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Calibrating Thermometers

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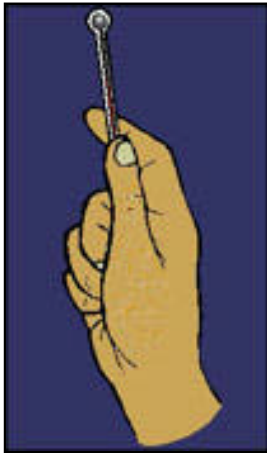
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Calibrating Thermometers Introduction

Discovery Question: How can I make sure my thermometer is providing a true reading?



In this activity you will calibrate and scale a thermometer.

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Thinking About the Question

How can I make sure my thermometer is providing a true reading?

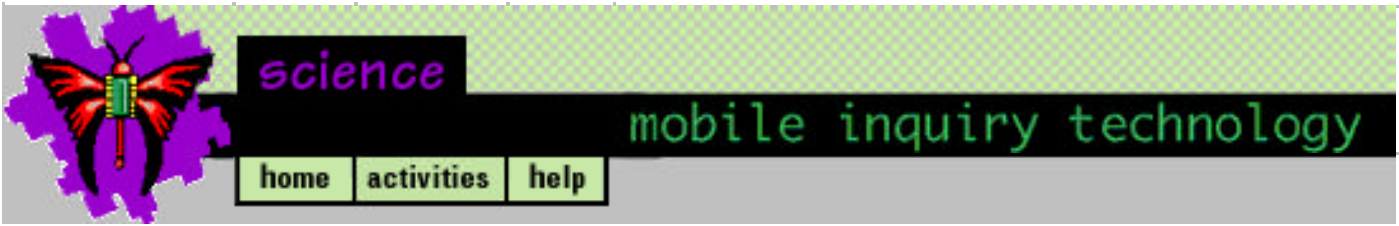
When you want to know how tall you are, you use a ruler to measure your height. The scale that is used to measure height is in feet or meters. If you want to know how much you weigh, a scale is used in pounds or kilograms. We need a "scale" to measure amounts of a specific desired quantity.

When you stand on the bathroom scale, do you accept its reading as true? How do you know that the scale on your furnace or air conditioning thermostat is registering the correct value? You use scales everyday. A true scientific instrument needs to be tested and registered at two known values to provide you with an accurate reading.

Think about your earlier class discussion about the temperature scale. Discuss with your group your ideas for determining the accuracy of your three measuring tools. This process is known as calibration.

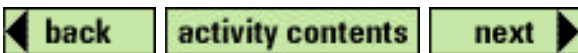
Go to "Investigating the Question" to see how to calibrate your thermometer.





Calibrating Thermometers Materials

- unmarked thermometer (available from Science Kit & Boreal Laboratories - thermometer blanks - Catalog Number 63351-00)
- marked standard Celsius thermometer
- boiling water (to be used only by the teacher)
- hot plate and container suitable for boiling water
- Styrofoam cups
- ice water (at least 250 ml per group)
- temperature probe
- water at varying temperatures (at least 250 ml per group)
- small cork - number 5 (for holding the unmarked thermometer)
- nail (around 20 D in size)
- fork (to hold the cork)
- permanent fine point Sharpie markers (one for each group)
- metric ruler





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Calibrating Thermometers Safety

The unmarked thermometers are made of glass. Care should be taken to not shatter or drop them.

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Calibrating Thermometers Investigation I

Testing an unmarked thermometer in freezing and boiling water



1. Watch your teacher demonstrate how to use the temperature probe. Refer to [Technical Hints](#) to see how to use the DataLogger software to record temperature.
2. Watch as your teacher places a standard thermometer in the boiling water. Note the reading on the standard thermometer. Did the thermometer read as you expected? Next, watch as your teacher places the unmarked glass tube in the boiling point of water. Your teacher will mark the level to which the liquid rises. Notice that the teacher is using a fine point pen to provide a small mark locating the boiling point. What Celsius value does this represent? Discuss with your group why this is necessary.
3. Your teacher will now place your temperature probe in the boiling water while running the DataLogger software on your computer. Refer to [Technical Hints](#) to see how to view data. Compare the predicted value of the boiling point with that provided by the probe.
4. Place the marked thermometer in a container of ice water. Wait until the liquid inside the thermometer stops falling. Note the temperature. Is it what you expected? Place the unmarked thermometer with cork in a container of ice water. Once the thermometer stabilizes, mark very carefully the freezing point of the ice water. What Celsius value does this represent? Next, place the temperature probe in the ice water while running the DataLogger software on your computer. Compare the predicted value of the freezing point with that provided by the probe.

