Pinniped BODY SHAPE
Does it conserve warmth?

How are pinnipeds adapted to living in cold water?

ACTIVITY

Activity Overview

To survive in cold ocean environments an organism's body must be adapted to life under water. A body will cool very quickly when in contact with water. The body shape of an organism is one adaptation that helps to conserve warmth.

You will learn how a pinniped's body shape is adapted to conserve warmth by simulating pinniped and human body shapes using plastic or latex gloves. You will use a Temperature Sensor to measure and graph changes in temperature of a pinniped body and a human body when plunged into ice water. The temperature sensors are connected to a TI CBL 2™ or Vernier LabPro and a TI-73 Explorer™.

Are pinnipeds shaped to conserve heat? How does a pinniped's body shape conserve warmth? What effect does surface area have on ability to conserve warmth?

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Procedure

1 Make the bodies.

a. Use a string to tie off the fingers of one of the gloves. This will be the *Pinniped Body*; the other glove will be the *Human Body*.

2 Get the ice water ready.

a. Fill a plastic tub with some ice cubes and enough cold tap water to dip in the *Pinniped Body* and *Human Body* at the same time.

3 Connect the Temperature Sensors to the CBL 2™or Vernier LabPro and TI-73 Explorer™.

a. Plug the Temperature Sensor for the *Pinniped Body* into Channel 1 of the CBL 2™ or Vernier LabPro.
b. Plug the Temperature Sensor for the *Human Body* into Channel 2 of the CBL 2™ or Vernier LabPro.
c. Use the link cable to connect the TI-73 Explorer™ to the interface.
d. Firmly press in the cable ends.

4 Set up the TI-73 Explorer™.

a. Turn on the TI-73 Explorer™ and start DATAMATE. (For instructions on DATAMATE see Appendix A.)
b. Press [CLEAR] to reset the program.

5 Set Up the Data

a. Select SETUP from the MAIN SCREEN by pressing [1].
b. If the TI-73 displays a temperature sensor in CH 1 and CH 2 then press [1] to return to the MAIN SCREEN and proceed to STEP 6. If not, continue with this step to set up the sensors manually.
   - Press [ENTER] to select CH1.
   - Select TEMPERATURE from the SELECT SENSOR MENU by pressing the number to the left.
   - Select the correct Temperature Sensor (in °C) from the TEMPERATURE MENU
   - To select CH 2, press [▼] once, then press [ENTER].
   - Select TEMPERATURE from the SELECT SENSOR MENU.
   - Select the correct Temperature Sensor (in °C) from the TEMPERATURE MENU.
   - Press [1] to return to the MAIN SCREEN

Materials*

- TI-73 Explorer™
- TI CBL 2™ or Vernier LabPro
- TI-73 DataMate
- 2 Temperature Sensors
- Plastic tub (about 30 cm X 60 cm)
- Ice cubes
- Cold tap water
- Warm tap water
- Stopwatch
- 2 Plastic or latex gloves
- String

TI-73 Explorer™

Temperature Sensor

* This activity has been written for the TI-73 Explorer™ but you can easily substitute the TI-83 or TI-83 Plus. Also see Appendix A for steps on how to transfer DataMate to your graphing device and how to use DataMate for data collection.

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6 Set Up the Graph

a. Select SETUP from the MAIN SCREEN by pressing 1.
b. Select MODE. Use the arrow keys (▲, ▼) to move the cursor next to MODE and press ENTER.
c. Press 2 to select TIME GRAPH from the SELECT MODE MENU.
d. Press 2 to select CHANGE TIME SETTINGS from the GRAPH SETTINGS MENU.
e. Enter 2 as the time between samples in seconds, and press ENTER.
f. Enter 120 as the number of samples, and press ENTER. Data will be collected for 240 seconds (4 minutes).
g. Press 1 to return to the SETUP SCREEN
h. Press 1 to return to the MAIN SCREEN

