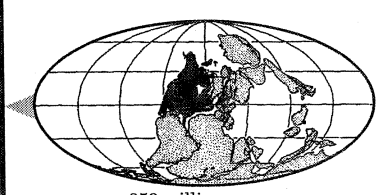
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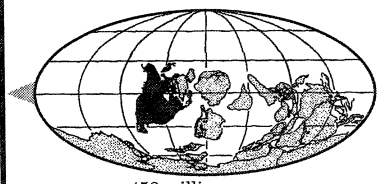
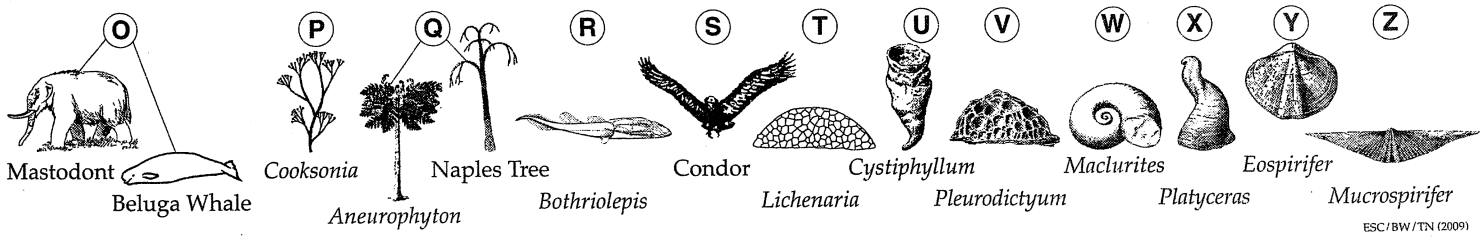
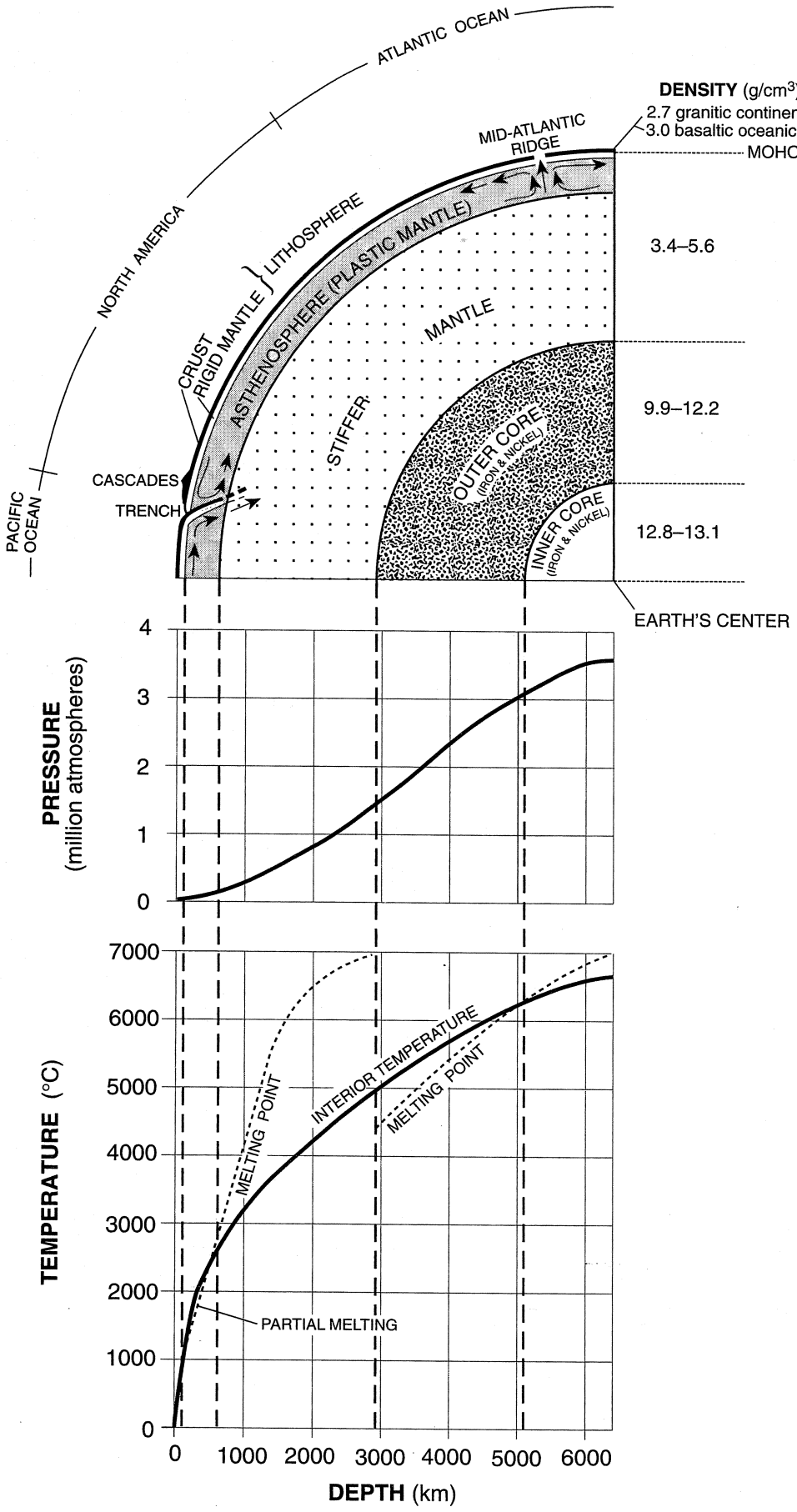

