

Investigation

Freezing point depression of a salt ice mixture

You may already know that in winter salt is put on roads to melt ice that forms. This is because adding impurities to the ice will reduce its melting point. The ice is still at 0°C above its new melting point. So it absorbs heat energy from the surroundings, as it melts, lowering the temperature until it freezes again. In this way the freezing point of ice can be lowered down to -20°C.

Materials

TI Graphing Calculator with DataMate program installed	crushed ice
CBL2 interface	spatula
Temperature probe	sodium chloride
2 plastic beakers	paper towel

Starting the DataMate Program and setting up

1. Use the following steps to start the DataMate program on your calculator:

TI—73, TI—82, and TI—83 Calculators:



Press **PRGM** then press the calculator key for the number that precedes **DATAMATE**. Press **ENTER**. An introductory screen will appear, followed by the main screen.

TI-83 Plus Calculators:

Press **APPS**, then press the calculator key for the number that precedes **DATAMATE**. Press **ENTER**. An introductory screen will appear, followed by the main screen.



2. Plug the Temperature Probe into channel **CH 1** on the CBL2 interface.
3. Check that you are getting a reading at about room temperature. If you get -999.9°C you know something is wrong! You will need to specify the probe. Press **1** **SETUP**. Channel 1 should show **STAINLESS (C)** so press **ENTER**. You will find the **SELECT SENSOR** menu. Press **1** **TEMPERATURE** and then press **4** to select **STAINLESS TEMP (C)**. Finally press **1** **OK** and you will return to the main screen.
4. Fit one beaker inside the other and fill it with crushed ice. Slide the temperature probe into to ice and let it come to the temperature of the ice (let the probe equilibrate). What would happen if you did not do this? How do you know if the probe has equilibrated? How long did this take?

Setting your recording times

1. Start the DataMate program. Press **CLEAR** to reset the program. DataMate will detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading.
2. Press **1**: **SETUP** and using the cursor buttons,  or  (be patient it's a bit sluggish!) select **MODE** press **ENTER**.
3. Select **2**: **TIME GRAPH** and the screen **TIME GRAPH SETTINGS** will appear.
4. The default settings are 180 samples every 1s experiment will collect temperature readings for 3 minutes. To change this select **2**: **CHANGE TIME SETTINGS**

5. Type in a time interval in seconds, press **ENTER**, then the number of samples press **ENTER**. The experimental length in seconds is then given this should be about 5 minutes (300s) for a trial run.
6. Press **1**: **OK** then and again press **1**: **OK** to return to the main screen.

Collecting data

1. Select **2**: **START** to begin data collection, a double “beep!” from the interface will confirm you are recording. You may stop data collection at any time by pressing the **STO→** key
2. A live graph will appear on the calculator screen. Wait about 60 seconds and add 2 spatulas of sodium chloride to the crushed ice and stir it in. Keep stirring the mixture.
3. After the data collection is complete the interface will “beep!” again and an autoscaled graph of the data will appear.
4. A cursor will appear flashing on the y-axis. Use the cursor keys  or  to examine the data points along the displayed curve of temperature vs. time. As you move the cursor right or left, the time (X) and temperature (Y) values of each data point are displayed below the graph. Move the cursor to the point when the salt was added to the ice. Record that time. Move the cursor to find the lowest temperature and record that time. How long did it take for the sodium chloride to lower the temperature of the ice?
5. To return to the main screen press **ENTER**.

Recording data

1. To save the data use the **5**: **TOOLS** option, then **1**: **STORE LATEST RUN**.
2. To see the stored data select **6**: **QUIT** and press the **STAT** key. Select **1**: **Edit** your data should appear in **L1** (time) and **L2** (temperature). You may now shut down the calculator and transfer the data to a computer for further processing in a program such as MS Excel or Star Calc using the TI Graph Link.

Further points to consider

- Which is the most appropriate recording method and why?
- What would happen if you repeated the experiment with different amounts of salt?
- What would happen if you used sucrose or ethanol instead of sodium chloride? Try it but try to make it a fair test (i.e. as similar to your experiment with sodium chloride as possible).
- What would you use as a control for these experiments?
- What sources of error are there in this experiment (list at least three)?
- What would you do to improve the reliability and accuracy of this investigation?