Lab Practical – Chapter 12 Solutions

OBJECTIVE: This will test students understanding of freezing point depression, concentration, saturation levels, and solubility. In this lab, students will add salt to ice. They will record time and temperature data and interpret their results. They will then share their data with their classmates and examine/use the class data to answer/support their answers to the analysis questions.

MATERIALS

Freezer pop
Container
Ice
Unknown Solutes (NaCl, $C_6H_{12}O_6$, $CaCl_2$, KNO_3,$MgCl_2$)
Thermometer
Watch/Timer

PROCEDURE:

Note: Each group will add their data to the Google Sheet shared with the class.

Part 1:

1. Gather your materials and add 750 grams of ice your container – the maximum mass on the scale is around 450g so you will need to use the provided container and add two masses that have a sum of 750g
2. Record observations of your unknown solute
3. Place the freezer pop in the container with the ice. Place the lid on the container and agitate the system for 10 seconds.
4. Measure and record the initial temperature of the ice/freezer pop set up
5. Record observations of the consistency of the freeze pop AND the ice in the container
6. Add 120 grams of your unknown solute to the container. Place the lid on the container and agitate the system for 10 seconds.
7. Measure and record the initial temperature of the ice/salt/freezer pop system
8. Record observations of the consistency of the freeze pop AND the ice in the container
9. Gently agitate the system for one minute
10. Measure and record the temperature of the system.
11. Record observations of the consistency of the freeze pop AND the ice in the container.
12. Repeat steps 8-10 until the temperature of the system remains constant for three minutes straight (+/- 0.2^{o}C). If additional rows are needed they may be added to the shared Google Sheet.

Part 2:

1. Add an additional 75 grams of your unknown solute to the container. Place the lid on the container and agitate the system for 10 seconds.
2. Measure and record the initial temperature of the ice/salt/freezer pop system for part 2
3. Record observations of the consistency of the freeze pop AND the ice in the container
4. Gently agitate the system for one minute
5. Measure and record the temperature of the system.
6. Record observations of the consistency of the freeze pop AND the ice in the container.

7. Repeat steps 8-10 until the temperature of the system remains constant for three minutes straight (+/- 0.2^{o}C). If additional rows are needed they may be added to the shared Google Sheet.
8. Remove the freezer pop from the container and place the lid on the container. Make sure that your container is clearly labeled and set the container on the front desk.

DISPOSAL:

Thoroughly rinse and dry off the outside of the Freezer Pop. Eat the freeze pop if you wish to do so.

DATA ANALYSIS: ANSWER THE FOLLOWING QUESTIONS BASED ON YOUR UNDERSTANDING OF SOLUTION CHEMISTRY

1. Make a copy of the Google Sheet that we filled in on Tuesday.

2. Create a line graph showing how the temperature changed over time for each of the samples (one chart with all 5 sets of data shown). Be sure to label all parts of your graph. Print an 8.5" x 11" copy of your completed chart

3. What trends do you notice from the graph?

4. In your own words, what is freezing point depression and what causes this phenomenon?

5. Explain why/how different solutes can affect the amount of the freezing point depression. You can use the data from the Google Sheet to support your explanation if desired. Feel free to include drawings/images if helpful.

CONCLUSION

What conclusions can you make about each of the unknown solutes using your observations and data, and the observations and data of the other groups?

Use scientific terminology to explain all results. ***BE VERY THOROUGH***. Feel free to include drawings/images.

EXTENSION OF LAB

What do you predict would happen to the boiling point of your solution if you were to heat the solution that you saved at the end of the lab? How would your prediction for your solution compare to your predictions for the solutions from the other groups in class?

After you and your lab partner have made your predictions, CAREFULLY (use a funnel if needed) measure 500 mL of your solution and transfer it to a 600 mL beaker.

Place the beaker on a hot plate and measure the starting temperature.

Turn the hot plate on and begin heating the solution.

Record the temperature every 5 minutes until you reach about 95^{o}C and then begin recording the temperature every minute.

Record temperatures on the appropriate tab of the shared Google Sheet

Make a note of when you think the solution begins to boil

Continue heating the solution for ten minutes after it begins to boil and record the temperature each minute.

Turn the hot plate off and allow the beaker to cool.

As a group, create a line graph of your data. You may do this in the shared Google Sheet

Did your predictions match the data?

Explain why the data matched (or did not match) your predictions?

Written Portion: Extension Questions

1. Would there be any benefit to using a mixture of salts to lower the freezing point of a solvent? Why or why not?

2. Can you determine the Molarity of your system with the information that you have?
   a. If yes, explain how you would do so.
   b. If not, explain what additional information you would need and how you might obtain it in order to determine the Molarity.

3. Describe the ideal/best conditions for applying salt to city roads in order to maximize the benefit and prevent the formation of ice on the roads. Be sure to discuss the condition/state of the solute as well as of the roads at the time of application.

4. Explain how the addition of the salt could still be useful when it is not practical for the ideal conditions to be met. What exterior forces might help the salt achieve its goal of lowering the freezing point?

5. If the oceans contain 3.5% by mass sodium chloride, what is the coldest temperature the water in the ocean could be theoretically? Density of ocean water = 1.025 kg/L

6. Are there any benefits to adding more salt/solute to a system if the goal is to get the freezing point as low as possible? Are there any limitations to the freezing point depression capabilities of a salt/solute? Explain your responses with the support of the resources provided with this test.

7. The partial pressure of CO_2 inside a bottle of soft drink is 4.0 atm at 25°C. The solubility of CO_2 is 0.12 mol/L. When the bottle is opened, the partial pressure drops to 3.0×10^{-4} atm. What is the solubility of CO_2 in the open drink? Express your answer in grams per liter.

8. The nonvolatile compound ethylene glycol, $C_2H_6O_2$, forms nearly ideal solutions with water. What is the vapor pressure of a solution made from 1.00 mol of $C_2H_6O_2$ and 9.00 moles of H_2O if the vapor pressure of pure water at the same temperature is 25.0 mm Hg?

9. A 20.0 mg sample of a protein (non-electrolyte) is dissolved in water to make 25.0 mL of solution. The osmotic pressure is 7.368×10^{-4} atm at $25^{o}C$. What is the molar mass (molecular weight) of the protein?

10. A 0.029 M solution of K_2SO_4 has an osmotic pressure of 1.79 atm at $25^{o}C$. Calculate the van't Hoff factor for this solution.