

Teaching Activity: Climate Change and Sea Level

Background: If global temperature increases, many scientists have indicated that an increase in sea level is one of the most likely secondary effects. Two factors will contribute to this accelerated rise in sea level. First, although the oceans have an enormous heat storage capacity, if global atmospheric temperatures rise, the oceans will absorb heat and expand (thermal expansion) in the ocean basins leading to a rise in sea level. Second, warmer temperatures will cause the ice and snow fields to melt, thereby increasing the amount of water in the oceans. It should be noted that only the melting of land-based ice and snow fields (i.e., ice fields of Antarctica and mountain glaciers) will increase sea level. The melting of floating ice (i.e., the North Polar ice cap) will not affect sea level.

Throughout the Earth's history there have been periods of glaciation followed by warming trends in which the glaciers retreated toward higher altitudes and higher latitudes. At present, glaciers throughout the world are receding and the masses of ice at both polar regions appear to be shrinking. The present interglacial warming period began approximately 14,000 years ago. At that time, sea levels were 75-100 meters below their present levels. As the massive snow and ice fields of the world began to melt, sea level rose rapidly at rates of as much as 1 meter per century. Over time, the rate of sea level rise declined to the present rate of 10-15 cm a century. An accelerated rise in sea level would inundate coastal wetlands and lowlands, increase the rate of shoreline erosion, exacerbate coastal flooding, raise water tables, threaten coastal structures, and increase the salinity of rivers, bays and aquifers. Even though sea level rise is considered to be one of the more likely effects of global warming there is still no scientific certainty as to the rate or amount of sea level rise.

Objective:

- To describe the change in water level when water is exposed to heat;
- To differentiate between thermal expansion and melting snow and ice fields as they relate to sea level rise;
- To predict the impact of rising sea level on coastal areas;

Important Terms: Sea level rise, thermal expansion, land based ice fields, floating ice caps;

Materials: For each team of students: Conical glass flask, two hole cork for flask, thin, glass tube, long thermometer, portable, clamp-on reflector lamp, 150 watt floodlight, dye (Any color), graph paper, ruler, paper/pencil;

Procedure:

1. Divide students into teams of 3-4.
2. Instruct students to fill the flask completely with very cold water (Note: To improve visibility, add dye).
3. Students should fit the cork stopper in the flask.
 - The thermometer and glass tube should be slid into the holes in the cork stopper. (See Figure 1 below.)

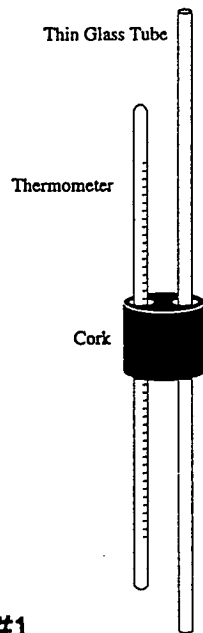


Figure #1

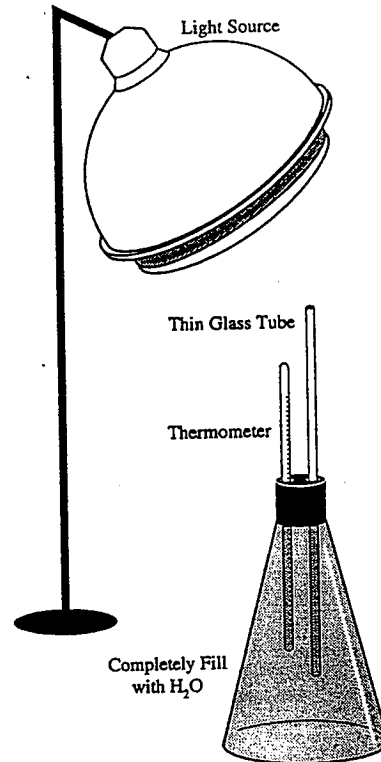


Figure #2

4. The water should rise a short way into the tube.
 - Instruct students to observe closely everything that occurs and record it on their lab sheets in both written form and as a drawing.
 - Students should also record both the temperature and the level of rise of the water in the tube.
5. Ask students to predict what they think will happen when the water in the flask is exposed to heat.
 - Students should record their predictions on their lab sheets.
6. Instruct students to turn on their heat lamps and begin to record the temperature every 2 minutes. (See figure 2 above.)
 - Students should record the temperature on the Data Table.
7. Instruct students to observe the level of the water in the tube and record those change in their lab sheets.

8. Instruct students to create a line graph of the data acquired in the thermal expansion activity they just conducted.
 - Review the basic steps for creating the line graph if necessary.
9. Students should complete the answers to the questions in the *Analysis and Conclusions* section.

