Lesson Objective

- Learn the molecular arrangement in liquids vs solids
- Understand freezing point depression in a solution
- Discuss the practical implications of freezing point depression

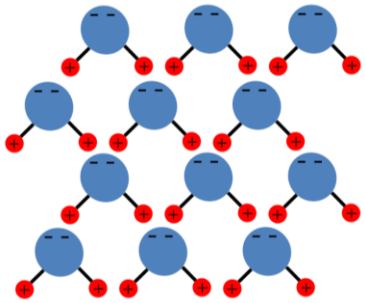
Activity 1: Start the ice cream (5 minutes)

We will be using a hand cranked ice cream maker to make a large container of ice cream for all to share. Students will take turns cranking the ice cream throughout the lesson.

As a group, pour ice cream mixture into canister and install crank assembly. Pour in ice and salt. Ask the students: why are we adding salt? If they don't know the answer, tell them we are about to find out!

Activity 2: Discussion and polar puzzle (15 minutes)

- Referring to the molecule/ion cutouts, ask students/help answer some of the following questions:
    - What is an element?
    - What do we call a particle made up of a collection of elements?
    - Do you know the chemical name of water?
    - What does H2O mean?
    - How many oxygen atoms and how many hydrogen atoms make up water?
    - Which circles – blue or red – probably represent oxygen?
- Build a crystal of water molecules.
    - if students are familiar with interaction between electric charge, ask them how two water molecules would arrange themselves
    - if students are not familiar with electric charge, you may want to simply explain that the molecules like to line up minus-to-plus and not minus-to-minus or plus-to-plus
    - ask the students to arrange all 12 water molecules so they fit on a sheet of paper. Hopefully, it looks like the picture below, an entirely unreal 2D ice crystal. I've added two minus signs to the oxygen molecules which may aid in this task.



    - explain to the students that they have just assembled a "crystal." In the case of water, it is also called ice. In other words, we have just "frozen water."

    - *optional*: ask the students what happens if we shake the piece of paper. This represents heat and should result in melting our crystal.
- Attempt (and fail) to build a crystal of salt water.
    - tell the students that salt water contains extra particles called ions. Table salt contains positive Sodium (Na^+) ions and negative Chloride/Chlorine (Cl^-).
    - add two ions to the collection of molecules and ask the students to assemble the ions and molecules so that charges match up appropriately. This should be more difficult/impossible.
    - ask the students if it is easier to freeze salt water or plain water? With this in mind, is it easier to melt salt ice or plain ice?
- Have the students read the three statements on their worksheet and pick the follow up response that they think is consistent.

<u>Activity 3: Melting experiment (25 minutes)</u>

Now that we know that salt melts ice at lower temperatures, we will investigate other potential solvents for their effectiveness. In this experiment we will be observing ice cubes melt in the presence of two potential solvents: salt, sugar.

- Introduce the methods to the students and ask them to predict which addition (or the control) will melt the most quickly and which will end at the coldest temperature.
- Label 3 plastic cups: “pure ice” or “control”, “salt”, “sugar.”
- In each respective cup place one ice cube of similar size.
- Fill the cup with cold water until about ¾ full.
- Add 1 tbsp. of salt or sugar as appropriate.
- Measure the temperature of each cup at two minute intervals and record. Stir the mixture before each temperature measurement.
- While waiting between measurements, discuss the practical applications of freezing point depression (antifreeze in radiators, preventing icy roads, making ice cream, etc….)
- Collect data until the mixture equilibrates (should be less than 20 minutes)
- *time permitting:* plot the temperature of each solution over time on the graph provided.
- Compare the result to predictions and discuss.

<u>Activity 4: eat ice cream (10 minutes)</u>

- Yum!