Lab 2: Phase transitions & ice cream

Lab sections on Tuesday Sept 18 – Friday Sept 21

In this lab you will observe how changing two parameters, pressure and salt concentration, affects the two phase transitions of water, boiling and melting. In Part I, your TF will demonstrate how reducing pressure changes the boiling point of soda, which is mostly water, by studying distillation with a rotovap. In Part II, you will study how different salt concentrations alter the melting temperature of water, and use your measurements to plot a phase diagram. Finally, in Part III, you will use the altered melting point of salty water to make ice cream – i.e. you will use an altered phase transition of one material to obtain a phase transition in another.

Equation of the week:

$$U = Ck_BT$$

	Description	Units
U	Bond energy for liquid to gas transitions	J
C	Constant (1.5 for water)	--
k_B	Boltzmann constant	J/K
T	Temperature	K

Part I: Demonstration of distillation using a rotovap

Materials:

- Rotovap
- 2 plastic containers (1 for the distillate /1 for the reduction)
- Plastic spoons for tasting

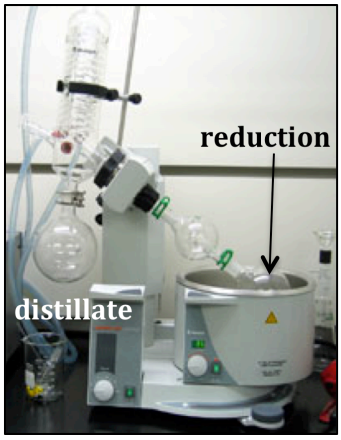
Ingredients:

- Soda
- Ice (for the condenser bath)

Procedure:

Your TF has prepared the rotovap for the distillation of soda. You will get to see and taste the two resulting products, the distillate and the reduction. Using a very sensitive instrument (your mouth!) you will determine if the various components of soda are volatile or not.

Please record your observations on the worksheet.



Part II: The effect of salt on the phase transition of water

Materials:

- 1 beaker
- 1 spoon
- 1 scale (1 g accuracy)
- 1 graduated cylinder
- 1 funnel
- 1 sieve
- 1 thermometer
- weighing cups

Ingredients:

- 1 L tap water
- 500 g ice
- 75 g salt

Procedure:

1. Measure 200 ml of tap water in a beaker.
2. Add 100g of ice to the beaker and stir vigorously.
3. Measure the temperature, but wait until it is steady (~10 sec) before you record the lowest stable temperature on the results chart (top row, last column). While waiting, the ice will partially melt and cool the water until the solution reaches a low enough temperature where the ice cannot melt further. The temperature at which this happens, is the melting point of water.
4. While there is still ice in the beaker, pour the solution through the sieve/funnel into the graduated cylinder. Toss the ice. Record the new water volume on the results chart in the column for "final volume of water". This step is necessary because some of the ice probably melted, and in order to calculate the salt concentration, we need to know the total volume of water it is dissolved in.
5. Next dissolve 5g of salt into 200 ml of tap water in a beaker.
6. Repeat steps 2-4 and record your measurements on the results chart.
7. Repeat for 10g, 20g, and 40g of salt.
8. Using your measurements for the "final volume of water", calculate the salt concentration in each beaker.
9. You now have all the data you need to plot your own phase diagram with temperature and salt concentration on the axes. Use the chart provided on the worksheet for this, and label it with the two phases we have observed, i.e. "solid" and "liquid".

Part III: Use the altered phase transition of salty water to make ice cream

Materials:

- Ziploc bags (2 large, 2 small)
- 1 scale (1 g accuracy)
- 1 oven mitt
- 1 plastic cup/group member
- weighing cups
- tasting spoons

Ingredients:

- 90 g heavy cream
- 100 g whole milk
- 20 g sugar
- ¼ tsp vanilla extract or other flavor
- 600 g ice
- 200 g salt

Procedure:

1. Fill a *large bag* with 600 g of ice. Add 200 g of salt.
2. Add heavy cream, milk, sugar, and vanilla extract (or other flavor) into the *small bag*. Seal it, trying to press out air bubbles, and place it into a second small bag to prevent

leaking.

