Name_____

ICE LAB

CURRENTS CAUSED BY TEMPERATURE

PURPOSE

To observe the movement of different temperatures of water as an example of how the oceans react to the sun and ice caps of the north and south poles.

MATERIALS

Aquarium, meter stick, lamp with high wattage bulb, food coloring..red and blue, 2 chunks of ice frozen with blue food coloring in it.

OBSERVATIONS

Once the demo has been set up, observe the movement of the blue water as the ice melts. Also look what happens to the red dye as the water under the lamp heats up.

QUESTIONS

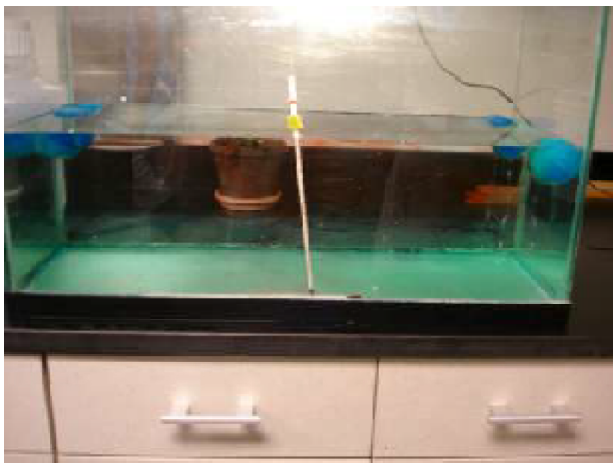
1. Why does the dye from the ice act the way it does?

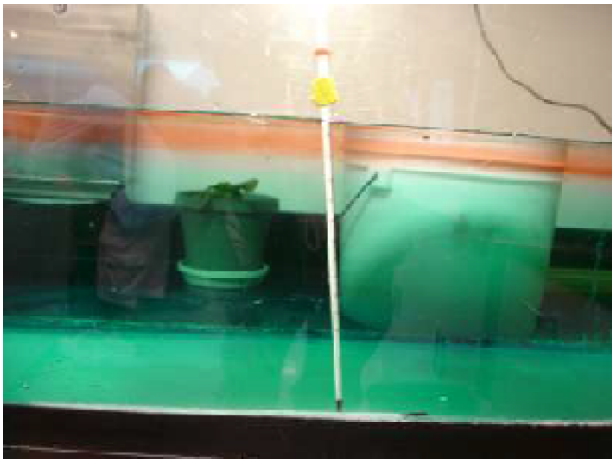
2. Why doesn't the red dye do the same?

3. What replaces the blue water? How can you tell?

4. After a while, what does the tank look like?

5. Give a summary of what this experiment has shown.





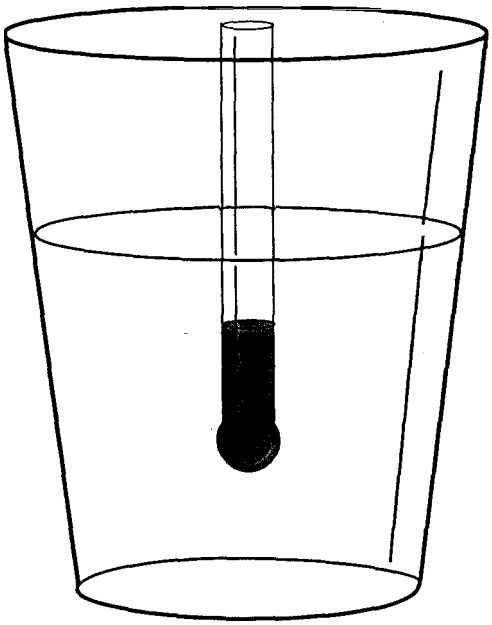
DARE TO BE DENSE

Lab

Suppose you are holding two boxes of equal size and mass. One box contains a kilogram of feathers and the other a kilogram of rocks. The masses of the boxes are the same. Does the box with rocks weigh more than the box with feathers? If you said they are equal in weight, you are right. This example demonstrates that a unit of mass, like the kilogram, is the same whether dealing with feathers or rocks.

