**Salt Truck Lab: Investigation of the effect of salt on the freezing point of water**

(7/2017)

**Teacher Notes:**

This lab is an introduction to Vernier equipment using the temperature probes. This is a good lab to use during the winter to help students make the connections between what they learn in the classroom and what they see going on outside with road crews. It can be used in ICP or introductory chemistry classes. An exercise in working through colligative properties can be added to the lab by the teacher since sodium chloride and calcium chloride have different “i” values.

This lab should take 45 minutes.

**Materials from Science Express:**

Veriner temperature probe

Interface (LabQuest, LabQuest 2 or LabPro or LabQuest Mini and laptop)

**Other Materials (per group):**

Sodium Chloride (10 g)

Calcium chloride (10 g)

2 beakers

Ice

Water

Stir plate (also available from science express). This is not required. Students can stir the solution, but constant stirring is recommended

**Teacher background**   
from the “Effective Anti-Icing Program” webpage of the Federal Highway Administration

De-icing and anti-icing both make use of chemical freezing point depressants.

Anti-icing: conducted to prevent the formation or development of bonded snow and ice for easy removal. Before a storm begins, an aqueous solution of sodium chloride and/or calcium chloride can be used as a salt brine on highways. It is spread on dry road surfaces. The solution sticks to the road surface until it reacts with moisture. As soon as the snow falls, the brine reacts without the precipitation causing a quick exothermic heating and melting. The new solution created will refreeze at the temperature of the salt brine, which is 5 degrees Fahrenheit for CaCl2 and 15 degrees Fahrenheit for NaCl. This results in less black ice and frozen roads. It is more cost effective and environmentally friendly.

De-icing: performed to break the bond of already-bonded snow and ice. It is commonly initiated only after 25 mm (~1 in) or more of snow has accumulated and bonded to the road. After a winter storm has begun, dry salt and abrasives are added to the top of existing snow. Most de-icing agents bounce on the surface causing various scattering and distribution. Abrasive agents act only to provide friction. The moisture in the snow pack will react with chemical salt agents causing a slow snow melt. Both of these reactive agents are considered environmentally toxic and costly.

**Pre-lab discussion topics for the class:**

* Have students noticed the salt trucks that spray the roads before a storm? Why do they do this instead of putting salt down?
* Why must the roads be dry to use the spray?
* Why do trucks put down rock salt instead of spray once the snow has already fallen?
* What does the salt do to the freezing temperature of water?

**Salt Truck Lab**

**Purpose:** Before, during, and after a winter storm, salt trucks can be seen on the roads. In this lab you complete an experiment to help you understand the effect of salt on the freezing point of water.

**Materials:**

Temperature probe and Vernier interface

2 beakers

Ice

Sodium chloride (NaCl)

Calcium chloride (CaCl2)

Stirring rod

Cold water

**Procedure:**

Part 1: Control

1. Fill a beaker half-way with cold water.
2. Add ice, filling the beaker to the top
3. Set the temperature probe to collect data for 10 minutes, taking 4 measurements per minute or every 15 seconds.
4. Insert the temperature probe and being collecting data. Write down your initial temperature in the data table.
5. While your temperature probe is collecting data, begin preparing for Part 2.
6. Record your final temperature in the data table.

Part 2: Sodium Chloride

1. Weigh out 10 grams of sodium chloride. Record the exact mass in your data table.
2. Fill a beaker half way with cold water.
3. When you are done with part 1, fill this beaker with ice to the top.
4. Insert the temperature probe and begin collecting data. Write down your initial temperature in the data table.
5. You will add salt every 90 seconds. You should stir your beaker to be sure the salt dissolves. About 20 seconds after you add the salt, record the time and temperature.   
    Be sure all of the salt is added by around 9 minutes.
6. Record your final temperature in the data table.
7. Create a line graph showing the temperature change over time.

Part 3: Calcium Chloride.

Repeat the procedure from Part 2 using Calcium Chloride.

For step 7, you can add this data to the graph you made for a NaCl. Use a different color to draw your line.

# Data

|  |  |  |  |
| --- | --- | --- | --- |
|  | Control | NaCl | CaCl2 |
| Total mass added |  |  |  |
| Initial Temperature |  |  |  |
| Final Temperature |  |  |  |
| Temperature Change |  |  |  |

Post-Lab Questions

1. What happened as the salt was added to the ice water? Explain why this happened.
2. Compare the NaCl and CaCl2. Which salt lowered the temperature of the water more?
3. If you were in charge of the city roads, and you could use one salt for making salt brine solution and one for de-icing after a storm, which salt would you use for each purpose?
4. Thinking about salt trucks in the winter and the data you collected in this lab, why do trucks add salt brine to the roads before a snowstorm?
5. Salt brine is an anti-icing agent and rock salt is a de-icing agent. How are they different?