

# Experiment: Boiling points of solutions

## Theory:

The boiling point and freezing points of a solution are different from the boiling and freezing points of a pure solvent. Adding a solute to a solvent elevates the boiling points and depresses the freezing point. The change in boiling points of a solution compared to a pure solvent can be measured, and the value can be calculated with the following formula:  $\Delta T = k_b m i$  ( $i$  is the number of particles produced by solute,  $k_b$  is the molar constant, and  $m$  is molality of a solution)

In this lab, you will find the boiling points of distilled water, a urea-water solution, and a salt-water solution. Temperature readings will be taken for the samples as each is heated from room temperature to the boiling point. The time and temperature data will be plotted on a single graph. From the graph you can compare the boiling points of the different samples.

## Procedure:

1. Precisely measure out 50.0 ml of distilled water with a graduated cylinder and place it into a small beaker. Put two or three boiling chips into each beaker.
2. Carefully place a thermometer in the beaker so that the bulb of the thermometer is about 1 cm above the bottom of the beaker.
3. Find the initial temperature of the water and record it in the data table.
4. Put the beaker on a hot plate, adjust the knob to 3.
5. Record temperature of the solutions in 30 second intervals. Continue until the sample has been at a full boil for 3 minutes.
6. Repeat steps 1-5 for urea water and salt water.

Time (min)	Temperature (°C)		
	Distilled water	Urea-water	Salt-water
0.00			
0.5			
1.0			
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			
6.0			
6.5			

## Calculations:

1. Complete a calculation to predict what the new boiling point for the urea-water solution should be.
2. Complete a calculation to predict what the new boiling point for the calcium chloride-water solution should be.

## Analysis and Conclusions

1. Construct a boiling-point graph using only the data collected for the temperature above 80°C, plotting temperature as a function of time. Plot the data for all three samples-distilled water, urea-water solution, and the calcium chloride water solution- on the same graph. Use different symbols or colors to differentiate among the data points for each of the three samples. Include best-fit curves for all three sets of data points.
2. Examine the graph. Do you see any pattern in the boiling points of the two solutions compared to the boiling points of the distilled water?
3. Examine the formulas for the two solutes, urea ( $\text{NH}_2\text{CONH}_2$ ) and calcium chloride ( $\text{CaCl}_2$ ). What inferences can you make about the effects of each of these two solutes on the boiling point of water?
4. Compare the boiling points of the two solutions from your graph to the predicted values from calculation 1 and 2. Do the experimental and predicted values match? If they differ, how might you account for the differences?
5. Explain why the boiling points of the solutions are higher than the boiling points of distilled water.