458 million years ago

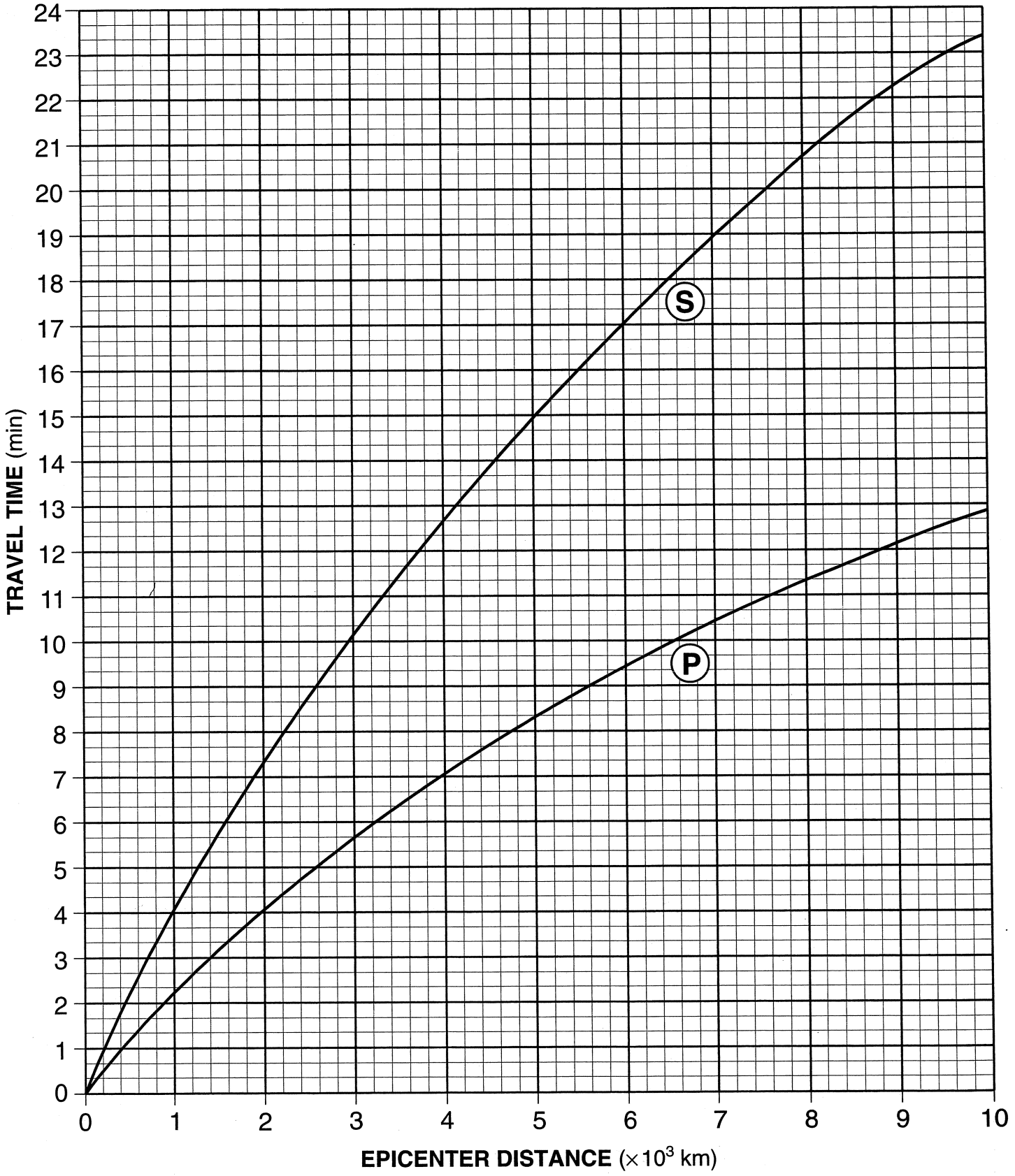


ESC/BW/TN (2009)

Inferred Properties of Earth's Interior



Earthquake P-Wave and S-Wave Travel Time



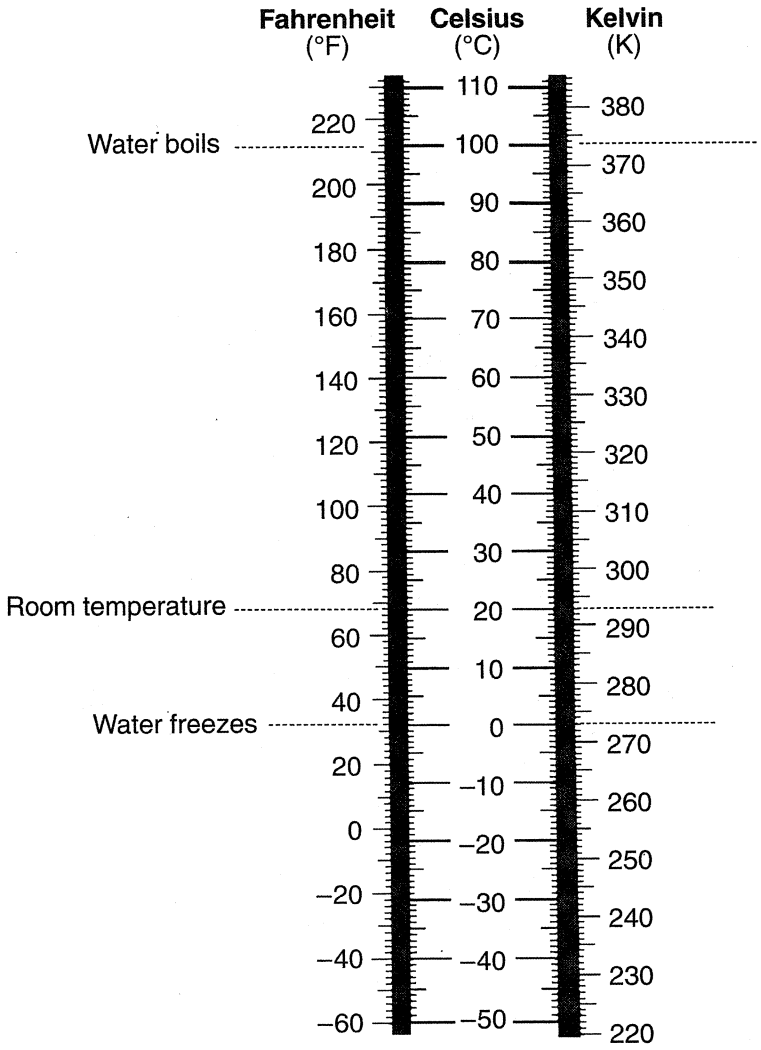
Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−28													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

