# Breaking the Ice: Freezing Point Depression

## Research Question

The purpose of this project is to determine which solutions of salt (NaCl), sugar (C12H22O11), pure water and white vinegar causes ice to melt the fastest. So, which solvent out of salt, sugar, and white vinegar is the most effective at melting ice?

## What is Freezing Point Depression and How do Solutes Affect it?

Freezing point depression is a colligative property where the freezing point of a liquid is affected by adding a solute making the liquid freeze at lower temperatures. Solutes such as salt, sugar, and white vinegar affect the freezing point of liquids through their cryoscopic constant, which determines how much the freezing point drops. The solutes with higher cryoscopic constants cause greater depression, which affects a liquid's ability to form a solid.

# Importance of This Project

**The importance of this project is to observe which cheap solvent out of salt, sugar, and white vinegar is the most effective at melting ice and keeping the road safe. Ice forms on the road when there is moisture from rain, snow, or fog. The water from these natural occurrences freeze when the temperature is below at or below 0° C, this is water's freezing point. The ice that forms on the road causes a road hazard, and many accidents can occur due to loss of traction. The loss of traction can cause the drive lose some control of their vehicle, steering becomes difficult, and the brakes become less effective. Solvents, such as the ones used in this experiment, are used to lower water's freezing point to prevent the formation of ice. As a result, the road becomes safer during the winter when ice formation is most prominent.**

# Procedures

## Preparation Standardized of Ice Samples

1. The water was poured into individual compartments of the ice cube mold to the fill lines.
2. This process was repeated until 12, identical, standardized ice samples were created.
3. The ice mold was placed in a freezer, and the samples were allowed to freeze for a minimum of 24 hours to ensure consistent initial temperature and crystalline structure.

## Preparation of Solute Solutions

1. 50 mL of tap water was poured into a cup (repeated 4 times into four different cups)
2. 15 mL of the first solute (NaCl) was measured using a measuring cup.
3. The measured solute was poured into a cup of measured tap water.
4. The cup was stirred using the spoon to dissolve the solute into the water.
5. The solution was transferred to a medium-sized plastic bag for containing.
6. Steps 2–5 were repeated for Sugar ($C_{12}H_{22}O_{11}$)
7. A control is created by leaving aside a cup with 50 mL of tap water.
8. 25 mL of White Vinegar poured into a beaker and measured using a scale that reads in mL
9. Steps 3-5 were repeated for White Vinegar
10. The control is also transferred to a medium-sized plastic bag for containing.

## Experiment Process

1. One standardized ice cube was removed from the freezer and immediately placed into a plastic container
2. ½ teaspoon of the salt solute was measured and poured onto the ice cube
3. The time it took the ice to melt was recorded with a stopwatch on a phone.
4. The time was written down.
5. The melted ice cube and solution in the bin were washed out.
6. Steps 1–4 were repeated two more times for the solution to obtain three replicate trials.
7. Steps 1–5 were repeated for each of the remaining test solutions (White Vinegar, Sugar ($C_{12}H_{22}O_{11}$) and the control solution.)
8. After every trial was completed, the average of every solution was calculated ((Trial 1 + Trial 2 + Trial 3) / Number of Trials = Average Time)

# Hypothesis, Independent/Dependent Variables

Hypotheses

**Hypothesis:** If solutions of salt, sugar, white vinegar, and pure water are applied to ice cubes, then salt would be the most effective at melting ice on average.
**Null Hypothesis:** If solutions of salt, sugar, white vinegar, and pure water are applied to ice cubes, then each solution would be same in terms of effectiveness on average.

Independent/Dependent Variables

Independent Variable: Independent variable: Solutes, (Solutes include Salt (NaCl), White Vinegar, Sugar ($C_{12}H_{22}O_{11}$). These solutes will be added to the water to see how it affects the time it takes the ice to melt.
**Dependent variable**: Water's freezing point, the temperature at which the water freezes being affected by the solutes and how long it takes for the ice to melt due to the change in the freezing point.