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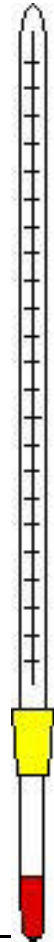
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Calibrating Thermometers Investigation II

Creating a scale on your thermometer



Now that you have identified the boiling and freezing point, how could you mark the other points between these two known points?

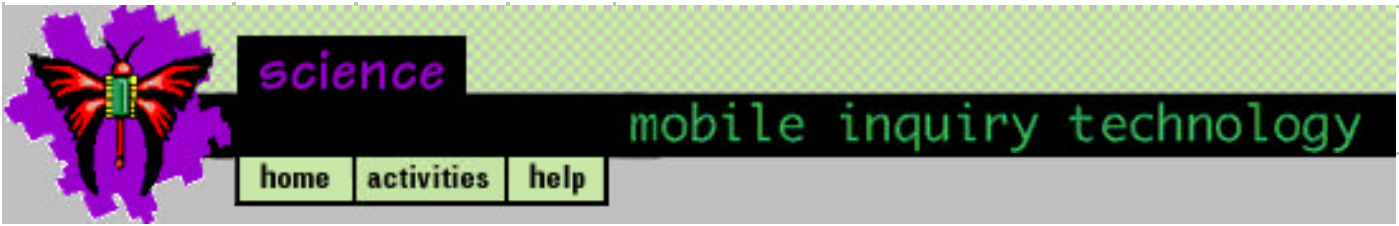
The Celsius scale is set to 100 equal divisions (degrees) between the freezing and boiling points. Does your thermometer present any difficulties in making accurate markings?

How many divisions could you make, and still be sure that they are accurate? Discuss these questions with your group and present your ideas to the class.

After you have discussed and agreed on a plan for marking the thermometer with your class, mark the thermometer.

Answer questions 1 and 2 in "Analysis".

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Calibrating Thermometers Investigation III

Testing different temperatures with your thermometer and temperature probe

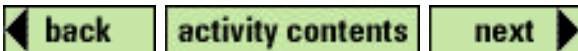
Create a spreadsheet to record your data and data of other groups. Refer to [Technical Hints](#) to see how to create a spreadsheet.

Obtain a Styrofoam cup of warm water from your teacher. The water will lose heat, so it is important to quickly take the temperature of your water with the your thermometer and temperature probe. It is suggested to test for a 1 minute period of time to allow the temperature probe to adjust to the temperature. Record the values on a spreadsheet.

Since every group in the class received a cup of water at the same temperature, ask another group for their readings. Record their values on the spreadsheet.

Repeat the process for two more trials at different temperatures. Record your results and that of another group on your spreadsheet. Find an average temperature value for the 1 minute period. Refer to [Technical Hints](#) to see how to find an average. Create a bar chart of all of the temperatures. Refer to [Technical Hints](#) to see how to create a bar chart. How did your readings compare to that of the other group?

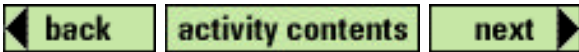
Answer questions 3-6 in "Analysis".





Calibrating Thermometers Technical Hints

- [Using the DataLogger software to record temperature](#)
- [Viewing data](#)
- [Creating a spreadsheet](#)
- [Transferring data to the spreadsheet](#)
- [Finding an average](#)
- [Creating a bar chart](#)

