

# Exercise 13.2a

## Colligative Properties

Name: \_\_\_\_\_

Date: \_\_\_\_\_ Per: \_\_\_\_\_

When a solute is added to a solvent, the vapor pressure of the solvent (above the resulting solution) is less than the vapor pressure above the pure solvent. This affects both the freezing point and boiling point of the solution. The change in freezing/boiling point is based on the identity of the solvent – the identity of the solute makes no difference as long as it will not leave the solution prior to phase change (i.e., it must be non-volatile for boiling point elevation). The important aspect of the solute is how many particles are produced by its dissolution. Electrolytes (ionic compounds) dissociate into multiple ions and their concentrations must be adjusted to reflect this in calculations.

### Freezing Point Depression

The freezing point of a solution is always lower than the freezing point of the pure solvent in the solution. The change in freezing point can be calculated using the formula below:

$$\Delta T_f = K_f \cdot m$$

This value represents the change in freezing point, not the new freezing point, so its value must be subtracted from the pure solvent's typical freezing point.

### Boiling Point Elevation

The boiling point of a solution is always higher than the boiling point of the pure solvent in the solution. The change in boiling point can be calculated using the formula below:

$$\Delta T_b = K_b \cdot m$$

This value represents the change in boiling point, not the new boiling point, so its value must be added to the pure solvent's typical boiling point.

**DIRECTIONS:** Calculate the following in the space provided:

- How much will the freezing point be lowered if enough sugar (**a non-electrolyte**) is dissolved in water to make a 0.500 *m* solution?
- What is the freezing point of a solution with a **non-electrolyte** solute dissolved in water if the concentration of the solution is 2.40 *m*?
- What is the freezing point of a solution that contains 2.50 mol of MgCl<sub>2</sub> (**ionic = electrolyte**) in 600. g of water?

- What is the boiling point of a solution in which 55.0 g KCl is dissolved in 500. g of H<sub>2</sub>O?

solvent	normal freezing point (°C)	K <sub>f</sub> (°C/m)
water	0.0	1.86
acetic acid	16.6	3.9
benzene	5.5	5.12
chloroform	-63.5	4.68
nitrobenzene	5.67	8.1

  

solvent	normal boiling point (°C)	K <sub>b</sub> (°C/m)
water	100.0	0.512
acetic acid	118.1	3.07
benzene	80.1	2.53
chloroform	61.3	3.63
nitrobenzene	210.9	5.24

