Chem 1 Hour\_\_\_\_\_ Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
Dr. Wexler
Lab: Effect of Solutes on the Freezing Point of Water
Date:

**Purpose:**
Measure and compare changes to the freezing point of a solvent when two different kinds of solutes are added.

**Introduction:**
Water freezes below 0°C. Ice floating in water will absorb energy (heat) from the water. This has two effects. First, the ice begins to melt. Second, the water becomes cooler. The water will not become cold enough to freeze, however, because at the freezing point of water (0°C) the rate of melting and refreezing is the same. This means that heat is absorbed and released by the ice at the same rate.
 

Frozen water molecules at the surface of the ice must absorb energy in order to detach from the ice (and therefore become liquid). They get this energy from the surrounding liquid. Adding salt increases the rate of melting, which increases the absorption of energy. As a result, the liquid water becomes colder than 0°C and it does so without freezing because the salt lowers the freezing point. **In other words, the ice can melt (cooling the liquid), but the liquid cannot refreeze until it is cold enough (the new, lower, freezing point).**

*The effect of solute on freezing point depends only on the particle concentration, not its chemical identity. For example, a one molar solution (1M, 1mole/liter) of NaCl will have a greater effect than a one molar solution of sucrose. This is because the NaCl, but not the sucrose, dissociates into two particles when dissolved in water (Na+ and Cl-).*

 **Objectives:**1. Understand what causes water to freeze or melt.
2. Determine the change in the freezing point of water when NaCl or sucrose is added. Sucrose is table sugar,
C12H22O11
3. Understand why salts are more effective than sugars in changing the freezing point of water.
4. Understand why solutes decrease the freezing point of liquids and cause supercooling.

**Procedure:**1. Fill a plastic cup halfway with water. Add a few chunks of ice.
2. Stir until the temperature stops decreasing. Record the temperature (°C). This is the freezing point.
3. Add 6 grams of NaCl. Stir with a spoon until dissolved.
4. Stir until the temperature stops decreasing. Record the temperature.
5. Repeat with an additional 6 grams of NaCl.
6. Repeat with one more additional 6 grams of NaCl.
7. Discard the salt solution and refill the plastic cup as before with water and ice.
8. Add 36 grams of sucrose. Stir with a spoon until dissolved.
9. Stir until the temperature stops decreasing. Record the temperature (°C)

**Results:**

|  |  |  |
| --- | --- | --- |
| Solute | Grams NaCl | Freezing point (°C) |
| 1. No solute (water alone) | 0g |  |
| 2. NaCl | (1) + 6g |  |
| 3. NaCl | (2) +6g = 12g total |  |
| 4. NaCl | (3) +6g = 18g total |  |
| 5. Sucrose | 6g |  |

**Discussion Questions:**1. What is the effect on the freezing point of water of adding NaCl?

2. What is the average effect of increasing the amount of NaCl by 6g?
Calculate this by summing the freezing point decreases of the three NaCl samples, then dividing by 3. Show your calculations.

3. Which solute, NaCl or sucrose, had a greater effect on the freezing point of water?

4. Explain why adding salt to ice water lowers the freezing point.

5. Explain **why** one solute had a greater effect than the other (comparing NaCl and sucrose) on the freezing point of water (see introduction)

6. Explain why adding salt to ice water causes the temperature of the water to drop: