Lower Merion High School Chemistry

# Molar Mass by Freezing Point Depression Lab #23

Water has a freezing point of 0°C and a boiling point of 100°C. When a solute such as table salt, NaCl, is added to water, the freezing point of the solution is lower than that of pure water and the boiling point of the solution is higher than that of pure water. The same is true for all solutions. By obtaining the change in the freezing point of a solvent by adding a solute, we can determine the molar mass of an unknown solute.

**Materials:**

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| Test Tube | CBL with Temperature Probe | Bunsen Burner |
| Naphthalene | Test Tube Clamp | Unknown Solute |

**Procedure:**

Connect the CBL to the calculator. Program the calculator for one temperature probe and choose "TIME GRAPH" under the "DATA COLLECTION" screen. Program the following information after selecting "TIME GRAPH". Time between samples in seconds **5**, Number of samples **100**, Y-MIN **0**, Y-MAX **120**, Y-SCL **5**.

Obtain approximately 10 grams of naphthalene. Record the exact mass of the naphthalene. Place the naphthalene into the test tube. Prepare a boiling water bath in a 400 mL beaker. Place the test tube with the naphthalene into the boiling water bath until all of the naphthalene melts. If the naphthalene takes more than three minutes to melt, reheat the water bath. After the naphthalene melts, remove the test tube from the water and place it in the test tube clamp. Place the temperature probe into the naphthalene and press "ENTER" to begin recording data on the calculator.

**DO NOT ATTEMPT TO PULL THE TEMPERATURE PROBE OUT OF THE FROZEN NAPHTHALENE!** After the experiment has been completed, press "ENTER" on the calculator and observe the graph. Somewhere in the middle of the graph, you should see a flat portion. Move your cursor to this flat portion of the graph and record the temperature at this point. After recording the temperature, press "ENTER" and select "YES" when the "REPEAT" screen appears. Reprogram the Y-MIN, Y-MAX and Y-SCL as you did previously.

Re-boil the water in the water bath and place the test tube, naphthalene and temperature probe into the water bath. Weigh approximately one gram of the unknown solute, and record its exact mass. Add the unknown to the test tube and melt both the naphthalene and the unknown. Use the temperature probe to make certain that the naphthalene and the unknown are melted and well mixed. Remove the test tube from the water bath and press "ENTER" to begin recording data on the calculator.

Again, allow the CBL to complete the trial and then press "ENTER". Obtain the temperature at the flat portion of the graph and then press "ENTER". Select "NO" when the "REPEAT" screen appears.

Once again, re-boil the water in the bath and place the test tube, mixture and temperature probe in the bath. Once the mixture has melted, remove the probe from the liquid and immediately wipe it off. Take two paper towels and open them up all the way. Wet the paper towels and place them on the lab table. Pour the melted mixture onto the wet paper towels and throw the towels in the trash can. Take the test tube up to your teacher.

Disassemble the CBL and calculator and put them away. Clean up.

**Calculations:**

Determine the difference in the two freezing points.

Use the formula for freezing point depression to determine the molar mass of the unknown solid.