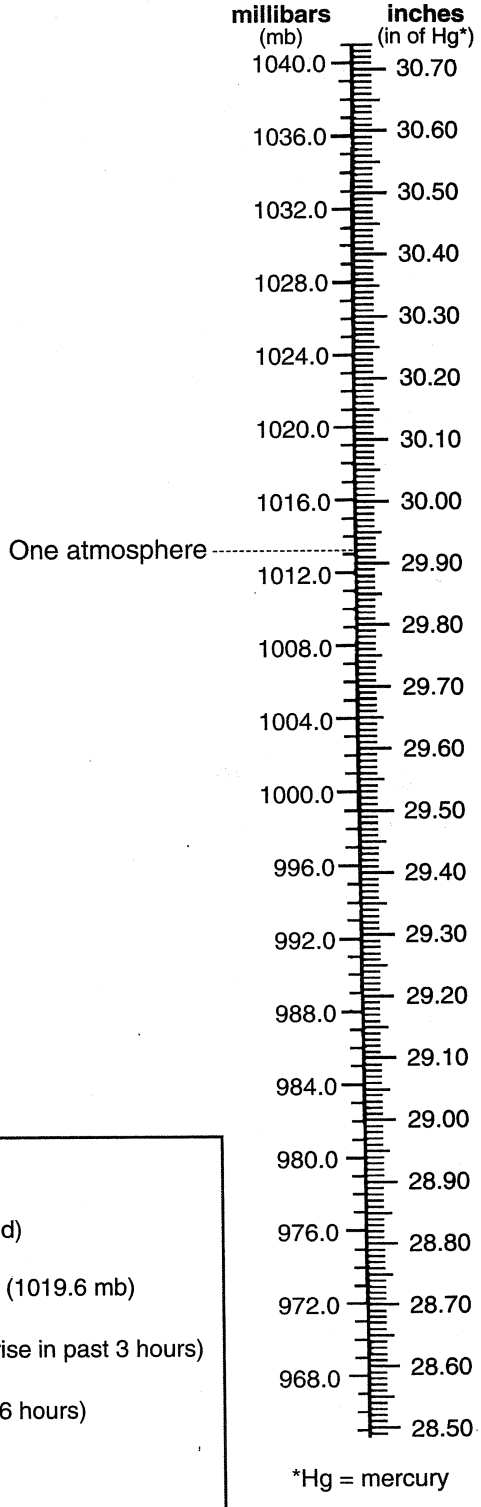
Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Temperature