Now think of the amount of space which would be taken up by the kilogram of rocks and the kilogram of feathers in the boxes. Which would have the greater volume? As you can imagine, the amount of space or volume of one kilogram of feathers, will be much greater than the amount of space taken up by one kilogram of rocks. This is because rocks are more dense than feathers.

The concept for dealing with both mass and volume is density. Density is the ratio of mass to volume in matter. A good reference material for understanding density is water. The density of water is 1.0 gm mass/ml (volume). If some form of matter (liquid, solid, gas) has a greater density than 1.0, then it is more dense than water and will sink in water. Matter less dense than water, with density less than 1.0, will float on water. Objects that float on water are called buoyant.



The instrument you will construct in this laboratory will be used to compare the density of water when different amounts of salt are added. Scientists call such an instrument a **hydrometer**. Hydro means water or liquid, and the suffix meter means a measuring device. Scientists use the hydrometer to compare densities of different liquids.

Objectives:

To see how the density of water is affected by adding salt.

Materials:

Fresh water
Clear plastic straw
Pea-size lump of modeling clay 8 oz.
Clear plastic cup Waterproof marked
Candle
Plastic Spoon
2 Tablespoons salt 1
Teaspoon sand Matches

Procedure:

1. Cut a small plastic straw to a length of 10 centimeters (cm). Close one end of the straw with a small bit of modeling clay. Water-seal the clay end of the straw with molten candle wax. Using a waterproof marker, draw a line around the straw at 5 cm below the open end (top) of the straw. This is your hydrometer.

2. Almost fill the plastic cup with fresh water. Place your hydrometer in the water. To calibrate your hydrometer to the standard density of fresh water, add sand, a little at a time, to the mouth of the straw until the line on the straw is exactly at water level. Use a ruler to measure the length of the straw above the water level (it should be 5 cm if your hydrometer is adjusted properly). Record your measurement on Data Table 1. Calculate the length of straw below the water level and record. Calculate the above water level to below water level ratio and record.

3. Add 1 teaspoon of salt to the water. Stir until completely dissolved. Again measure the length of the straw above the water level and record your results and ratio calculations in Data Table 1. Add a second tablespoon of salt. Repeat the above procedures and calculations.

Data Table 1

Amount of salt	Total length of straw	Above water length	Below water length	Ratio above/below

Questions:

1. How does the amount of added salt affect the density of the liquid?

2. Define density and give an example of how the density of a piece of matter may be determined.

3. Explain what buoyancy is and tell how buoyancy is related to the density of a liquid.

4. Predict how your hydrometer would react if more salt were to be added to the water.

5. In which body of water would you expect your body to be more buoyant: a freshwater lake of the open ocean ? Explain why.

6. During the spring and summer months, manatees often swim upriver from saltwater bays into freshwater areas. As these animals swim upstream, what happens to their buoyancy?

EXPERIENCING A THERMOCLINE

PURPOSE: Create and observe a thermocline created from waters of two different temperatures and densities.

BACKGROUND: The thermocline is a region where water temperature changes rapidly over a relatively short change in depth. Colder water is denser and therefore stays below the less dense warm water. The different densities create a separation between the warm and cold water at a particular depth. During an El Nino event the thermocline is significantly deeper, causing less nutrients to come up to the surface. With fewer nutrients available, the phytoplankton (tiny light-harvesting plants that make up the base of the marine food chain) do not bloom or grow in large numbers. This affects every level of the food chain.

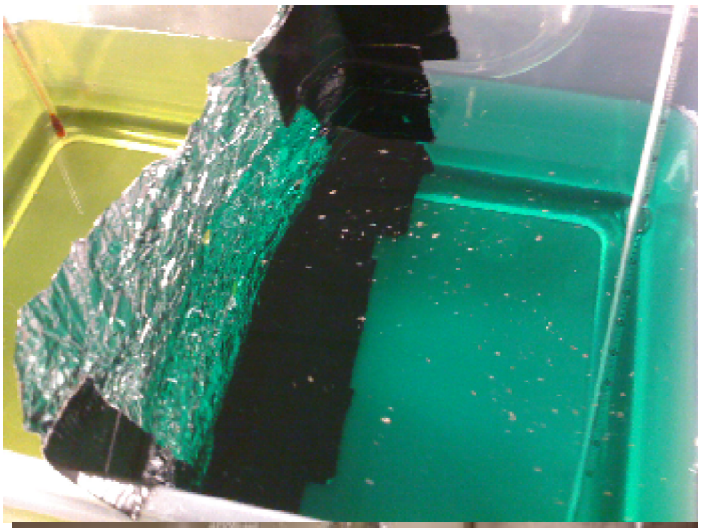
MATERIALS:

