Experiment 14
It's Snow Big Deal

OUTCOMES

After completing this experiment, the student should be able to:

- use computer-based data acquisition techniques to measure temperatures.
- draw appropriate conclusions based on the results of a simple experiment.
- prepare a written report which accurately and succinctly conveys the information obtained in the experiment and the conclusions drawn as a result of it.

DISCUSSION

Living in Minnesota, we are all used to the presence of large amounts of snow and ice in the winter and the subsequent salting and sanding of the roads. While we may be used to living with the consequences of salt on the roads and our cars, why do we dump all of that salt on the roads? How does it affect the temperature of the snow and ice?

If the temperature of a liquid is lowered to a certain point, the liquid will begin to change into a solid, in a process we know is called *freezing*. We observe this every time we make ice cubes in the freezer. The temperature at which a liquid changes into a solid is called its *freezing point*. Every pure liquid has its own characteristic freezing point. What is the freezing point of pure water? What temperature must a mixture of pure ice and water be once it levels off?

However, once impurities are added to a liquid, its freezing point will change. This is one example of a *colligative property*. If you've discussed these properties in lecture, you should review them now so you may apply that knowledge toward the experiment. In this experiment you will determine how the addition of various compounds to snow (or an ice/water mixture) will affect that mixture's temperature, and you will explain your results in terms of the freezing points of the new mixtures. While doing this, you will also learn how to use computer-based methods to gather data.

Computer-based data acquisition techniques are used in upper division science courses, as well as in professional laboratories and other workplace settings. The primary advantage of computer-based methods in any laboratory setting is the speed with which data can be gathered. Computers also assist in data analysis and can improve the overall efficiency and accuracy of laboratory and business processes. To be prepared to work in *any* type of professional environment, you must be familiar with computer-based methods of data collection and analysis.

In the laboratory, data-gathering probes are utilized when working with computer-based data acquisition techniques. *Data-gathering probes* are simple electronic devices that respond to different types of stimuli by sending out electrical voltage signals. The signals by themselves

may appear to have little meaning, but computer software can interpret and display the signals as meaningful data. In order for the software to correctly interpret the signals, however, it is necessary to *calibrate* the probe. Calibration consists of feeding the probe a signal of known value and teaching the software to recognize that value as a reference point. Some probes will already have a calibration file built in to the hardware and software. Other probes (like pH probes) require that the calibration be done manually.

In today's experiment, you will use a temperature probe to record the temperature of snow (or ice water if there is not sufficient snow present) with and without various salts. Probes connect to the *signal interface*, which serves as a switchboard for routing signals into the computer, where the software interprets the signals.

PROCEDURE

1. Collect 400 to 500 mL of snow from outside. If no snow is accessible, ice will be available in the lab to make ice water.

2. Plug the temperature probe into Channel 1 of the Vernier LabPro™ interface. Open the *LoggerPro* application from the Start menu or desktop. If the temperature probe is not automatically identified by the software and interface, open the file for the stainless steel temperature probe from the **Probes & Sensors** folder of the **Experiments** folder.

3. Adjust the experiment length to 3 minutes and the sampling rate to take 1 reading every 5 seconds. (*NOTE: This may require the instructor's demonstration*.)

4. Make sure that your columns are labeled with the proper units. Make changes, if necessary. Adjust the time column to read to two decimal places. The temperature measurements are accurate to approximately ± 0.1°C, so adjust the temperature readings to the correct number of decimal places. (*NOTE: This may require the instructor's demonstration*.)

5. Place 100 mL of snow or an ice/water mixture into a 150 mL beaker.

6. Plunge the temperature probe into the middle of the snow and stir the mixture. Start the data collection by clicking the green button  next to "Collect" on the *Logger Pro* tool bar.

7. You will notice that the time and temperature readings will be displayed on the data table and the points will be plotted as the experiment runs.

8. Continue stirring until the experiment stops on its own after 3 minutes.

9. Examine the data in the table and on the graph. What is the significance of the temperature at which the readings leveled off?

10. Save your file by clicking on the disk icon in the upper left portion of your screen. Then select "Store Latest Run" from the *Experiment* menu, so you can graph a new set of data. (*NOTE: This may require the instructor's demonstration.) When using the Interface, get in the habit of saving your file and storing the latest run whenever you complete a trial. Failure to do so may result in all of your data being lost in an experiment. Remember – save early and often!*

11. *Repeat* the experiment, mixing 8 g of sodium chloride into a fresh 100 mL of snow or ice water. Continue to gently stir without touching the sides of the beaker while readings are being taken.

12. *Repeat* the experiment a second time, mixing 8 g of Ice Melt into a fresh 100 mL of snow or ice water. Continue to gently stir without touching the sides of the beaker while readings are being taken.

13. *Repeat* the experiment a third time, mixing 8 g of a sugar into a fresh 100 mL of snow or ice water. Continue to gently stir without touching the sides of the beaker while readings are being taken.

14. Did the temperature readings level off on your additional trials? If so, at which temperature(s)? Was the temperature higher or lower than for pure snow? Is this what you expected? Explain.

ASSIGNMENT

1. When you are finished with all of the trials, print out a copy of the graph with all the trials in *LoggerPro*. You may insert a text box to create a legend to explain which trial corresponds to each data set. Use the *Print Preview* feature to make sure that the graph fits on the page. Some of the data columns may print out as well.

2. Write a report (2 or 3 paragraphs in length) summarizing your results. Address the following items in your report:
   - When the probe was placed into the pure ice-water and other three ice-water mixtures, at which temperatures did the readings level off (or become more level)?
   - By adding the solutes, what has happened to the freezing point of each mixture?
   - Were the results what you expected? Explain.
   - Which of these substances would be the best to use on your sidewalk? Why? Think of this in terms of the freezing point of the ice on the sidewalk.

Name _____ Lab Section _____

PRELAB QUESTIONS

1. How do you predict the temperature of snow will be affected by the addition of salt?

2. Give two examples of instances where you would use computers to make a measurement.

3. Which safety precautions, if any, must be observed during this experiment?