3. Place the bag with the ice cream ingredients inside the large bag with ice. Place the entire package into a second large bag to prevent leaking.
4. Shake, massage, or gently throw the bag between members in your group until the ice cream becomes solid. The way you do this will affect the texture – try to find a group doing it differently, and compare!
5. Remove the small bag with ice cream from the large bag with ice. Wipe off the top of the small bag and then open it carefully. Spoon into the cups and enjoy!

Lab 2: Worksheet

Name: _____ TF: _____

Part I: Demonstration of distillation using a rotovap

1. Based on your observations of the distillate and the reduction, which of the following components would you predict are volatile and which are not volatile at the temperature and pressure inside the rotovap flask?

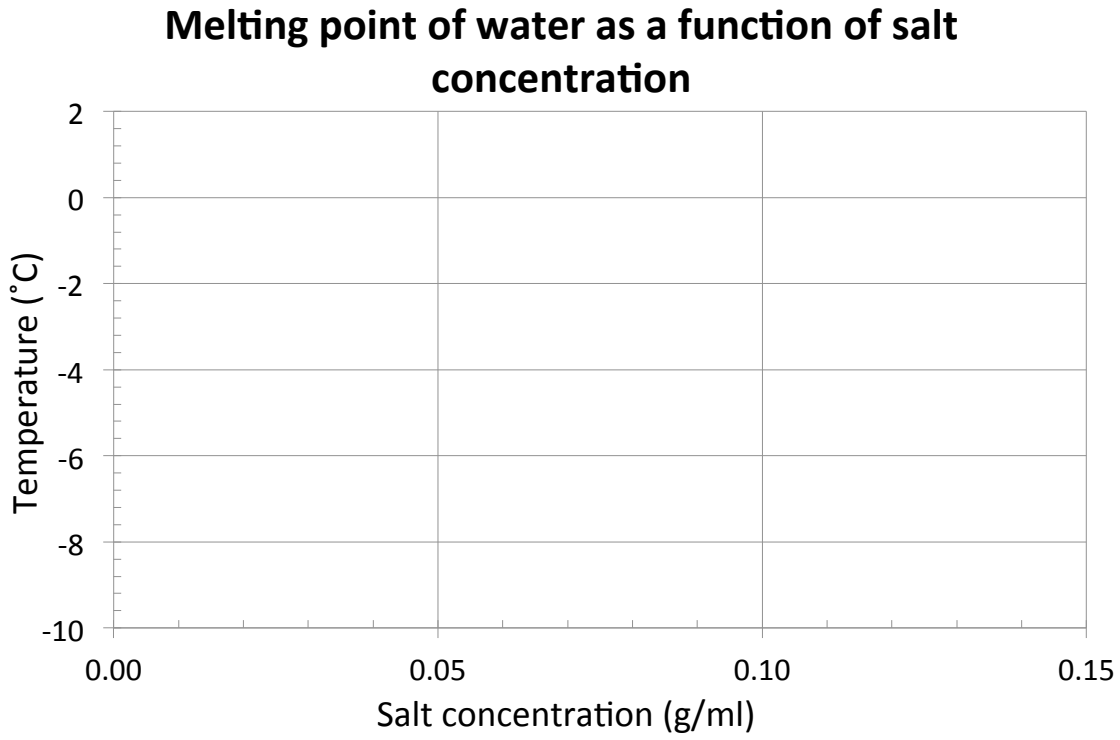
	Sugar	*Acid*	*Color*	*Aroma*	*Carbonation*
Volatile					
Not Volatile					

Part II: Effect of salt on the phase transition of water

2. Record your measurements on the chart below.

Mass of salt (g)	Initial volume of water (ml)	Initial mass of ice (g)	Final volume of water (ml)	Final salt concentration (g/ml)	Melting point of salt+water (˚C)
0					
5					
10					
20					
40					

3. Use your data from the previous page to plot a phase diagram describing how the melting point of water varies with the salt concentration. Label the two phases you observed, i.e. “solid” and “liquid”.



4. In Part II, steps 1-4, you mixed water with ice without adding any salt. You then measured the temperature. Why did some of the ice melt even without the addition of salt?

5. Later in Part II, steps 5-7, you added salt to the ice/water mix. You probably observed that the temperature decreased further the more salt you added. Based on what we discussed in lecture, explain in **two short sentences** why the melting temperature of water decreases in the presence of salt.