

How do PINNIPEDS stay warm?

How are pinnipeds adapted to living in cold water?

ACTIVITY



Activity Overview

Pinnipeds and other animals that live in cold regions have adapted to extreme weather conditions by developing layers of insulation materials. For example, pinnipeds use blubber, birds use feathers, and sheep use wool.

In this activity, you will perform an experiment to explore how different types of insulation materials work. You will make mitts from plastic bags filled with shortening (simulating blubber), feathers, and wool. You will also make a mitt filled with air. You will observe the effects of different insulation materials by placing your hands in the mitts and then putting them into ice water.

After making your initial observations, you will measure and graph the temperature changes in each mitt using a Temperature Sensor connected to a TI CBL 2™ or Vernier LabPro and a TI-73 Explorer™. You will then compare the measured changes with the differences in temperature you were able to feel with your hands inside the mitt.

How are pinnipeds adapted to living in cold water? Which type of insulation material works the best?



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Part A. Making Observations

Procedure

1 Make the mitts.

- Blubber mitt:** Fill a plastic Ziploc® bag 1/3 full of shortening. Turn a second plastic Ziploc® bag of the same size inside out and insert it into the bag with shortening. Align the Ziploc® tops and zip the two bags together (or use duct tape to seal the seam), trapping the shortening between the two bags.
- Air mitt:** Using two plastic Ziploc® bags of the same size, repeat the above procedure without the shortening, trapping only a bit of air between the two bags.
- Feather mitt:** Cut the feathers into small pieces. Fill a plastic Ziploc® bag 1/3 full with the feathers. Turn a second plastic Ziploc® bag of the same size inside out and insert it into the bag with the feathers. Squeeze the bags to force out as much air as possible. Align the Ziploc® tops and zip the two bags together (or use duct tape to seal the seam), trapping the feathers between the two bags.
- Wool mitt:** Cut the wool yarn into small pieces. Fill a plastic Ziploc® bag 1/3 full with the wool yarn. Turn a second plastic Ziploc® bag of the same size inside out and insert it into the bag with the wool. Squeeze the bags to force out as much air as possible. Align the Ziploc® tops and zip the two bags together (or use duct tape to seal the seam), trapping the wool yarn between the two bags.

2 Get the ice water ready.

- Fill a plastic tub with some ice cubes and cold tap water. The tub should be large enough to dip in two mitts at the same time.

3 Experience how the insulating layers work.

- Put one hand into the blubber mitt and one hand in the air mitt. Place both mitts into the ice water at the same time.
- Leave both hands in the ice water for at least one minute. A classmate will use the stopwatch to record the time.
- Note which hand feels colder first.
- Remove the mitts from the ice water and take your hands out.

Note: You may choose to compare other combinations of mitts such as feathers and wool.

Part B. Measuring Temperature in the Blubber and Air Mitts

Procedure

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

- Plug the Temperature Sensor for the blubber mitt into Channel 1 of the CBL 2™ or Vernier LabPro.
- Plug the Temperature Sensor for the air mitt into Channel 2 of the CBL 2™ or Vernier LabPro.
- Use the link cable to connect the TI-73 Explorer™ to the interface.
- Firmly press in the cable ends.

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Materials*

- TI-73 Explorer™
- TI CBL 2™ or Vernier LabPro
- TI-73 DataMate
- 2 Temperature Sensors
- 4 1-quart Ziploc® bags
- Vegetable Shortening, Wool Yarn, Feathers
- Plastic tub (about 30 cm X 60 cm)
- Ice cubes
- Cold tap water
- Stopwatch



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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2 Set up the TI-73 Explorer™.

- Turn on the TI-73 Explorer™ and start the DATAMATE application. (For instructions on DATAMATE see Appendix A.)
- Press **CLEAR** to reset the program.
- Select SETUP from the MAIN SCREEN by pressing **1**.
- 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 3. 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

3 Set Up the TI-73 Explorer™ for Data Collection

- Select SETUP from the MAIN SCREEN by pressing **1**.
- Select MODE. Use the arrow keys (**↑**, **↓**) to move the cursor next to MODE and press **ENTER**.
- Press **2** to select TIME GRAPH from the SELECT MODE MENU.
- Press **2** to select CHANGE TIME SETTINGS from the GRAPH SETTINGS MENU.
- Enter 2 as the time between samples in seconds, and press **ENTER**.
- Enter 120 as the number of samples, and press **ENTER**. Data will be collected for 240 seconds (4 minutes).
- Press **1** to return to the SETUP SCREEN
- Press **1** to return to the MAIN SCREEN