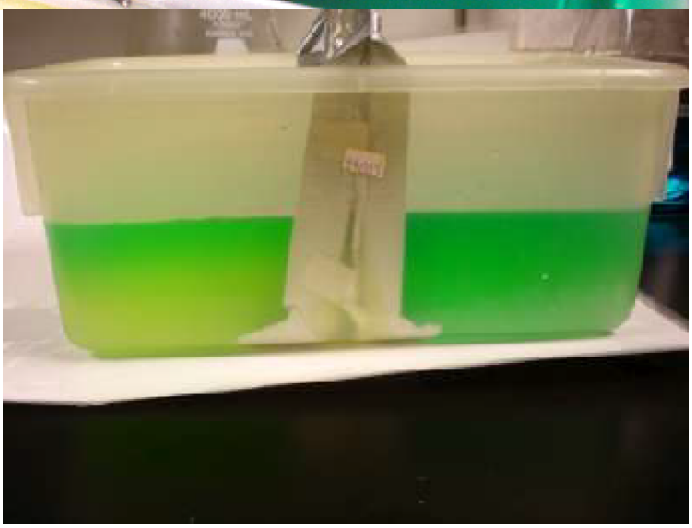
plastic box	aluminum foil	masking tape
thermometer	ruler	food coloring (2 colors)
pepper	scissors	sharp pencil
1 gallon very warm water		1 gallon very cold water

(do not pour ice cubes into the "thermocline in a box" they will float and ruin your thermocline)

PROCEDURES:

I. Cut a piece of foil slightly larger and wider than the plastic box. . Tape it into the box so that it makes a waterproof barrier that divides the aquarium in two.
2. Add one color of food coloring to the warm water and a different color to the cold water.
3. At the same time, pour warm water into one side of the box and cold water into the other side. Fill until the box is about 2/3 full. The foil barrier should keep the two different temperature / density waters separate. If you don't pour at the same time the foil barrier may collapse.
4. Sprinkle pepper on the warm water's surface and the cold water's surface.
5. Record the temperature and color of the warm water side and the cold water side.
6. With a sharp pencil, poke a hole in the foil near the bottom and just below the water's surface.
7. Observe for 3 minutes.





Questions

Ql. On which side does the pepper floating on the surface move?

Q2. What does the movement of the pepper indicate about how the water is following through the holes in the foil?

--. Take a temperature reading, starting at 1cm below the water's surface. Be very careful. Disturb the water as little as possible. Record additional reading every cm until you reach the bottom.

Q3. Make an observation about the temperature readings you recorded.

Q4. From the temperature readings, at approximately which measurement is the thermocline located?

--. Look at the two different colors of water and where they meet, using a ruler on the outside of the box, measure from the bottom to the approximate location where the two colors meet.

Q5. From this measurement, at approximately which measurement is the thermocline located? Observing that the two different colors and temperatures of water have flowed through the holes in the foil and are layered on both sides of the box, answer the following

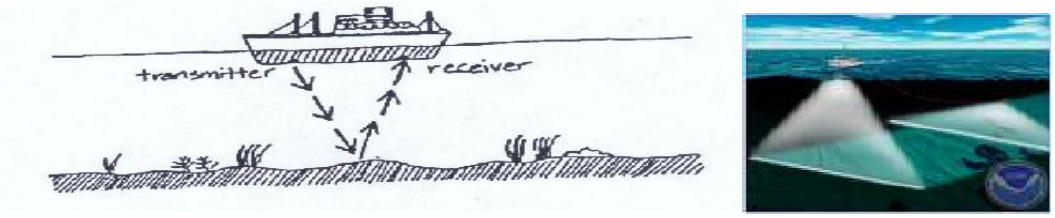
Q6. Which temperature of water is the top layer? What does this suggest about it's density compared to the other temperature water.

