Key

$K_f \cdot m \cdot i$ → moles solute / kg solvent

Chemistry: Colligative Properties

1. A solution is prepared in which 171.0 grams of sucrose, $C_{12}H_{22}O_{11}$, is dissolved into 150.0grams of water.
   a. How many moles of solute are there? $171 / 342 = .5 mol$
   b. What is the molality of the solution? $.5 mol / .15 kg = 3.33 m$
   c. What is the freezing point depression (ΔT_f)? $\Delta T_f = K_f \cdot m \cdot i \quad \Delta T_f = -1.86 \cdot 3.33m \cdot 1 = -6.2°C$
   d. What is the new freezing point? $0 + -6.2 = -6.2°C$
2. What is the freezing point of a solution of a nonelectrolyte dissolved in water in the concentration of the solution? .24m
   $\Delta T_f = K_f \cdot m \cdot i \quad -1.86 \cdot .24 \cdot 1 = -.4464 \quad 0 + -.4464 = -.4464°C$
3. Calculate the expected freezing point depression of a 0.200m KNO_3 solution.
   $\Delta T_f = -1.86 \cdot .2 \cdot 2 = -.744°C$
4. What is the expected boiling point elevation of water for a solution that contains 150g of sodium chloride dissolved in 1.0kg of water?
   $150g / 58 = 2.59 mol / 1 = 2.59m \quad \Delta T_b = K_b \cdot m \cdot i$
   $\Delta T_b = .51 \cdot 2.59m \cdot 2 = 2.64°C$
5. Determine the boiling point elevation of H_2O in a 2.5m solution of glucose in H_2O.
   $\Delta T_B = .51 \cdot 2.5m \cdot 1 = 1.28°C$
6. How many grams of antifreeze, $C_2H_4(OH)_2$ would be required per 500g of water to prevent the water from freezing at a temperature of –20 C
   $0 - -20 = -20 \ \Delta T_f \quad -20 = -1.86 \cdot m \cdot 1 \quad m = 10.75m = x/.5$
   $5.38 mol / 62g = 333.56g$
7. The freezing point of an aqueous solutions of barium nitrate is –2.65 C. Determine the molal concentration of barium nitrate.
   $-2.65 - 0 = -2.65 = -1.86 \cdot m \cdot 3 = .475m$
8. What is the boiling point of a solution of ethyl alcohol, C_2H_5OH, that contains 20.0g of the solute dissolved in 250g of water?
   $20g / 46 = .435 mol / .250 = 1.74m \quad \Delta T_B = .512 \cdot 1.74m \cdot 1 = .89$
   $K_b \quad 100 + .89 = 100.89°C$
9. A solution is prepared in which 33.0grams of $MgCl_2$ is dissolved in 100.0grams of water. What is the freezing point of this solution?
   $33g\ MgCl_2 / 95 = .35 mol / .1 kg = 3.47m$
   $\Delta T_f = -1.86 \cdot 3.47 \cdot 3$
   $-19.38°C$
   $F = 0 + -19.38 = -19.38°C$

$\frac{97g}{212} = .46mol / .3kg = 1.53m$

10. A solution contains 97.0 grams of K_3PO_4 dissolved in 300.0g of water. What is the new boiling point? $\Delta T_B = .51 \cdot 1.53m \cdot 4 = 3.11°C$ $100 + 3.11 = \boxed{103.11°C}$

11. How much will the freezing point be lowered if enough sugar is dissolved in water to make a 0.50molal solution? $\Delta T_f = -1.86 \cdot .5 \cdot 1 = \boxed{-.93°C}$

12. A researcher places 0.653mol of an unknown nonelectrolye in 505g naphthalene. What is the new freezing point? $\frac{.653}{.505} = 1.29m$ $-6.8 \cdot 1.29 \cdot 1 = -8.79$ $80.2 + -8.79 = \boxed{71.41°C}$

13. If a solution has 0.304mol of a nonvolatile nonelectrolyte in 264g of the alcohol, what is the new boiling point? $\frac{.304mol}{.264kg} = 1.29m$ 1.152m. $1.22 \cdot 1.152m \cdot 1 = 1.405°C$ $78.4 + 1.405 = \boxed{79.805°C}$

Solvent	normal freezing pt	K_f (C/molal)	normal boiling pt	K_b (C/molal)
Water	O C	-1.86	100 C	0.512
Naphthalene	80.2 C	-6.8	217.7 C	3.56
Ethyle alcohol	-117.3 C		78.4 C	1.22