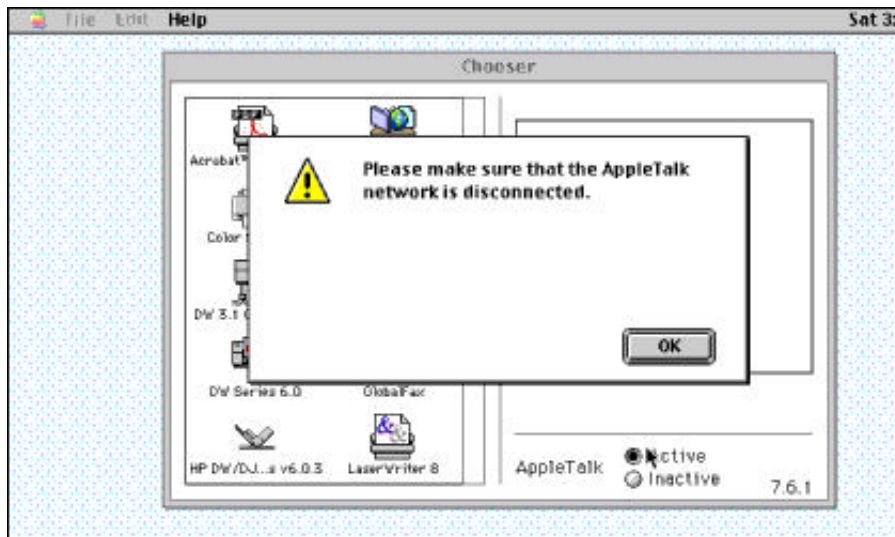




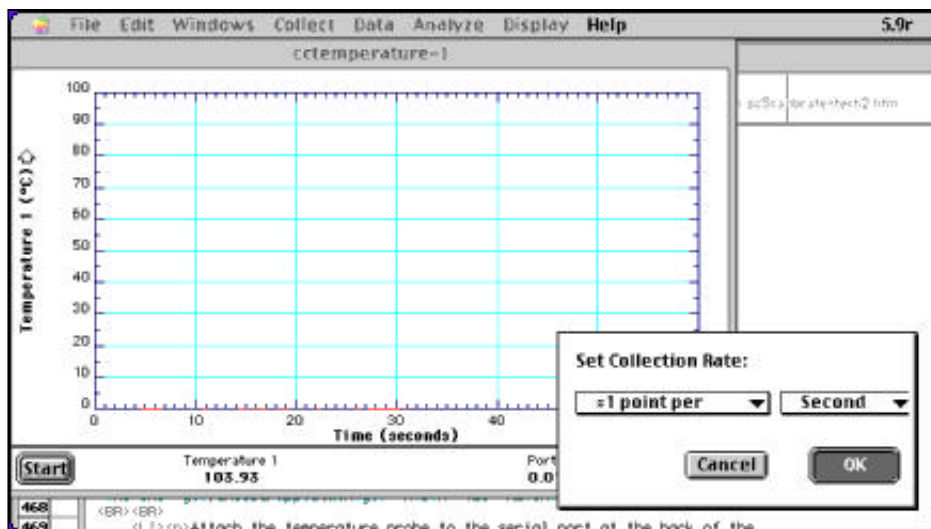
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To use the DataLogger software to record temperature:

1. Open the Chooser from under the Apple menu. Make sure AppleTalk is inactive.



2. Attach the temperature probe to the serial port at the back of the computer.
3. Double click on file named "cctemperature". It will automatically ask you if you want to load the "cctemperature.CLB" (calibration file for temperature probe). Click OK.
4. Select the Collect menu and choose Data Rate. For this activity select 10 points per second.
5. From the Display menu select One Graph. Also from the Display menu choose Set All Min, Max. For this experiment, select 0-60 for seconds. Click OK. Select 0-100 for degrees Celsius. Click OK.



6. Click Start to begin to collect data.

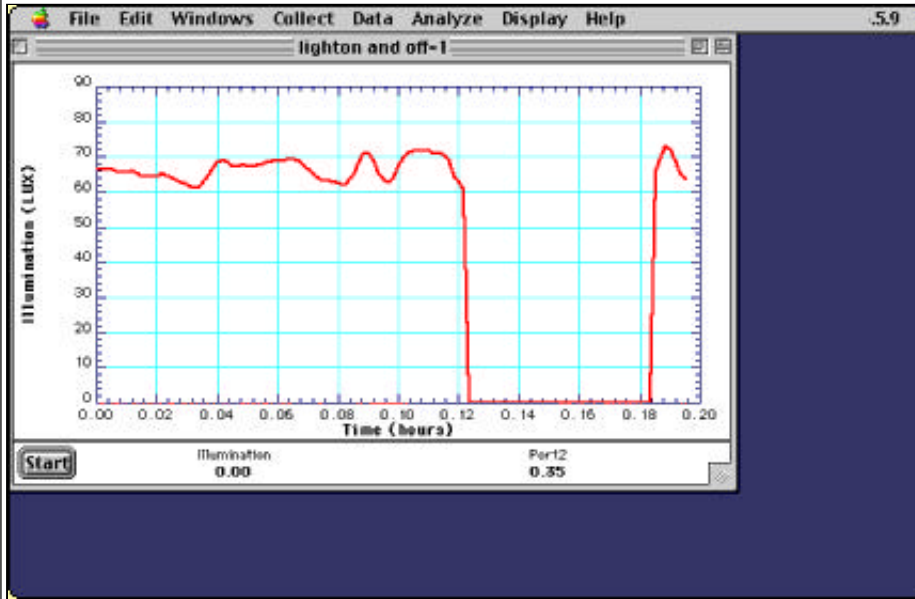
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Calibrating Thermometers Technical Hints

To view data:

Select Data Table A from the Windows menu.



