Date _____ Laboratory Instructor _____

Unknown no. _____

REPORT SHEET | EXPERIMENT

Colligative Properties: Freezing Point Depression and Molar Mass

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1. Final buret reading 15.3 mL
2. Initial buret reading 25 mL
3. Volume of cyclohexane 9.7 mL
4. Mass of cyclohexane 7.49 g
   (show calculations) 0.7726 · 9.7 = 7.49g
5. Mass of paper plus unknown 1.08 g
6. Mass of paper 0.76 g
7. Mass of unknown 0.32 g

A. Warming Curve for Pure Cyclohexane

Trial 1

Temp °C	Time (min)	Temp °C	Time (min)
7.1	0		
7.1	0.5		
7.5	1		
8.2	1.5		
8.6	2		
9.8	2.5		
10.5	3		
11.5	3.5		
12.9	4		
13.4	4.5		
14.2	5		
14.9	5.5		

8. Freezing point of pure cyclohexane from warming curves X 8.3 °C

9. Average freezing point 8.3°C

B. Determination of the Molar Mass of an Unknown

Trial 1

Temp °C	Time (min)	Temp °C	Time (min)
0.7	0		
1.3	0.5		
2.2	1		
3.4	1.5		
4.5	2		
6.0	2.5		
7.3	3		
8.6	3.5		
9.5	4		
10.6	4.5		
11.5	5		
12.2	5.5		

Trial 2

Temp °C	Time (min)	Temp °C	Time (min)

10. Freezing point of solution (trial 1) 4.5 °C (trial 2) X °C

11. Average freezing point of solution 4.5°C

12. Δt 3.8 °C

13. Molality of unknown (show calculations) 0.186 m

$\Delta T = K_f m$ $\Delta T = 3.8°C$

$K_f = 20.4\ °C/m \rightarrow 3.8 = 20.4m$

$m = 0.186$

14. Molar mass of unknown (show calculations) 230.216 g/mol

$m = \frac{n}{1\text{Kg solvent}}$ where n = number of moles $\rightarrow 0.186 = \frac{n}{0.00744\text{Kg}}$

$n = 0.00139\text{moles}$

$\frac{0.32\text{g (mass of unknown)}}{0.00139\text{ (moles of unknown)}}$

230.216 g/mol

HAND IN YOUR WARMING CURVES WITH YOUR REPORT SHEET.

QUESTIONS

1. What are the major sources of error in this experiment?
During the measurement of cyclohexanes freezing point we agitated it. However, we did repeat this agitation during the unkown trial.
2. Suppose throughout the experiment, your thermometer consistently read a temperature. 1.2° lower than the correct temperature. How would this have affected the molar mass you found?
It wouldn't. As long as Δt remains the same the calculations work out identically.
3. Which aqueous solution has the lower freezing point—0.10 *m* NaCl or 0.10 *m* glucose?
0.1m of NaCl, this is because NaCl will dissassociate in water, doubling the particles present. Glucose will remain a 0.1m solution.

4. If the freezing point of the solution had been incorrectly read 0.3° lower than the true freezing point, would the calculated molar mass of the solute have been too high or too low? Explain your answer.

Too high. This is because the more solute you add to a solution

5. Arrange the following aqueous solutions in order of increasing freezing points (lowest to highest temperature): 0.10 *m* glucose, 0.10 *m* $BaCl_2$, 0.20 *m* NaCl, and 0.20 *m* Na_2SO_4.

$BaCl_2$, Na_2SO_4, NaCl, glucose

6. What mass of NaCl is dissolved in 200 g of water in a 0.100 *m* solution?

$\frac{0.1 m \text{ of NaCl}}{1 Kg \text{ water}} \div 5 = \frac{0.02 m \text{ NaCl}}{200 g H_2O}$ $58.44 g/mol \cdot 0.02 m = 1.17 g$

7. Calculate the molalities of some commercial reagents from the following data:

	HCl	$HC_2H_3O_2$	$NH_3(aq)$
Formula weight (amu)			
Density of solution (g/mL)			
Weight %			
Molarity			

8. A solution of 2.00 g of para-dichlorobenzene (a clothes moth repellant) in 50.0 g of cyclohexane freezes at 1.05°C. What is the molar mass of this substance?

$\Delta t = K_f m$ $T_{f\,cyclohexane} = 6.6°$

$\Delta t = 6.6 - 1.05 = 5.55$

$5.55 = 20.4m$

$0.272 = m$

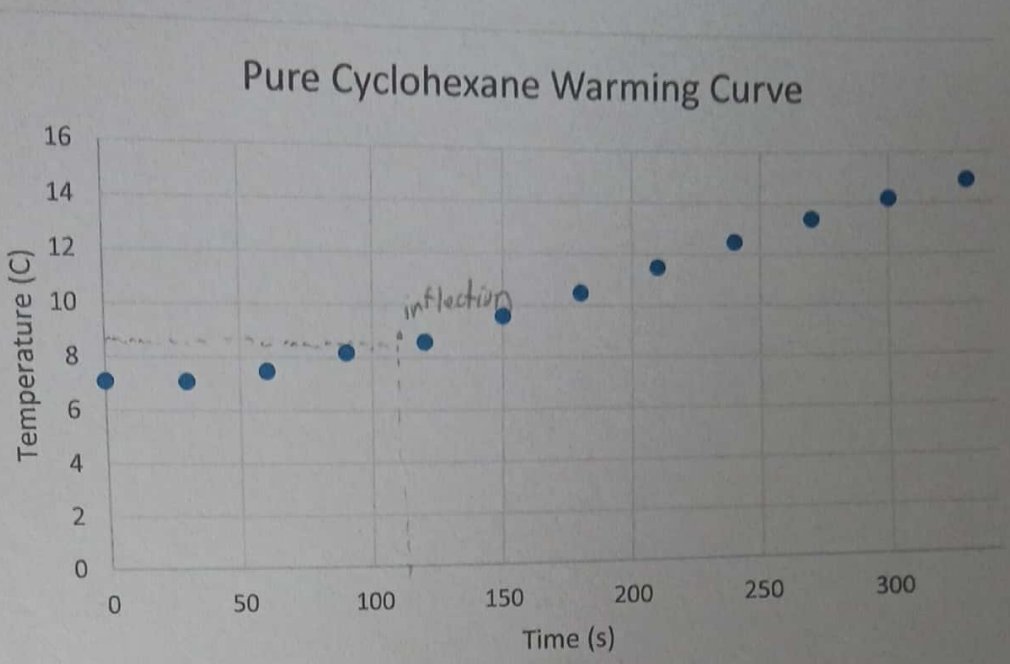
$0.272 = \frac{n(\text{moles of solute})}{0.05 kg}$

$0.0136 mol = n$

$\frac{2 g}{0.0136 mol} = 147.06 g/mol$

Trial 1

	temp
0	7.1
30	7.1
60	7.5
90	8.2
120	8.6
150	9.6
180	10.5
210	11.5
240	12.5
270	13.4
300	14.2
330	14.9



Trial 2

me	Temp
0	0.7
30	1.3
60	2.2
90	3.4
120	4.5
150	6
180	7.3
210	8.6
240	9.6
270	10.6
300	11.5
330	12.2