Laboratory Investigation Name _____

Chemistry: Form L8.3A Date _____ Period _____

Measuring Molal Freezing Point Depression

PROBLEM

How does the presence of dissolved solute affect the freezing point of water?

INTRODUCTION

When a substance freezes, the particles come together in regular geometric patterns to form crystals. The attractions that hold the particles together in a solid are influenced by the shape of the particles and the distribution of charges. Dissolved solute interferes with the orderly organization of solvent particles into crystals making it more difficult for the solvent to freeze. As a result, the freezing point is depressed. In this laboratory investigation, you will measure the magnitude of the freezing point depression for both electrolyte and nonelectrolyte solutes.

MATERIALS (*per group*)

Beaker (600 mL); electrolyte solutions (1m, 2m, 3m, and 4m); ice; nonelectrolyte solutions (1m, 2m, 3m, and 4m); rock salt; test tube rack; test tubes (5); thermometer

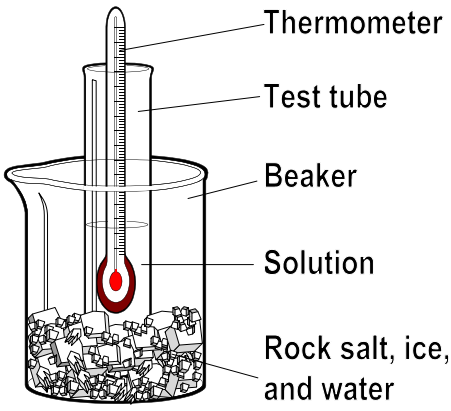
PROCEDURE

1. Record the names of the electrolyte and nonelectrolyte solutions you are using in the data table on the next page.

2. Prepare an ice bath by placing a mixture of crushed ice, rock salt, and a small amount of water in a large beaker.

3. Fill a test tube about one fourth of the way with deionized or distilled water. Pure water is a solution with a concentration of 0m.

4. Measure the freezing point of the solution by inserting a test tube into the ice bath and stirring the solution in the test tube with a thermometer. After ice crystals begin to form in the test tube (and prior to the contents of the test tube freezing solid), record the temperature in the data table on the next page.



5. Measure the freezing points of the remaining solutions by repeating step 3 with a quarter test tube of each.

6. Prepare a graph on a separate sheet of graph paper with concentration on the *X*-axis and freezing point on the *Y*-axis. Plot the points for the electrolyte and non-electrolyte on the same axis using ⊙ to represent the electrolyte points and ⊗ to represent the nonelectrolyte points. The freezing point of pure water represents a 0m solution for both the electrolyte and the non-electrolyte. Draw the best straight line for each set of points (**a separate line for the electrolytes and the nonelectrolytes**).

7. Find the molal freezing point depression for the electrolyte and nonelectrolyte solutions by determining the absolute value of the slopes of each of the lines. Record the results in the data table on the next page. Note whether the electrolyte and nonelectrolyte are the same.

8. Find the accepted value for the molal freezing point depression is 1.86°C/mol. Perform an error analysis using the observed value for the nonelectrolyte by finding, first, the absolute error, and, then, the percentage error.

OBSERVATIONS

Concentration	Freezing Point	
	Nonelectrolyte NAME: _____	Electrolyte NAME: _____
0m (water)		
1m		
2m		
3m		
4m		
slope		

Error Analysis

1. Observed molal freezing point depression for nonelectrolyte . . . . . _____
2. Accepted value for molal freezing point depression . . . . . _____
3. Absolute error . . . . . _____
4. Percentage error . . . . . _____

CONCLUSIONS

1. Why is the slope of the line the molal freezing point depression? _____

2. What is a colligative property? _____

3. How does comparing the molal freezing point depression of the electrolyte and the nonelectrolyte show that freezing point depression is a colligative property? _____

4. What causes freezing point depression? _____

5. What are the likely sources of error in this laboratory investigation? _____

6. What is the expected freezing point of 2m $CaCl_2(aq)$? _____