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Chem 205 Report

Colligative Properties

Name: _ **Date:** 19-04-2013.

Partner:

Purpose: - To measure the change in temp of water as it freezes, and so determine its freezing pt.
- To measure the drop in freezing temp. (freezing depression) & the elevation in boiling pt caused by the dissolution of solute in water.
- To study the effect of different solutes (electrolytes & non electrolytes) on freezing pt & boiling pt.

Part I: Freezing point of water

What is the purpose of adding salt to the ice bath?
To lower or decrease the freezing pt of water.

What is the freezing temperature of pure water?
$T_F = 0°C$

Note: Attach all the experimentally obtained data and tables.

Part II: Freezing Point Depression

Table 1: Molality and Freezing point of Solutions

Solute	i	Molality	T_f calculated	T_f observed	% Error
$C_{12}H_{22}O_{11}$	1	0,500	- 0,93°C	-1,2°C	22,5%
NaCl	2	0,500	- 1,86	- 3,60	48%
$CaCl_2$	3	0,500	- 2,79	- 5,9	52%
$Fe(NO_3)_3.9H_2O$	4	0,500	- 3,72	-4,6	19%

Show one sample calculation for each calculated quantity (for one solution only).

$C_{12}H_{22}O_{11}$: $\Delta T_F = iK_F m \Rightarrow 0,0 - T_F = 1(1,86)(0,500)$
$\Rightarrow T_F = -0,93°C$.

Part III: Boiling Point Elevation

Table 2: Molality and Boiling Point of Solutions (in 25.00 g of solvent)

Solute	Mass	Moles	i	Molality	T_b calculated	T_b observed	% Error
NaCl (1)	1,461	0,024	2	0,96	100,9984	100.9	0,0975%
NaCl (2)	2,9220	0,0499	2	1,996	102,078	101,2	0,865%
$CaCl_2$ (1)	2,7748	0,0250	3	1	101,56	100.6	0,954%
$CaCl_2$ (2)	5,5495	0,05	3	2	103,12	102.3	0,801%

Show one sample calculation for each calculated quantity (for one solution only).

$m_{NaCl} = 1,461$

$n_{NaCl} = \frac{m}{M} = \frac{1,461}{58,5} = 0,024$ moles

$m = \frac{n_{solute}}{m_{solvent}} = \frac{0,024}{25 \times 10^{-3}} = 0,96\ m$

$\Delta T_b = i K_b m = (2)(0,52)(0,96) = 0,9984$

$\Delta T_b = T_b - 100$

$T_b = \Delta T_b + 100 = 0,9984 + 100 = 100,9984°C$

Questions

1. a) What is the molality of a solution containing 2.68g of naphthalene ($C_{10}H_8$) in 38.4 g of benzene (C_6H_6)?

   b) What is the freezing point of the above solution? K_f of benzene = 5.12 °C/m. Freezing point of benzene = 5.5 °C.

a) $n_{C_{10}H_8} = \frac{m}{M} = \frac{2,68}{10 \times 12 + 8} = 0,021$ moles of naphtalene

$molality = \frac{0,021}{0,0384} = 0,55\ m$

b) $\Delta T_F = i K_f' m = 0,55 \times 1 \times 5,12 = 2,816$

$\Delta T_F = T_F^\circ - T_F = 5,5 - T_F$ $\quad \Delta T_F = 5,5 - 2,816 = 2,7°C.$

2. Calculate the molality of 6.0 M H_2SO_4 solution. The density of the solution is 1.34 g/mL. $d = \frac{m_{solut°}}{V_{solut°}}$. assume that the $V_{solution} = 1L$.

$m_{solut°} = d \times V = 1,34 \times 1 \times 10^3 = 1340g$

$m_{solvent} = m_{solution} - 6,0 \times M \times 1 = 1340 - 6 \times (2 \times 1 + 32 + 4 \times 16) \times 1$

$= 752g$

$molality = \frac{6}{m_{solvent}} = \frac{6}{752 \times 10^{-3}} = 7,9\ m$

3. A solution that contains 55.0 g of ascorbic acid (Vitamin C) in 250.0 g of water freezes at –2.34°C. Calculate the molar mass (in units of g/mol) of the solute. K_f of water is 1.86°C/m.

$\Delta T_F = T_F^\circ - T_F = 0 - (-2,34) = 2,34$

$\Delta T_F = i K_f m \Rightarrow m = \frac{\Delta T_F}{i K_f} = \frac{2,34}{1 \times 1,86} = 1,25\ m$

$molality = \frac{n_{solute}}{mass\ solvent} \Rightarrow n_{solute} = m \times m_{solvent} = 1,25 \times 0,25$

$= 0,3125$ moles

$n = \frac{m}{M} \Rightarrow M = \frac{m}{n} = \frac{55}{0,3125} = 176\ g/mol$