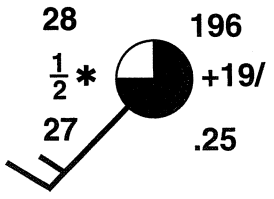
Pressure



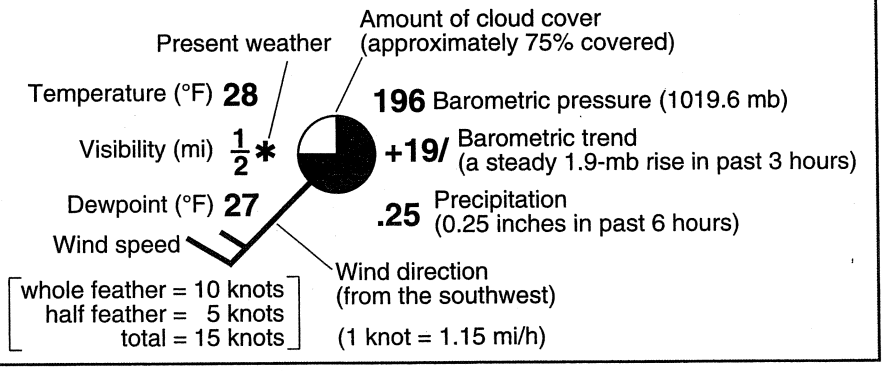
*Hg = mercury

Key to Weather Map Symbols

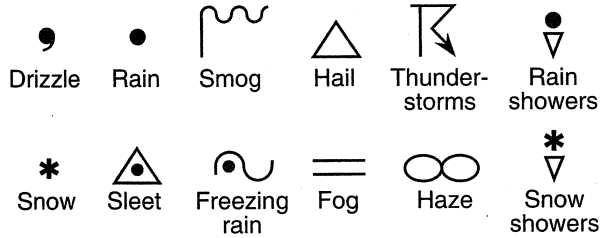
Station Model



Station Model Explanation



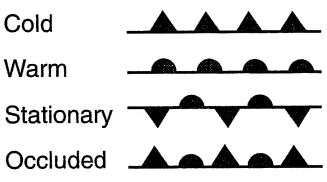
Present Weather



Air Masses

cA	continental arctic
cP	continental polar
cT	continental tropical
mT	maritime tropical
mP	maritime polar