Q7. Why did the water flow through the holes?

Q8. As water flowed through the two holes, why didn't one side fill up faster than the other side?

Q9. If you repeated this activity but used water of the same temperatures, describe what you think would happen?

HOW OCEAN DEPTH IS MEASURED BY SOUNDING



Much of the oceans topography has been mapped by the use of devices such as sounding. In this method sound is sent from a ship's transmitter to the ocean's bottom at an angle. It bounces back to the ship at the same angle and is picked up by a receiver on the same ship. We know that the speed of sound is about 1534 meters per second (1534 m/s). By using this information and applying the following formula, ocean depth can be measured and mapped.

The formula for measuring ocean depth:

$$D = 1/2\ T \times V$$

D = depth

T = time

V = speed or velocity of sound in water (1534 meters per second)

Using this formula, find the depths of the ocean in the given locations and plot the depths on the graph top make a topographical map.

In a certain area of the ocean, a ship traveling in a straight line receives the following sonar signals:

Location A. 1st signal.....1 second

Location B. 2nd signal.....2 seconds

Location C. 3rd signal.....4 seconds

Location D. 4th signal.....8 seconds

Location E. 5th signal.....6 seconds

Location F. 6th signal.....4 seconds

Location G. 7th signal.....2 seconds

Location H. 8th signal.....2 seconds

Location I. 9th signal.....2 seconds

Location J. 10th signal.....1 seconds

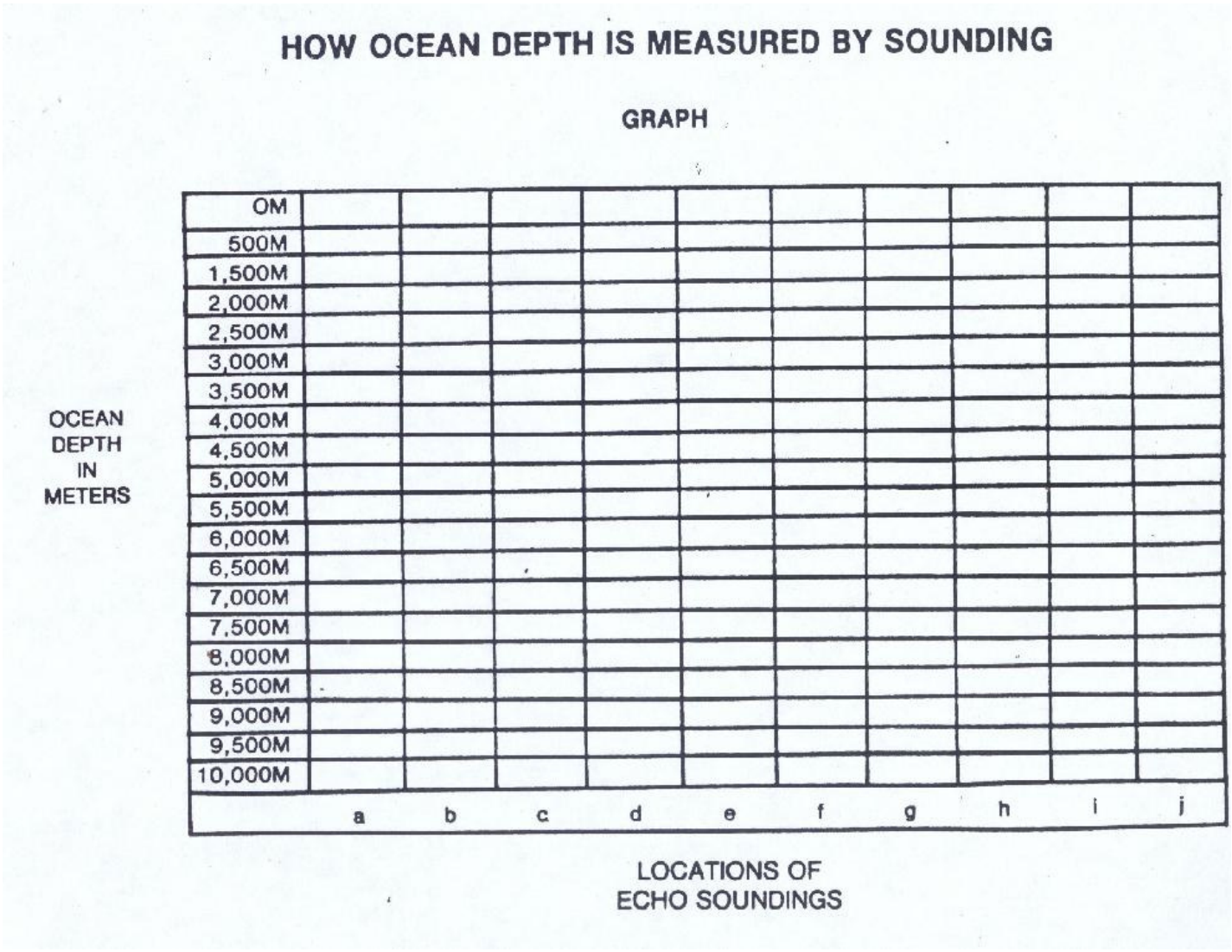
Find the depth at each location.