7 Adjust the Scale on the Time Graph

a. Select SETUP from the MAIN SCREEN by pressing 1.
b. Select MODE. Use the arrow keys (▲, ▼) to move the cursor next to MODE and press ENTER.
c. Press 2 to select TIME GRAPH from the SELECT MODE MENU.
d. Press 3 to select ADVANCED from the GRAPH SETTINGS MENU to adjust the scale on the TIME GRAPH.
e. Press 2 to select CHANGE GRAPH SETTINGS from the ADVANCED GRAPH SETTINGS menu.
f. Press 1 to select CH1-TEMP.
g. Enter −5 for Ymin=? by pressing (−) 5. Then press ENTER.
h. Enter 30 for Ymax=?, and press ENTER.
i. Enter 1 for Yscl=?, and press ENTER.
j. Press 2 to select CHANGE GRAPH SETTINGS from the ADVANCED GRAPH SETTINGS menu.
k. Press 2 to select CH2-TEMP.
l. Enter −5 for Ymin=? by pressing (−) 5. Then press ENTER.
m. Enter 30 for Ymax=?, and press ENTER.
n. Enter 1 for Yscl=?, and press ENTER.
o. Press 1 to select OK to return to TIME GRAPH SETTINGS.
p. Press 1 to select OK to return to the SETUP SCREEN.
q. Press 1 to select OK to return to the MAIN SCREEN.

8 Collect your temperature data

a. Measure equal amounts of warm water and pour them into the *Pinniped Body* and the *Human Body*.
b. Secure a Temperature Sensor in each body. Make sure the tip of the Temperature Sensor is in the middle of the bodies.
c. Using a string, tie off each glove around the Temperature Sensor.
d. Plunge the bodies into the ice water. *Note: You may need to add more ice cubes into the ice water.*
e. Press 2 on the TI-73 Explorer™ to begin data collection.
f. At the end of the 240-second time period, a graph is displayed representing the change in temperature for both gloves.

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9 Complete the Data Analysis section. Answer the questions in your journal.

↺ *To collect your temperature data again, press ENTER to return to the main screen, warm up the Temperature Sensors in your hands until they read the same temperature (greater than 25º C) and repeat Step 8.*

Data Analysis

1 Draw a sketch of the graph created by your graphing device. Label *Pinniped Body* the curve that represents the temperature for the pinniped glove. Label *Human Body* the curve that represents the temperature for the human glove. *(Note: P1 represents the sensor connected to CH1 and P2 represents the sensor connected to CH2).*

2 By observing your graph how does the temperature in the *Pinniped Body* change during the four-minute period?

3 By observing your graph how does the temperature in the *Human Body* change during the four-minute period?

4 Copy Table 1 into your journal.

Table 1

	A **Temperature at the beginning of Experiment (°C)**	**B** **Temperature at the end of Experiment (°C)**	**A-B** **Change in Temperature (°C)**
Pinniped Body			
Human Body			

Use the left and right arrow keys (◄, ►) to move the cursor along a curve. Use the up and down arrow keys (▼, ▲) to move the cursor from one curve to the next. The time (x) and temperature (y) values of each data point are displayed below the graph. The matching Sensor number for each curve is displayed in the upper right corner of the screen

5 Record the temperature of each glove at the beginning of the experiment in Column A of the table (x = 0).

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6 Record the temperature of each glove at the end of the experiment in Column B of the table (x = 240).

7 Find the change in temperature by subtracting Column B from Column A (A-B). Record the change in temperature for each glove in Table 1.

8 Which body shape had the greatest change in temperature?

9 Which body shape had the least change in temperature?

10 A body shape with nooks and crannies will have a greater surface area than a body shape that does not have nooks and crannies. Which body shape had a greater surface area, *Pinniped Body* or *Human Body*? Explain.

11 Knowing that you added equal amounts of water to both gloves, what caused the different rates of cooling in the *Pinniped Body* and *Human Body?*

12 Human bodies have arms and legs while pinniped bodies lack these body parts. Explain how this adaptation helps keeps a pinniped warm?

13 If the experiment was an hour long rather than 4 minutes long, what do you think would have happened to the temperature of the ice water, the *Pinniped Body*, and the *Human Body*?

14 Based on your data, which will keep your hands warmer, gloves or mittens? Explain.