

WKS
Colligative Properties of Solutions
(FP depression and BP elevation)

Name Key
Period _____

How Concentration of Solute affects Boiling points and Freezing points: $\uparrow M \uparrow BP$ and $\uparrow M \downarrow FP$

The greater the amount of solute molecules/ions dissolved in the water, the greater the effect (the boiling point increasing and the freezing point decreasing).

Ex: Boiling point of 2 M NaCl solution is **higher** than a 1 M NaCl solution.

Ex: Freezing point of a 2 M NaCl solution is **lower** than a 1M NaCl solution.

- 1) Arrange the following solutions from lowest to highest boiling point.

2 grams of NaCl / 10 mL of water ; 1 gram of NaCl / 10 mL of water; 3 grams of NaCl / 10 mL of water.

Lowest BP 1 gram 2 grams 3 grams highest BP

- 2) Arrange the following solutions from lowest to highest freezing point

2 mL alcohol / 20 mL water; 4 mL alcohol / 20 mL water; 3 mL alcohol / 20 mL water

Lowest FP 4 mL 3 mL 2 mL highest FP

- 3) Arrange the following from lowest to highest boiling point

1 M CO₂ (aq) ; 3 M CO₂ (aq) ; 4 M CO₂ (aq); 2 M CO₂ (aq); 5 M CO₂ (aq)

Lowest BP 1 M 2 M 3 M 4 M 5 M highest BP

- 4) Arrange the following from lowest to highest freezing point

1 M CaCl₂ (aq) 3 M CaCl₂ (aq) 2 M CaCl₂ (aq) 4 M CaCl₂ (aq)

Lowest FP 4 M 3 M 2 M 1 M highest FP

ANALYSIS of Club Soda (carbonated water) demo: Explain as thoroughly as possible. Use concepts discussed in class.

- 1) **Unopened bottle of club soda:** It is placed in -8 °C ice/salt bath. It does not freeze. Why not?

Since there is a high concentration of CO₂ in the soda (high pressure = high concentration), the freezing point has decreased to below -8°C. Since the temperature is above the freezing point, the soda remains liquid.

- 2) **Bottle is opened:** While the club soda is still at -8 °C, the bottle is opened. Now it freezes. Why?

When the bottle is opened, the pressure inside the bottle drops, and the solubility of CO₂ drops as well. The CO₂ bubbles out of solution, and as the concentration of the solute drops, the freezing point rises. When the freezing point comes above -8°C, the temperature of the soda is now low enough to freeze the liquid.