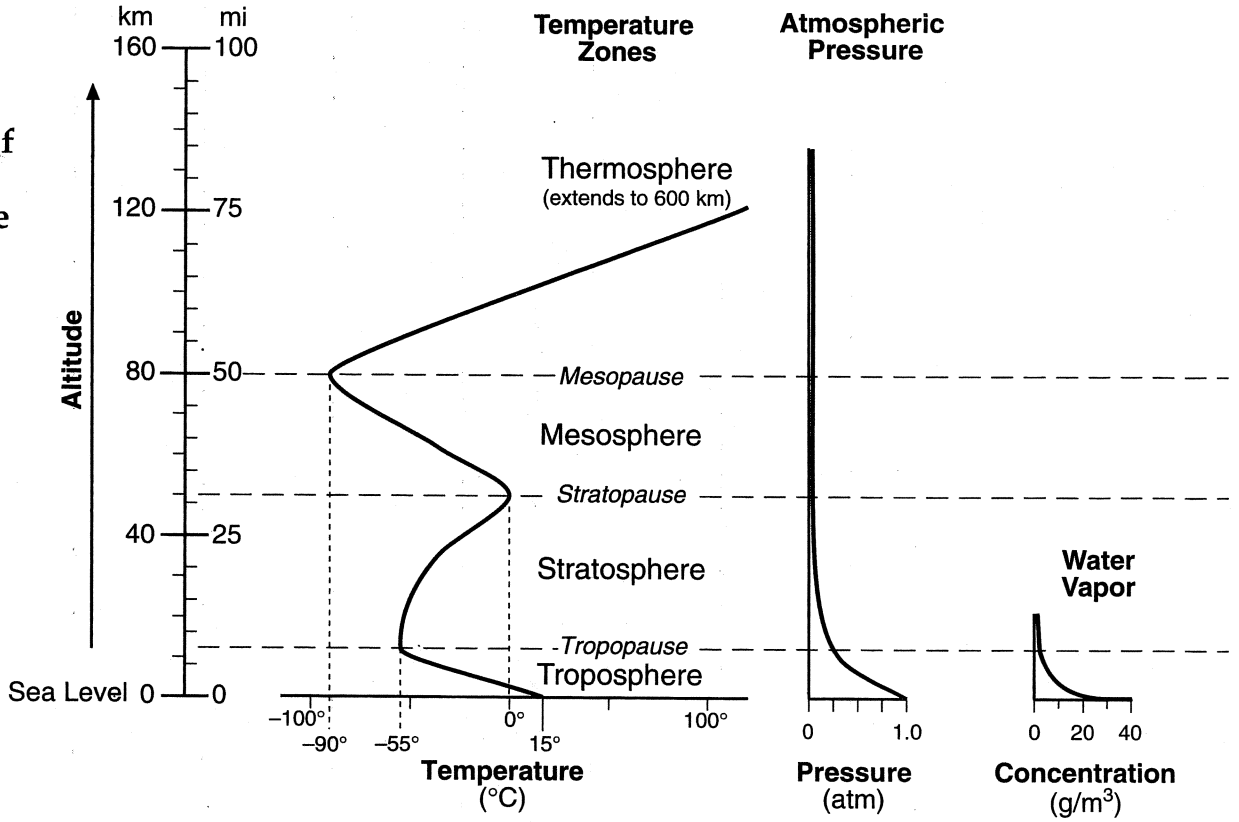
Fronts



Hurricane

Tornado

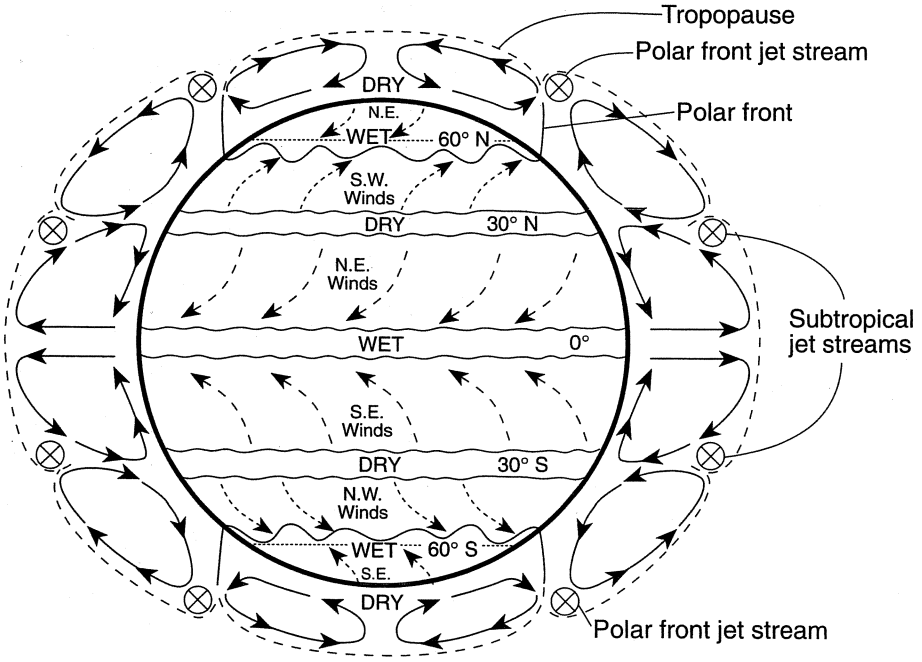