Analysis and Conclusions:

1. Why did the level of water in the flask change?
Answer: As water warms, it expands.
2. What implications does this experiment suggest might occur if the oceans warm?

Answer: If the ocean temperatures warm sufficiently to cause expansion, sea level would rise, thus inundating coastal wetlands and other coastal low-lying areas,

3. If global warming is not sufficient to cause significant snow and ice melt, would you expect this thermal expansion to be enough to cause coastal flooding and erosion?
Answer: No, it will likely be enough to measure, but not enough to cause significant coastal problems.

4. Which would you expect to have a greater affect on sea level- the melting of the North Polar or South Polar ice caps? Would it make a difference? Why?

Answer: North Polar ice melting would have4 little effect on sea level. That ice is already floating, therefore, displacing its volume in water. If the South Polar ice cap melted, the water would run off the Antarctic continent into the ocean, increasing the ocean volume (and sea level) substantially.

Extensions:

- Have students design an experiment or demonstration to test the idea discussed in question #4.
- Challenge the class to consider the possible impacts of sea level rise in areas such as South Florida or Bangladesh.
 - Pairs of students should prepare research projects and report back to the class.]

Student Activity Sheet: Climate Change and Sea Level

Background: If global temperature increases, many scientists indicate that an increase in sea level is one of the most likely secondary effects. Two factors will contribute to this accelerated rise in sea level. First, although the oceans have an enormous heat storage capacity, if global atmospheric temperatures rise, the oceans will absorb heat and expand (thermal expansion) leading to a rise in sea level. Second, warmer temperatures will cause the ice and snow fields to melt, thereby increasing the amount of water in the oceans. It should be noted that only the melting of the land based ice and snow fields (i.e., the ice fields of Antarctica and mountain glaciers) will increase sea level. The melting of floating ice (i.e., North Polar ice cap) will not affect sea level.

Throughout the Earth's history there have been periods of glaciation followed by warming trends in which the glaciers retreated toward higher altitudes and latitudes. At present, glaciers throughout the world are receding and the masses of polar ice at both polar regions appear to be shrinking. The present interglacial warming period began approximately 14,000 years ago. At that time, sea levels were 75 to 100 meters below present levels. As the massive snow and ice fields of the world began to melt, sea level rose rapidly at rates of as much as 1 meter per century. Over time the rate of sea level rise has declined to the present rate of approximately 10-15 cm per century.

Task: You will conduct an experiment that will demonstrate the effects of thermal expansion on water level. Discussion groups will follow this activity as you explore the potential impact of sea level rise on a global and local scale.

Materials: For each team: A conical glass flask, two-hole cork for the flask, thin, glass tube, long thermometer, portable, clamp-on reflector lamp, 150-watt floodlight, dye, graph paper, ruler, paper/pencil;

Procedure:

1. Working with your team, completely fill the flask with very cold water (for increased visibility, add some dye to the water.)
2. Place the cork into the top of the flask. Slide the thermometer and the glass tube in the holes in the cork. (See Figure 1.)

Figure #1

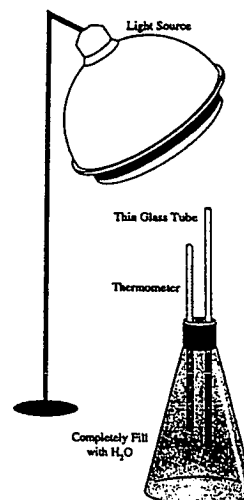
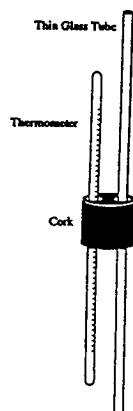


Figure #2

- The water should rise a short way in the tube. Draw what you see happening in the space below.

- Record both the temperature of the water and the water level in the tube in the **Data Table**.
3. What do you think will happen when the water in the flask is exposed to heat? Write your answer in the space below.
 4. Place the flask with the water in it under the heat lamp (See Figure 2).
 - Turn on the lamp and record the temperature and water level measurements every two minutes on the **Data Table**.
 5. Create a line graph of the data your recorded on the Data Table.
 - Review the process for setting up the graph with the teacher.
 6. Answer the questions in the *Analysis and Conclusions* section.

Analysis and Conclusions:

1. Why did the level of water in the flask change?
2. What implications does this experiment suggest might occur if the oceans warm?
3. If global warming is not sufficient to cause significant snow and ice melt, would you expect this thermal expansion to be enough to cause coastal flooding and erosion problems?
4. Which would you expect to have a greater affect on sea level- the melting of the North Polar or South Polar ice caps? Would it make a difference? Why?

