COLLIGATIVE PROPERTIES

Solvent	*Normal Freezing Pt* (°C)	*Molal Freezing Point Constant,* K_f (°C/m)	*Normal Boiling Point* (°C)	*Molal Boiling Point Constant,* K_b (°C/m)
Acetic Acid	16.6	-3.90	117.9	3.07
Camphor	178.8	-39.7	207.4	6.61
Ether	-116.3	-1.79	34.6	2.02
Phenol	40.9	-7.40	181.8	3.60
Water	0.00	-1.86	100.0	0.51

1. What is the freezing point depression of water in a solution of 75.0 g sucrose ($C_{12}H_{22}O_{11}$) and 500.0 g water? What is the actual freezing point of this solution?
2. A solution made with ether as the solvent boils at 36.20 °C. What is the molal concentration of the solution?
3. If 0.650 mols of solute are dissolved in 0.500 kg of camphor, what is the freezing point of the solution?
4. A water solution that contains ~~420.0~~ 124.0 g of solute in 250.0 g of water is found to boil at 103.50C. Utilize this data to determine the molar mass of the solute.
5. A solution contains 50.0 g of sucrose, $C_{12}H_{22}O_{11}$, dissolved in 500.0 g of water. What is the boiling point of this solution?

1. $\Delta t_f = K_f m$ $\quad m = \frac{0.219\ mol\ C_{12}H_{22}O_{11}}{0.5000\ kg} = 0.438\ m\ C_{12}H_{22}O_{11}$

$75.0\ g\ C_{12}H_{22}O_{11}\left(\frac{1\ mol\ C_{12}H_{22}O_{11}}{342.34\ g}\right) = 0.219\ mol\ C_{12}H_{22}O_{11}$

$= \left(-1.86\ \frac{°C}{m}\right)(0.438\ m)$

$= -0.815\ °C$ $\quad$ Actual F.Pt = 0.00°C − 0.815°C → −0.815°C

2. B.Pt = 36.20°C ~ Ether Soln.

$\Delta t_b = 36.20°C - 34.6°C = 1.6°C$

$\Delta t_b = K_b m$

$\frac{\Delta t_b}{K_b} = m$

$\frac{1.6°C}{2.02\ \frac{°C}{m}} = 0.79\ m$

3. $\Delta t_f = K_f m$

$= \left(-39.7\ \frac{°C}{m}\right)\left(\frac{0.650\ mol}{0.500\ kg}\right)$ (1.30 m)

$= -51.6°C$

f.pt camphor: 178.8°C − 51.6°C

$= 127.2°C$

4. $\frac{124.0\ g\ solute}{1.7\ mol} = 73\ \frac{g}{mol}$

$\Delta t_b = 100.0°C - 103.5°C = +3.5°C$

$\Delta t_b = K_b m$

$\frac{\Delta t_f}{K_b} = m$

$\frac{(-3.5°C)}{-0.51\ \frac{°C}{m}} = 6.9\ \frac{mol}{kg}(0.2500\ kg) = 1.7\ mol$

5. $50.0\ g\ C_{12}H_{22}O_{11}\left(\frac{1\ mol}{342.34\ g}\right) = 0.146\ mol$

$m = \frac{0.146\ mol}{0.5000\ kg} = 0.292\ m$

$\Delta t_b = K_b m$

$= \left(0.51\ \frac{°C}{m}\right)(0.292\ m)$

$= 0.15$

↳ b.pt = 100.15°C