Selected Properties of Earth's Atmosphere



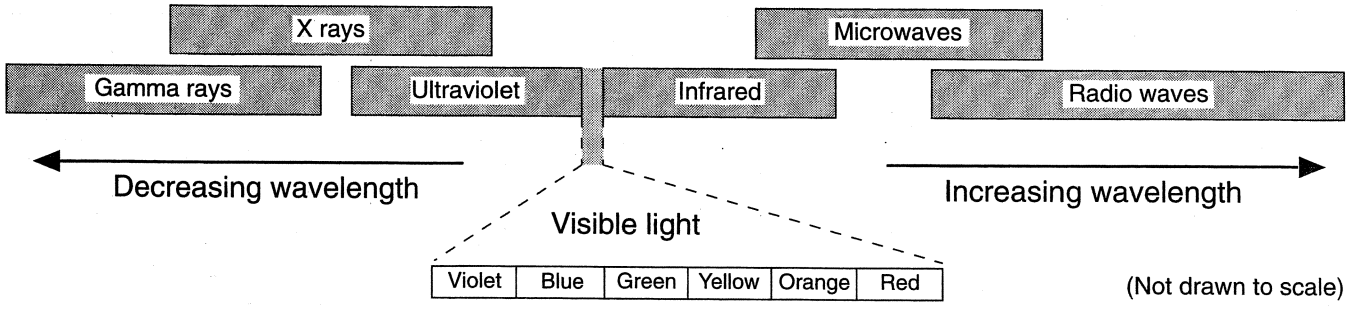
Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