A_____ B_____ C_____

D_____ E_____ F_____

G_____ H_____ I_____ J_____

Use the supplied graph and draw a map of this part of the ocean's floor (topography)



Making and Ocean Profile

Imagine you are the sonar crew working with the world famous oceanographer, Captain Jacques Yves Cousteau of the sailing ship *Calypso.* Your scientific mission is to chart the Atlantic sea floor along 39°N latitude. You set sail from Atlantic City, New Jersey and traverse the mighty ocean to your destination in Lisbon, Portugal. Along the way, you use your sophisticated sonar to probe the unseen depths below. You collect a wealth of data on the depth of the ocean floor, which is in the table on the next page. Now, you will use that data to create a graph and profile of the ocean bottom. Good luck, and may the seas be kind to you...

Set up Your Graph Paper

Take time to make sure that your graph paper is properly set up. A well-designed graph includes the following:

1. A title that identifies your data
2. An x-axis and a y-axis
3. Axis labels including metric units
4. Well-chosen number scales along each axis

Here are some questions to help design your graph:

1. What data and label go along the x-axis?
2. What data and label go along the y-axis?
3. If we are plotting depth below the ocean surface, where should we put zero on the y-axis?

Plot Your Data

Plot each point in the data table on your graph. Once all of the points are plotted, connect the points with straight lines. This will give you a profile of the changing depth of the ocean as you travel along 39°N latitude in the Atlantic Ocean from west to east.

Analyze Your Data

Research ocean floor features in your textbook, in the library, on the Internet, or from your class notes. On your graph, identify and label the following features: *Continent, Continental Shelf, Continental Slope, Abyssal Plain, Mid-Ocean Ridge, Island,* and *Seamount.* Note that this traverse does not cross any *Trenches.*

Answer the Following:

