Chum 152LL: Experiment #2 - The Determination of K_f -

Freezing Point Depression Constant for Glacial Acetic Acid

Introduction

The properties of solutions can differ substantially from those of pure solvents or solutes. Changes in the behavior of the solutions that are due primarily to the concentration of solute particles rather than the properties of those particles are known as colligative properties. These properties many include

Vapor Pressure Lowering
Boiling Point Elevation
Freezing Point Depression
Osmotic Pressure

The magnitude of freezing point depression of a solution is related to its molar concentration expressed in the following equation,

$$\Delta T_f = (i)(K_f)(m),$$

where K_f is the molal freezing point depression constant for the solvent, m is the molality of the solution, and i is the number of particles produced per formula unit (i is 1 for a nonelectrolyte solution).

Molality = moles of solute/kg solvent

In today's lab, glacial acetic acid is the solvent. Freezing point of pure glacial acidic acid will be determined first. And then, Freezing points of solutions of water (the solute) in glacial acetic acid will be measured, which will lead to the determination of K_f, freezing point depression constant for glacial acetic acid.

Procedure

1. Obtain Interface, temperature probe, connect them and to the computer. Start *Logger Pro* Program. Data and graph display will come on automatically.
2. Obtain a clean, **DRY** large test tube. Place the test tube in a 200 mL beaker (weighing beaker) and weigh the test tube in the beaker to the nearest 0.0001 g.
3. Carefully, pour 5 ~ 6 mL glacial acetic acid into the large test tube (liquid height at about 1 inch) Obtaining weight of glacial acetic acid in test tube and weighing beaker.
4. Obtain mass reading of glacial acetic acid.
5. Fill a large beaker (400 mL or 600 mL) half way with ice and water mixture.

6. Immerse the test tube with glacial acetic acid in the above ice water bath and start data recording of the temperature. **Constantly stir** (gently) the acid. The freezing point is the temperature at which the liquid solidifies. If you have supercooling, the temperature will have dropped below freezing point and come quickly back up to the freezing point when glacial acetic acid solidifies.

7. Keep on stirring and recording data till the temperature has stayed constant for more than one minute. Stop recording. Rezoom graph display with the  button. Then Use the Smart Tool () to pinpoint the freezing point of glacial acetic acid. Print out the graph and write on it what your group has decided to be the freezing point of glacial acetic acid.

8. Take out the test tube with temperature probe from the ice water bath. Warm it in some warm water till glacial acetic acid melts.

9. Repeat steps 6 ~ 8 for pure glacial acetic acid.

10. Dry the outside of the test tube with glacial acetic acid as much as possible with paper towel. Weight it again in the weighing beaker.

11. Add three ~ five drops of distilled water into the test tube. Obtain weight of the solution in test tube with weighing beaker.

12. Repeat steps 6 ~ 8 twice with the solution. (Note that the freezing point of solution will not stay constant, rather decreases continuously while freezing as the solution gets more and more concentrated. It's important to stir well and note the temperature when first solid crystal occurs.)

13. Repeat step 10.

14. Add two ~ three more drops of distilled water into the test tube. Obtain weight of the 2^{nd} solution in test tube with weighing solution.

15. Repeat steps 6 ~ 8 twice with the 2^{nd} solution.

16. Gather data and present data in tabulated format and calculate K_f for glacial acetic acid based on experimental findings.

Note: It is very important that all the mass readings are taken very accurately in this experiment. Make sure that the temperature sensor will remain free hanging using a micro-clamp when weighing solutions and adding more solutes. It should not be washed or wiped.