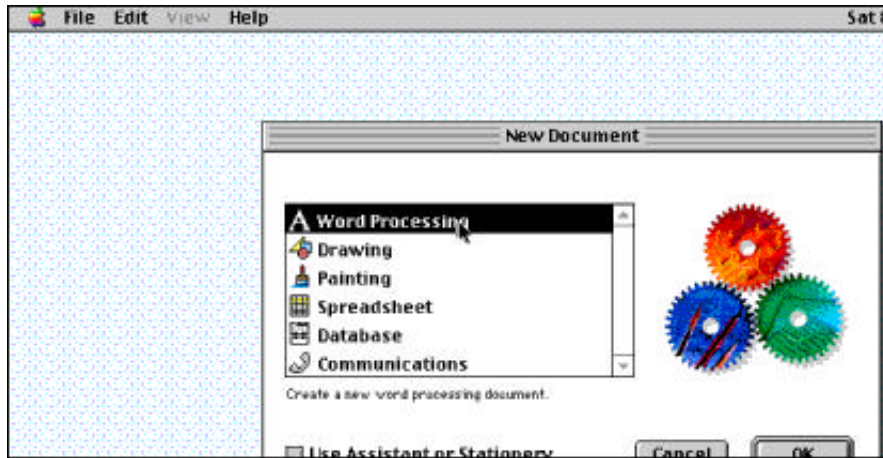
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To create a spreadsheet:

1. Select the spreadsheet option in ClarisWorks.



2. Enter time (sec) in Cell A1. Type the name of your group in Cell B1. List the name of the sharing groups in the adjoining columns.

	A	B	C	D	E	F	G	H	I
1	time (sec)	My Group	Group Name						
2									
3									
4									
5									
6									
7									
8									
9									
10									
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12									
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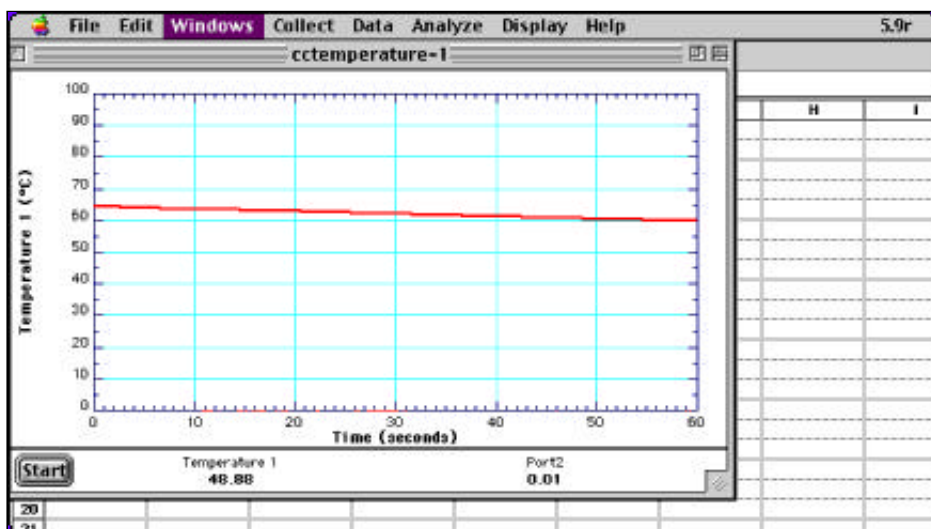
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Calibrating Thermometers Technical Hints

To transfer data to the spreadsheet:

1. From the Windows menu in DataLogger, select Data A Table. Highlight all of the data in the first to columns. Press on the Open Apple key (next to the space bar) and the C key at the same time. The Edit menu should blink.
2. Move to your spreadsheet. Highlight Cell A1 and B1. Select Paste (or press the Open Apple key and the V key at the same time) to paste your data into the spreadsheet.



