4.R: Determination of the Molar Mass by Freezing Point Depression (Lab Report)

Lab Report: Determination of Molar Mass by Freezing Point Depression

Experimental Data

Unknown ID number: _____

Part 1: Freezing Point of Pure PDB	
Mass of large empty test tube	
Mass of test tube & PDB	
Mass of PDB (by difference)	

Part 2: Freezing Point of PDB-Unknown Mixture (~2 g)	
Mass of vial & unknown	
Mass of vial & unknown minus Sample I	
Mass of unknown added (by difference)	

Part 3: Freezing Point of PDB-Unknown Mixture (~4 g)	
Mass of vial & unknown	
Mass of vial & unknown minus Sample II	
Mass of unknown added (by difference)	
Total mass of unknown added	

Temperature Measurements: Record the temperature every 30 seconds as the pure solvent and two solutions are cooled. Note the temperature at which any solid first appears.

Time Elapsed (minutes)	Temperature (°C)		
---	Pure Solvent (PDB only)	Solution I (PDB + Sample I)	Solution II (PDB + Sample II)
0			
0.5			
1.5			
2			
2.5			
3			
3.5			
4			
4.5			
5			
5.5			
6			
6.5			
7			

Time Elapsed (minutes)	Temperature (°C)		
7.5			
8			
8.5			
9			
9.5			
10			
10.5			
11			
11.5			
12			
12.5			
13			
13.5			

Graphical Analysis of Data

Use Excel to create three separate graphs of "Temperature versus Time" for the pure solvent and the two solutions studied. Each graph should have an appropriate title and labeled axes with an appropriate scale. Add two trendlines to the data points of each graph. You can do this by hand with a ruler or by using Excel. The first line is applied to data points that correspond to the cooling of the liquid stat: these are the points on the steep part of the graph. The second line is applied to data points that correspond to the co-existence of both the solid and liquid (freezing): these are the points on the part of the graph where the temperature levels out. Extrapolate the two trendlines towards each other until they intersect. The temperature at the point of intersection is the solvent freezing point and should be clearly shown on each graph. **Attach your three graphs to this report.**

Record the freezing point temperatures obtained from the graphs below:

- Pure PDB _____°C
- Solution I _____°C
- Solution II _____°C

Calculation of Molar Mass

Complete the table below with the results of your calculations. Be sure to include all units. Note that K_f PDB = 7.10 °C·kg·mol^{-1}.

	Solution I	Solution II
Mass of PDB added		
Total mass of unknown added		
Freezing point of pure PDB		
Freezing point of solution		
Total Freezing point depression, ΔT_f		
Molality of solution		
Moles of unknown in solution		
Molar Mass of unknown		

- Unknown number _____ has an average molar mass of _____g/mol.

- On a separate sheet of paper, show the equations used and calculations performed for molality of the solutions, moles of unknown in the solutions, and molar mass of the unknown. **Attach your sheet to this report.**

Questions

1. Look up the freezing point of para-dichlorobenzene. This may be found in the *CRC Handbook of Chemistry and Physics* (library) or from various online sources.

- Freezing Point of PDB =_____
- Reference source used:

2. Using the freezing point from your reference source, determine the percentage error in your experimentally measured freezing point. Show your calculation below, and be sure to report your answer to the correct number of significant figures.
3. Suppose you find out that the actual molar mass of your unknown solid is exactly three times larger than the value you determined experimentally. What could you conclude about the nature of your unknown solid and the assumptions you made in your calculations in such a case? Explain.
