AP Chemistry Lab
Molar Mass by Freezing Point Depression

Pre-Lab Questions

1. What is the formula and molar mass for t-butyl alcohol?
2. What is the normal melting/freezing point for t-butyl alcohol?
3. What is the difference between a solvent and solute?
4. What is molality and how is it different from Molarity?

Part 1-Find the freezing point of your solvent.

1) Get an oversized test tube. Fit it with a two-hole rubber stopper containing a temperature probe and a copper wire for stirring.

2) Find the mass of the whole apparatus. You may put it in an Erlenmeyer flask to make it stand on a balance. Always mass the apparatus the same way during this lab.

3) Place approximately 25 mL of liquid t-butyl alcohol in the test tube and mass it.

4) Freeze the alcohol by placing it in an ice bath and stirring the alcohol constantly with the copper wire. Monitor the temperature the whole time you do this. You need to monitor the temperature until the solid had been present for at least 3 minutes. Use a CBL hooked to your calculator and the time/temp graph function. Choose 600 data points and 5 seconds between samples. You may interrupt the program at any time you happen to finish.

5) Load the data from the calculator into one of the desktop computers and save it to a floppy by using a name like trial number one.

6) Melt the alcohol by placing the apparatus in a hot water bath.

7) Repeat this procedure to find the freezing point a second time. Call the data file trial two.

Part 2-Find the freezing point of your solution.

1) Using the same sample you used for the part 1 of this lab add approximately 0.20 grams of water dropwise to the alcohol. The water is now your solute.

2) Find the freezing point of your mixture twice the same way you did in part 1. Call these data files trial 3 and 4.

3) Clean out the test tube thoroughly by heating the alcohol and pouring it into the waste container. DO NOT ALLOW ANY TO GO DOWN THE DRAIN. IT WILL FREEZE IN THE PIPES AND CLOG THE DRAIN.

4) If any test tubes are left behind filled with the alcohol the whole class will receive a zero on the lab.

Part 3- Find the freezing point of an unknown mixture.

1) Prepare a new sample of the t-butyl alcohol and weigh it the same way. To this add about 2.0 g of the unknown. Find the freezing point of this mixture twice the same way you did in parts 1 and 2. Call these data files trials 5 and 6.

2) Dispose of the mixture the same way.

3) Clean up and go home.

Analysis of the Data

You need to determine the temperature at which the pure solvent froze. Then you must determine the temperature at which the first mixture froze. This is used to find the freezing point depression in part 2 and the freezing point depression constant for the t-butyl alcohol. The data from part 3 is used to determine the freezing point depression for the unknown solvent. Using the Kf you determined in part 2 you can now determine the molar mass of the unknown.

Your lab will book and formal report will contain at least 3 computer generated graphs if you place the lines for both trials from each part on the same axes or six graphs if you do them individually. These are easily done if you move your data files into Excel or a similar program. I recommend trying Vernier's Graphical Analysis. Then it can be transferred into your lab by printing it out and pasting it in.

Sample Data Tables
Parts 1 and 2

Mass of empty apparatus	
Mass of apparatus and alcohol	
Mass of apparatus, alcohol, and water	
Mass of water alone	

Part 3

Mass of empty apparatus	
Mass of apparatus and alcohol	
Mass of apparatus, alcohol, and unknown	
Mass of unknown alone	
Freezing point of alcohol (determined from graph)	

Afterwards

Freezing point of pure alcohol	
Freezing point of first mixture	
Freezing point depression with water	
Freezing point depression constant for t-butyl alcohol	
Freezing point with unknown	
Freezing point depression with unknown	
Molar mass of unknown	

Post-Lab Questions

1. Calculate the percent error for your molar mass based on the value provided.

2. Suppose a significant, but unknown, amount of solvent was lost during part 1 and 2 of the procedure. How would this affect your answer for the molar mass of the unknown? Show numbers.

3. Suppose the inside of the test tube was not totally dry when you started part 3. How would your calculated molar mass be different? Give concrete examples.

4. Give one reason why your melting/freezing point could be wrong. Explain the ramifications of it.