1. What ocean floor structure occurs between 0 and 160 km east of New Jersey?_____

2. What ocean floor structure occurs between 160 and 1050 km east of New Jersey?_____

3. What ocean floor structure occurs between 1000 and 2000 km east of New Jersey?_____

4. What ocean floor structure occurs between 2000 and 3000 km east of New Jersey?_____

5. What is the scale of your x-axis? 1 unit =

6. What is the scale of your y-axis? 1 unit =

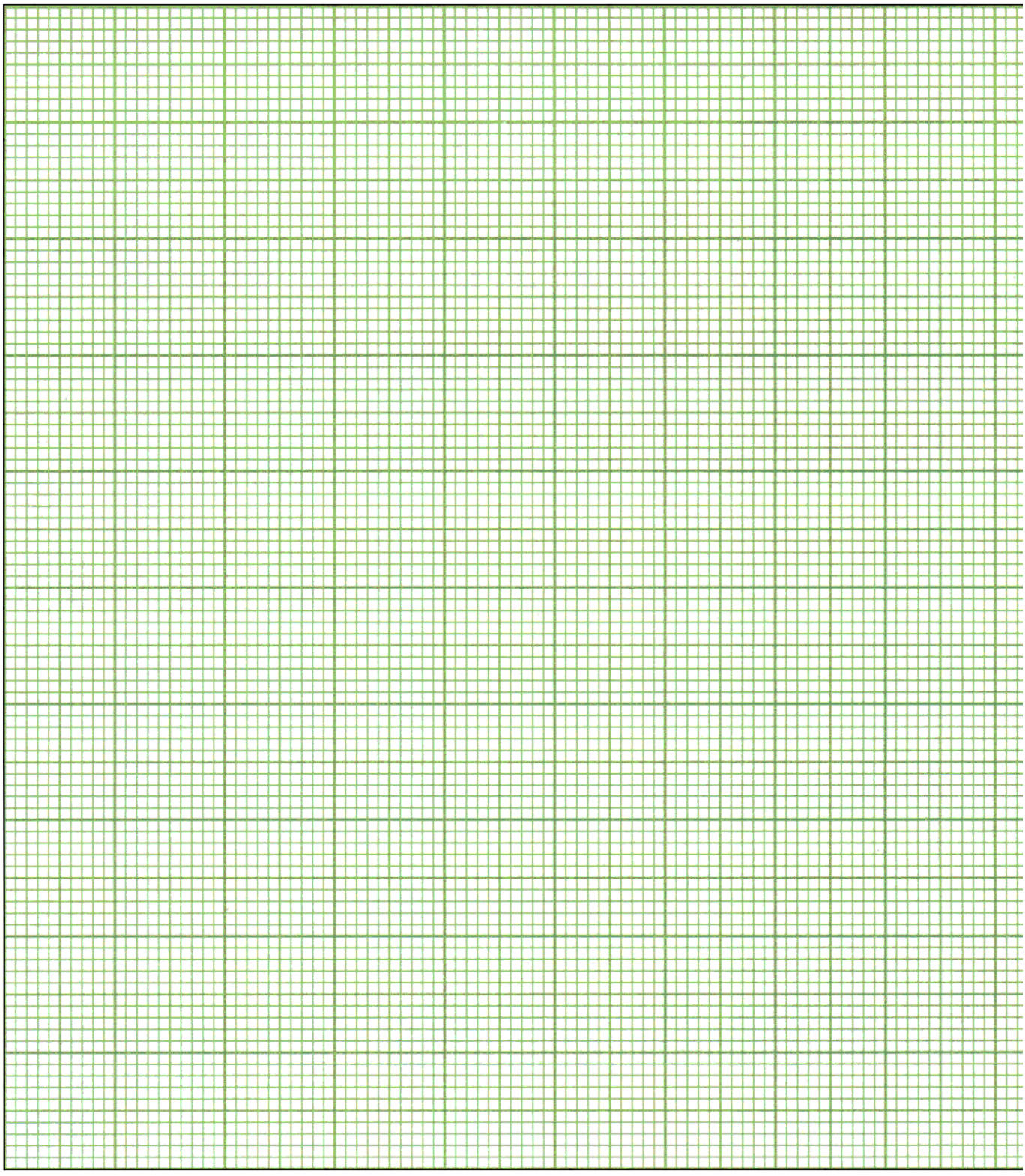
7. If you wanted to draw your profile to scale, the units and distances along both your x-axis and y-axis would have to be the same. Your profile as it is drawn now is exaggerated. To find the vertical exaggeration, divide your x-axis by your y-axis.

   What is the exaggeration?_____

8. If you drew your profile to scale, about how long a sheet of paper would you need?_____

Atlantic Ocean Profile Data along 39°N Latitude		
Sonar Reading	Distance from New Jersey (km)	Depth to Ocean Floor (m)
1	0	0
2	160	165
3	200	1800

4	500	3500
5	800	4600
6	1050	5450
7	1450	5100
8	1800	5300
9	2000	5600
10	2300	4750
11	2400	3500
12	2600	3100
13	3000	4300
14	3200	3900
15	3450	3400
16	3550	2100
17	3600	1330
18	3700	1275
19	3950	1000
20	4000	0
21	4100	1800
22	4350	3650
23	4500	5100
24	5000	5000
25	5300	4200
26	5450	1800
27	5500	920
28	5600	180
29	5650	75
30	5700	0



Profile of a Tropical Ocean

Tropical ocean waters have certain physical characteristics, which include temperature and salinity. These two characteristics are influenced by variables that act on the ocean waters. The variables include amount of sunlight received, proximity to the equator, and seasonal effects associated with precipitation and with the discharge of major river systems thousands of kilometers upstream. In addition, temperature and salinity depend on whether the waters are on or below the ocean surface.