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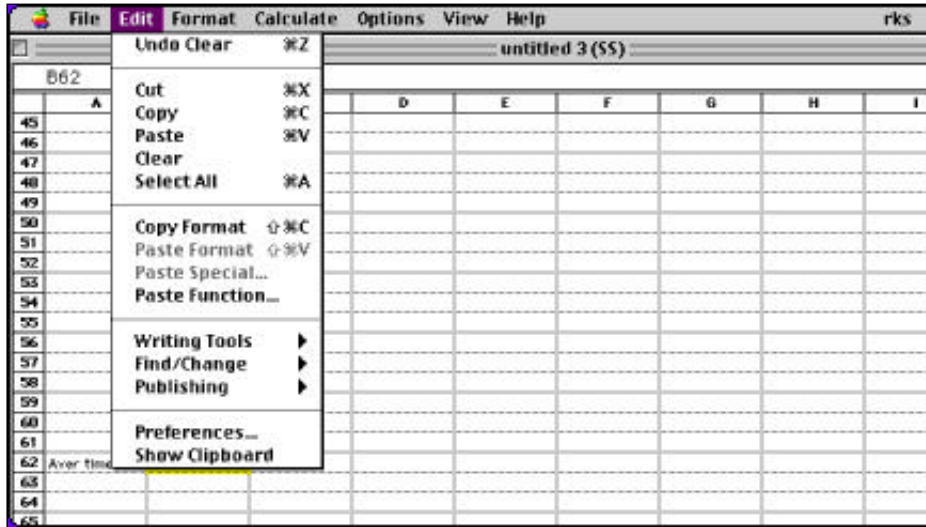


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Calibrating Thermometers Technical Hints

To find an average:

1. Type Aver time (sec) in Cell A62. Select Cell B62. From the Edit menu, select Paste Function. Scroll down and choose Average. Click OK.
2. In the Title Bar highlight everything inside the parenthesis. Type B2, B61. Click on the checkmark.



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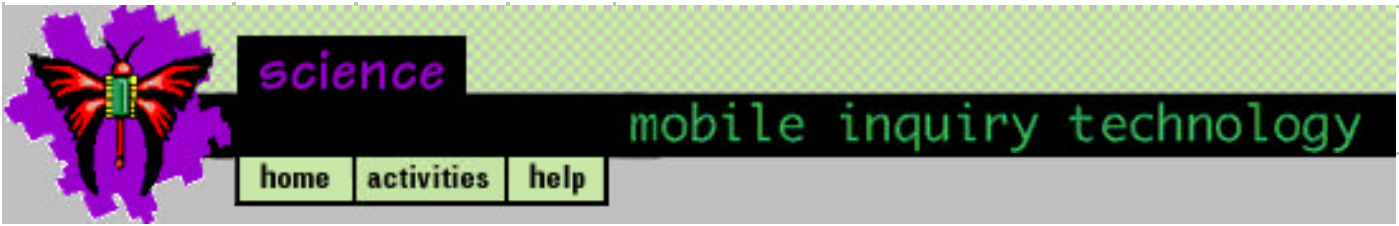
Calibrating Thermometers Technical Hints

To create a bar chart:

1. Highlight Aver time (min) and all other data in the same row.
2. Choose Make Graph from the Options window.
3. Make sure Bar graph is highlighted and select the General button. Select Series in Rows. Click OK

	A	B	C	D	E	F	G	H	I
45	44	61.33	60.69						
46	45	61.33	60.48						
47	46	61.26	60.26						
48	47	61.19	60.05						
49	48	61.04	59.98						
50	49	60.97	59.84						
51	50	60.9	59.69						
52	51	60.83	59.55						
53	52	60.76	59.41						
54	53	60.69	59.41						
55	54	60.62	59.27						
56	55	60.48	59.12						
57	56	60.48	59.05						
58	57	60.48	59.05						
59	58	60.4	58.98						
60	59	60.26	58.91						
61	60	60.19	58.77						
62	Aver time(sec)	62.465	58.345						
63									
64									
65									

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Calibrating Thermometers Analysis

Answer the following questions on paper:

1. In what ways does the availability of water help in creating a temperature scale?
2. Imagine you find an old thermometer and you are not sure if it is accurate. Describe how you would go about checking its accuracy.
3. Was your thermometer as accurate as the temperature probe? What might explain the difference?
4. Think about when you would want to use each type of thermometer. Give a few examples and explain your reasons.
5. How did your temperature readings compare to that of the other groups?
6. What variables might account for differences in temperature readings between groups?





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Calibrating Thermometers Further Investigation

Design and perform your own activity to use an unmarked thermometer and temperature probe to investigate the boiling and freezing point of salt water.

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