(Not drawn to scale)



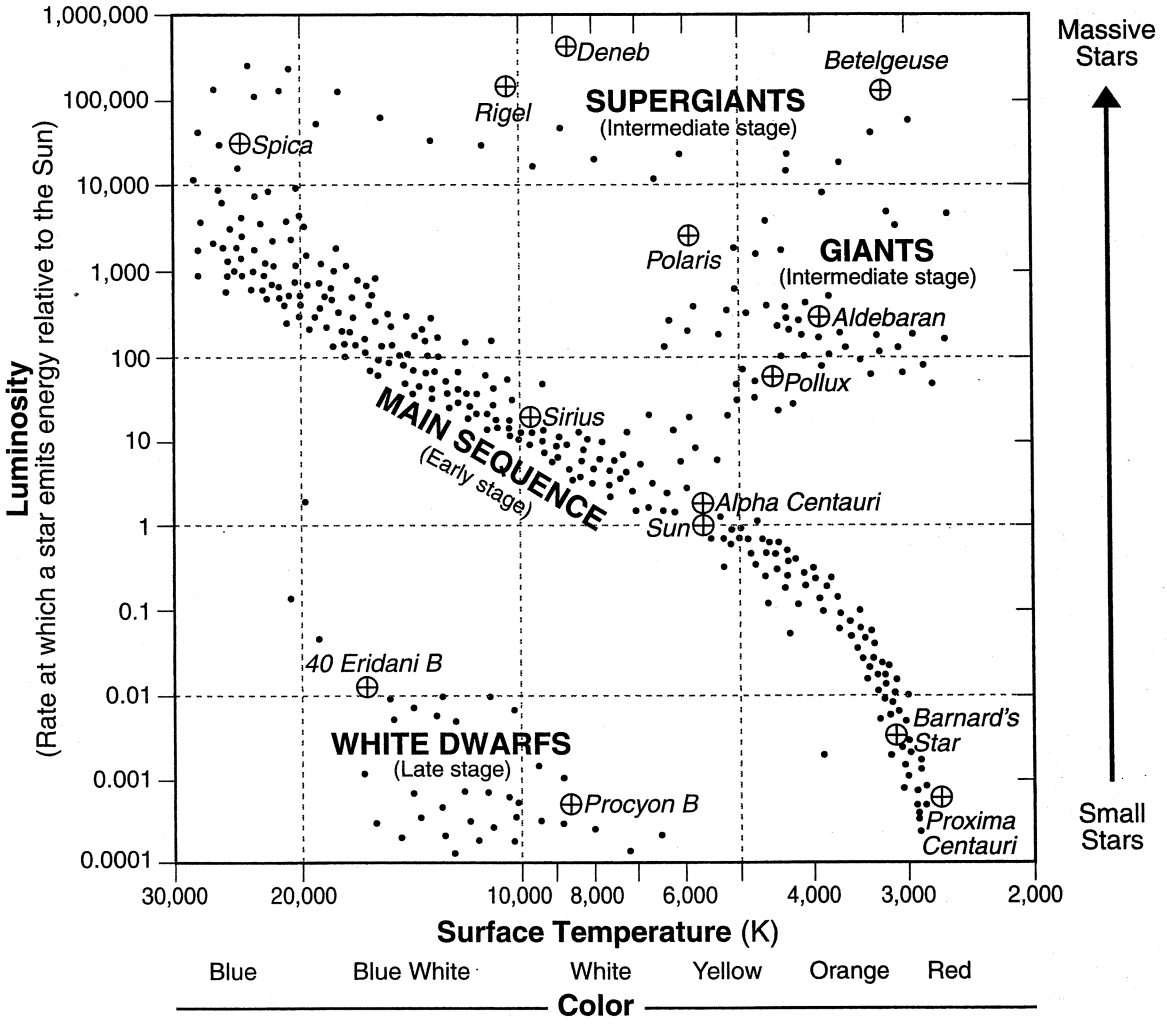
Electromagnetic Spectrum



(Not drawn to scale)

Characteristics of Stars

(Name in italics refers to star represented by a ⊕.)
(Stages indicate the general sequence of star development.)