Ocean water is 96.5 percent pure water and 3.5 percent dissolved solids, such as salt, and dissolved gases, such as oxygen. The amounts of these dissolved substances remain relatively constant. The salinity of ocean water is measured in terms of parts (solid material) per thousand of ocean water.

Water is considered the universal solvent. It can dissolve most substances, if only in very small amounts. Because some substances are very soluble in water, their concentration in the oceans of the earth is quite high. Approximately 95 percent of the dissolved solids in ocean water are six elements: chlorine, sodium, magnesium, sulfur, calcium, and potassium. The salts in ocean water come from the land and, to a lesser extent, from the evaporation of the ocean water.

Table 1 Salinity in the Warm Tropical Waters *Off* the Coast of Florida

Depth (meters)	Parts per Thousand	
	Minimum	Maximum
0	34.40	35.98
50	34.77	36.20
100	36.20	37.00
150	36.52	37.20
200	36.50	37.10
250	36.40	36.97
300	36.20	36.80
350	35.93	36.60
400	35.67	36.35
450	35.43	36.09
500	35.23	35.78
550	35.07	35.53
600	34.92	35.33
650	34.88	35.22
700	34.83	35.10
750	34.80	35.03
800	34.80	34.97
850	34.83	34.93
900	34.87	34.93
950	34.90	34.97
1000	34.97	35.00

1. What is the minimum salinity level at the ocean surface?_____

What is the maximum salinity level at the ocean surface?_____

2. What is the difference in salinity between the minimum and maximum levels at sea level?

3. What is the minimum salinity at a depth of 1000 meters?

How does it differ from the maximum salinity at the same depth?

4. How does the minimum salinity level vary between sea level and a depth of 1000 meters?

What might account for this difference?_____

The dissolved gases that warm ocean waters contain are mostly oxygen, carbon dioxide, and nitrogen. The concentration of these gases depends on their concentration in the atmosphere, their solubility, and the temperature and salinity of the ocean water.

Table 2 Dissolved Oxygen in the Warm Tropical Waters Off the Coast of Florida

Depth (meters)	Milliliters per Liter	
	Minimum	Maximum
0	4.32	5.41
50	4.31	5.25
100	4.18	5.26
150	3.96	4.91
200	3.88	4.71
250	3.90	4.42
300	3.92	4.29
350	3.79	4.25
400	3.50	4.13
450	3.17	3.95
500	3.02	3.71
550	2.92	3.58
600	2.90	3.46
650	2.92	3.24
700	2.92	3.33
750	3.00	3.37
800	3.08	3.50
850	3.25	3.63
900	3.37	3.83
950	3.58	4.28
1000	3.78	4.30

The most abundant gas dissolved in ocean water is nitrogen. It is of little importance to the plant and animal life in the earth's oceans, however. Oxygen enters ocean water through the process of photosynthesis, which is carried out by green plants in the ocean. Oxygen also enters the water from the atmosphere and from the rivers emptying into the ocean.

5. In what units is the amount of oxygen in ocean water measured?

6. At which level in the ocean is the amount of dissolved oxygen the greatest?

7. Scan the columns that show the amount of dissolved oxygen in ocean water. What happens to the amount of dissolved oxygen between sea level and a depth of 1000 meters?

8. What might account for this variation in the amount of dissolved oxygen in ocean water?

Solar energy and the properties of water itself determine the temperature of ocean water. Some scientists estimate that absorption of light energy accounts for more than 99 percent of the heat entering the sea. Only a small amount of the heat in the sea comes from the heat in the earth's interior. The amount of heat entering the sea is frequently equal to the amount of heat leaving the sea through the process of evaporation. Winds blowing over the ocean waters also cause the waters to cool off and evaporate. The range of temperatures in the ocean is one of the factors that causes ocean currents and influences the location of marine organisms. The temperature of ocean water, like the salinity, remains fairly constant. This consistency in temperature maintains a balance in marine life and exerts a steady influence along the shoreline of neighboring land areas.