4 Adjust the Scale on the Time Graph

- Select SETUP from the MAIN SCREEN by pressing **1**.
- Select MODE. Use the arrow keys (**↑**, **↓**) to move the cursor next to MODE and press **ENTER**.
- Press **2** to select TIME GRAPH from the SELECT MODE MENU.
- Press **3** to select ADVANCED from the GRAPH SETTINGS MENU to adjust the scale on the TIME GRAPH.
- Pressing **2** to select CHANGE GRAPH SETTINGS from the ADVANCED GRAPH SETTINGS menu.
- Press **1** to select CH1-TEMP.
- Enter -5 for Ymin=? by pressing **←** **5**. Then press **ENTER**.
- Enter 30 for Ymax=?, and press **ENTER**.
- Enter 1 for Yscl=?, and press **ENTER**.



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- 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.

5 Collect your temperature data.

Important: The mitts need to be at room temperature before starting the data collection. Wait for at least 10 minutes after completing Part A before collecting your temperature data.

- a. Secure a Temperature Sensor in each mitt. Make sure that the tip of the sensor is in the center of the mitt. Be careful not to puncture the plastic bag with the sensor.
- b. Dip the mitts into the ice water. *Note: You may need to add more ice cubes into the ice water to make sure that you start with about the same temperature as in Part A.*
- c. Press **[2]** on the TI-73 Explorer™ to begin data collection.
- d. At the end of the 240-second time period, a graph is displayed representing the change in temperature for each mitt.

6 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 25° C) and repeat Step 5.*

Data Analysis

- 1** Draw a sketch of the graph created by your graphing device. Label *Blubber* the curve that represents the temperature for the blubber mitt. Label *Air* the curve that represents the temperature for the air mitt. (*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 blubber mitt change during the four-minute period?
- 3** By observing your graph how does the temperature in the air mitt change during the four-minute period?



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- 4 Copy Table 1 into your journal.

Table 1

	A	B	A-B
	Temperature at the beginning of Experiment (°C)	Temperature at the end of Experiment (°C)	Change in Temperature (°C)
Blubber mitt			
Air mitt			
Feather mitt			
Wool mitt			

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 the blubber and air mitts at the beginning of the experiment in Column A of the table (x = 0 seconds).
- 6 Record the temperature of the blubber and air mitts at the end of the experiment in Column B of the table (x = 240 seconds).
- 7 How does your data compare to which hand felt colder when you first made observations with the mitts in your hands?

Part C. Measuring Temperature in the Feather and Wool Mitts

Procedure

- 1 Collect your temperature data.

Important: The mitts need to be at room temperature before starting the data collection. Wait for at least 10 minutes after completing Part A before collecting your temperature data.

- Secure the Temperature Sensor from Channel 1 in the feather mitt. Make sure that the tip of the sensor is in the center of the mitt.
- Secure the Temperature Sensor from Channel 2 in the wool mitt. Make sure that the tip of the sensor is in the center of the mitt.
- Dip the mitts into the ice water. *Note: You may need to add more ice cubes into the ice water to make sure that you start with about the same temperature as in Part A and Part B.*
- Press **2** on the TI-73 Explorer™ to begin data collection.
- At the end of the 240-second time period, a graph is displayed representing the change in temperature for each mitt.

- 2 Complete the Data Analysis section. Answer the questions in your journal.



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Data Analysis

- 1 Draw a sketch of the graph created by your graphing device. Label *Feather* the curve that represents the temperature for the feather mitt. Label *Wool* the curve that represents the temperature for the wool mitt. (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 feather mitt change during the four-minute period?
- 3 By observing your graph how does the temperature in the wool mitt change during the four-minute period?

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

- 4 Record the temperature of the feather and wool mitts at the beginning of the experiment in Column A of Table 1 in your journal ($x = 0$ seconds).
- 5 Record the temperature of the feather and wool mitts at the end of the experiment in Column B of Table 1 in your journal ($x = 240$ seconds).
- 6 Find the change in temperature by subtracting Column B from Column A (A-B). Record the change in temperature for each mitt (blubber, air, feather, and wool) in Table 1.
- 7 Using Table 1, which mitt had the greatest change in temperature?
- 8 Using Table 1, which mitt had the least change in temperature?
- 9 Based on your data, which insulating material worked the best? Explain.
- 10 Based on your data, and information from the Research Article, describe how pinnipeds are adapted to living in cold water.