Solar System Data

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm^3)
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3

Properties of Common Minerals

LUSTER	HARDNESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	COMPOSITION*	MINERAL NAME
Metallic luster	1–2	✔		silver to gray	black streak, greasy feel	pencil lead, lubricants	C	**Graphite**
	2.5	✔		metallic silver	gray-black streak, cubic cleavage, density = 7.6 g/cm^3	ore of lead, batteries	PbS	**Galena**
	5.5–6.5		✔	black to silver	black streak, magnetic	ore of iron, steel	Fe_3O_4	**Magnetite**
	6.5		✔	brassy yellow	green-black streak, (fool's gold)	ore of sulfur	FeS_2	**Pyrite**
Either	5.5 – 6.5 or 1		✔	metallic silver or earthy red	red-brown streak	ore of iron, jewelry	Fe_2O_3	**Hematite**
Nonmetallic luster	1	✔		white to green	greasy feel	ceramics, paper	$Mg_3Si_4O_{10}(OH)_2$	**Talc**
	2		✔	yellow to amber	white-yellow streak	sulfuric acid	S	**Sulfur**
	2	✔		white to pink or gray	easily scratched by fingernail	plaster of paris, drywall	$CaSO_4 \cdot 2H_2O$	**Selenite gypsum**
	2–2.5	✔		colorless to yellow	flexible in thin sheets	paint, roofing	$KAl_3Si_3O_{10}(OH)_2$	**Muscovite mica**
	2.5	✔		colorless to white	cubic cleavage, salty taste	food additive, melts ice	NaCl	**Halite**
	2.5–3	✔		black to dark brown	flexible in thin sheets	construction materials	$K(Mg,Fe)_3 AlSi_3O_{10}(OH)_2$	**Biotite mica**
	3	✔		colorless or variable	bubbles with acid, rhombohedral cleavage	cement, lime	$CaCO_3$	**Calcite**
	3.5	✔		colorless or variable	bubbles with acid when powdered	building stones	$CaMg(CO_3)_2$	**Dolomite**
	4	✔		colorless or variable	cleaves in 4 directions	hydrofluoric acid	CaF_2	**Fluorite**
	5–6	✔		black to dark green	cleaves in 2 directions at 90°	mineral collections, jewelry	$(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$	**Pyroxene** (commonly augite)
	5.5	✔		black to dark green	cleaves at 56° and 124°	mineral collections, jewelry	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3Si_6O_{22}(O,OH)_2$	**Amphibole** (commonly hornblende)
	6	✔		white to pink	cleaves in 2 directions at 90°	ceramics, glass	$KAlSi_3O_8$	**Potassium feldspar** (commonly orthoclase)
	6	✔		white to gray	cleaves in 2 directions, striations visible	ceramics, glass	$(Na,Ca)AlSi_3O_8$	**Plagioclase feldspar**
	6.5		✔	green to gray or brown	commonly light green and granular	furnace bricks, jewelry	$(Fe,Mg)_2SiO_4$	**Olivine**
	7		✔	colorless or variable	glassy luster, may form hexagonal crystals	glass, jewelry, electronics	SiO_2	**Quartz**
	6.5–7.5		✔	dark red to green	often seen as red glassy grains in NYS metamorphic rocks	jewelry (NYS gem), abrasives	$Fe_3Al_2Si_3O_{12}$	**Garnet**

*Chemical symbols:

Al = aluminum	Cl = chlorine	H = hydrogen	Na = sodium	S = sulfur
C = carbon	F = fluorine	K = potassium	O = oxygen	Si = silicon
Ca = calcium	Fe = iron	Mg = magnesium	Pb = lead	Ti = titanium

✔ = dominant form of breakage