9. What factors influence the temperature of ocean water?

10. How does the temperature of the tropical ocean water influence people living in Florida?_____

Table 3 Temperature in the Warm Tropical Waters Off the Coast of Florida

	Temperature (°C)											
Depth (meters)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	26.5	26.2	26.2	26.5	27.5	27.9	28.2	28.4	28.8	29.2	28.6	27.6
10	26.5	26.2	26.2	26.5	27.5	27.9	28.2	28.3	28.8	29.0	28.6	27.5
20	26.5	26.2	26.2	26.3	27.5	27.9	28.1	28.3	28.6	29.0	28.6	27.5
30	26.4	26.2	26.1	26.3	27.3	27.8	28.1	28.2	28.6	28.8	28.7	27.7
40	26.3	26.2	25.9	26.5	27.3	27.8	28.1	28.0	28.4	28.8	28.8	27.9
50	26.2	26.2	25.8	26.5	26.7	27.5	27.9	27.9	27.5	28.7	28.4	27.6
60	26.0	26.2	25.7	26.4	26.3	27.2	27.4	27.6	27.0	27.9	27.6	27.4
70	26.1	26.2	25.7	25.8	25.8	26.6	26.9	26.8	26.6	27.0	26.9	27.0
80	25.9	26.0	25.4	25.8	25.3	25.9	26.2	26.0	26.2	26.3	26.3	26.0
90	25.6	25.6	25.5	25.3	25.0	25.4	25.8	25.6	25.5	25.5	25.6	25.5
100	25.3	25.5	25.1	25.0	24.6	25.0	25.2	25.0	25.1	25.5	24.7	24.9
150	22.3	22.9	22.8	22.8	22.0	22.0	22.6	22.0	22.8	22.9	22.5	22.0
200	19.9	20.0	20.1	19.8	19.5	19.7	20.2	20.1	20.0	20.3	19.7	19.5
250	18.0	18.1	18.3	17.9	18.2	17.9	18.1	18.0	18.2	18.4	17.8	17.5
300	16.9	17.0	16.9	16.6	16.5	16.8	16.8	16.9	17.0	17.0	16.9	16.4
350	16.0	15.7	15.6	15.6	14.9	15.5	15.5	15.5	15.8	15.8	15.4	15.1
400	14.3	14.1	14.2	14.4	13.7	14.1	14.2	14.2	14.3	14.1	14.0	14.1
450	13.5	12.9	12.9	13.2	12.3	12.6	13.0	12.9	13.0	13.1	13.0	12.8
500	12.6	11.6	11.8	11.2	11.5	10.8	11.8	11.9	12.0	12.3	11.2	11.8
600	10.0	10.0	9.5	9.4	9.5	9.5	9.5	9.6	9.8	9.8	9.5	10.0
700	7.9	8.0	7.7	7.7	7.7	8.0	7.9	8.0	8.0	8.2	7.9	8.2
800	6.5	6.5	6.6	6.6	6.4	6.6	6.4	6.6	6.7	6.6	7.0	6.9
900	5.8	6.1	5.9	5.9	5.8	5.8	5.9	5.9	5.9	6.0	6.1	6.0
1000	5.2	5.3	5.3	5.3	5.3	5.3	5.2	5.4	5.2	5.3	5.3	5.3

11 00	4.8	4.9	4.9	4.9	4.9	4.8	4.9	4.9	4.9	4.8	4.8	4.8
1200	4.6	4.6	4.7	4.6	4.6	4.5	4.5	4.6	4.5	4.7	4.6	4.5
1 300	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.4
1 400	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.4	4.3	4.3
1 500	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.3	4.2	4.2

11. What is the warmest water temperature at sea level?_____

12. During which month is the surface water of the ocean the warmest?_____

13. What is the greatest range in ocean temperature from the surface to a depth of 1500 meters?

14. During which month(s) is the ocean temperature the coolest?

What would account for these temperatures?

15. What is the average temperature of ocean water at sea level for the year?

16. What factors might account for the fact that ocean temperature does not vary at a depth of 1500 meters?