

Chemistry of Solutions

Do you know how to make a solution? Can you determine the concentration of the solution that you made? How does your solution behave? Try the following activity and find out.

Materials

- table salt (NaCl)
- water
- several Styrofoam™ cups
- sauce pan
- cup measure
- tablespoon measure
- thermometer (as used in making candy)
- wooden spoon or wooden stir stick

Exploration

Step 1 Place 1 level tablespoon of table salt in a Styrofoam cup. Add 1/2 cup water to the cup. Mix thoroughly. Is this a saturated solution? One tablespoon of table salt weighs approximately 12 grams. There are approximately 240 mL in a cup. Based on this information, calculate the molarity and molality of this solution. (Hint: Not all of the information that you need is given here. You have to find some of it.)

Step 2 Heat 1 cup water in the sauce pan until it is boiling. Suspend a thermometer in the water and record the temperature. Add 1 tablespoon salt to the water. Do not remove the water from the heat. Mix the solution with the wooden spoon or stir stick, never the thermometer. Record the temperature after it levels off. Explain your results.

Step 3 Fill a Styrofoam cup with crushed ice. What do you think the temperature of ice is? Hold the thermometer in the ice and record the temperature after it levels off. Place 3 tablespoons salt in the cup. Stir with the spoon or stir stick. Observe the thermometer. What happens? Why?

Challenge

Why is it important that we understand solution chemistry? What are the applications of what you have seen in this activity?

Chemistry of Solutions

This activity can be used to introduce solution chemistry.

Concepts

solution, solute, solvent, freezing point depression, boiling point elevation, molarity, molality

Expected Student Responses to Exploration

Step 1 (a) The solution is not saturated (all of the solute dissolved).

(b) molarity (M) = 3.5 moles of solute/liters of solution molality

(m) = 3.5 moles of solute/kilograms of solvent

It is important to note that the molarity and molality are roughly the same because the solvent (water) has a density of nearly 1 g/mL.

Step 2 (a) The temperature of the solution will increase by approximately 2°F.

(b) This is because solutions have lower vapor pressures than the pure substance, which necessitates a higher temperature for the solution to boil.

Step 3 (a) Temperatures will vary.

(b) The temperature of the solution will decrease by approximately 9°F.

(c) Once again, the solute lowers the vapor pressure, which depresses the freezing point of the solution.

Expected Student Answer to Challenge

It is important that we understand solution chemistry because most chemical reactions do not take place between pure substances, but between ions and molecules dissolved in solvents.

The concepts employed here are used in automobile antifreeze and the salting of roads in the winter.

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