

Experiment 14 – Molar Mass of a Solid

Pre-Lab Hints:

- Refer to first paragraph of introduction and the definition in the margin on the same page.
 - Refer to Ebbing and Gammon, sections 4.1 (electrolytes) and 12.8 (ionic solutions).
Determine i (Van't Hoff factor) for each substance as the number of ions in the formula.
- Refer to equation 14.1, and consider the effect of glacier and aquifer molalities.
As the change in freezing point increases, the actual freezing point decreases.
- Refer to equations 14.1 and 14.3. To solve for molality (m), either use MM (molar mass) as a variable, or substitute an assumed MM of 100 g/mole into equation 14.3.
Show equations on a separate sheet of paper, rather than the page in the lab manual.
Include all units and conversion factors in your calculations.
- Refer to steps A4, B3, B4, and B5. There is one graph (plot) for each cooling curve.
Explain using a complete sentence.
 - Refer to Figure 14.3. Determine which physical property value is found on the cooling curves and is needed to complete the molality calculations.
- Show all equations on a separate sheet of paper.
Include all units and conversion factors in your calculations.
Line C3. Convert Line B2 into kg using (1 kg / 1000 g) as the conversion factor.
Line C4. Use this equation: $\text{moles solute} = (\Delta T / k_f)(\text{kg cyclohexane})$
Line C5. Value is same as Line B3.
Line C6. Divide mass of solute (Line B5) by moles of solute (Line B4)
Include the calculated molar mass, along with the other two values given, to determine the average molar mass among all three data points in 5b.
Skip the standard deviations in 5b.

Procedure Notes:

- Part A. Refer to Figure 14.4 when assembling experimental apparatus.
Note that the ice bath in step 1 requires both ice *and* water.
Determine mass of empty test tube and 250-ml beaker before obtaining solvent.
Record the time and temperature data at 30 s intervals on a *separate sheet of paper*.
Refer to Figure 14.3 to understand what the graph(s) should look like.
Indicate **location** of the **freezing point** on your **graph**.
Ideally, a plateau will be visible where the solvent or solution is freezing.
Sometimes, however, this is not observed.
Therefore, visually observe the freezing process carefully.
- Part B. Use lower portion of solute mass range (additional 0.1 g per trial), or T_f in trial 3 will be less than 0 °C, and solution will not freeze in the ice bath without adding NaCl.
Plot each graph **separately** on graph paper. Do not combine lines on same graph.
Indicate location of **freezing point** on **each** graph. (See figure 14.3)
Also, write the molalities for each trial before determining the moles of solute.
Provide your **calculations**. Skip standard deviations.

Post-Lab Questions (refer to equations 14.1 and 14.3 in lab manual)

1. Suppose you use a miscalibrated thermometer that reads $1.0\text{ }^{\circ}\text{C}$ higher than the actual temperature throughout the entire experiment. Consider how the miscalibration affects each temperature measurement, and then determine what happens to your ΔT_f values. What would be the overall effect on your molecular weight calculations?
2. Suppose a small amount of your solid sample is lost and does not get dissolved in the solvent. How does this affect your number of solute moles and your molality? What happens to ΔT_f ? What would be the overall effect on your molecular weight calculations?
3. Suppose a small amount of the cyclohexane vaporizes, so that there is actually less solvent mass than what you had recorded. How does this affect your molality and your ΔT_f ? What happens to your calculations for the number of moles? What would be the overall effect on your molecular weight calculations?
4. Review the paragraph about sodium chloride on the first page of the experiment's introduction, and review "BP/FP of Ionic Solutions" in the chapter 12 class notes. Suppose your dissolved solute dissociates into ions so that "i" (the Van't Hoff factor) is larger than 1. Using $\Delta T = i k_f m$, determine what happens to your ΔT_f . How are your calculations for molality, moles, and molecular weight affected if the "i" is neglected and you assume $\Delta T = k_f m$?
5. Suppose you determine the solvent T_f correctly, but then you interpret your other graphs incorrectly, so that the solutions' T_f values, even though they are less than that of the solvent, are interpreted as higher than their actual values. Use the equation $\Delta T_f = T_f(\text{solvent}) - T_f(\text{solution})$ to determine how this affects your ΔT_f values. Then, determine how this affects your calculations for molality, moles, and molecular weight.