

How Salty Do You Like Your Water?

Introduction

Do you remember that a **solution** is a homogeneous mixture? Usually you think of solids like Kool-Aid® powder dissolved in water when you think of solutions. The **concentration** of a solution is a measure of the amount of solid that is dissolved in a given quantity of water. A **dilute solution** contains only a small amount of solid. In contrast, a **concentrated solution** contains a large amount of solid.

The concentration of a solution can be measured in terms of its **molarity**. Molarity is the number of moles of a solid dissolved in 1 L of water solution. Molarity is also known as molar concentration. To determine the molarity of any solution (solid dissolved in water), use the following equation:

$$\text{Molarity (} M \text{)} = \frac{\text{number of moles of solid}}{\text{number of liters of solution}}$$

Suppose you wanted to make a one molar (1 M) solution of sodium bicarbonate, NaHCO_3 . Here's what you would do:

- First, you need to calculate the formula weight of sodium bicarbonate by using the periodic table and adding the atomic weights of each element in the formula.
 $23.0 + 1.0 + 12.0 + (3 \times 16.0) = 84.0$ grams .
- To make a 1 M solution, you need 1 mole of sodium bicarbonate. Weigh 84.0 grams of sodium bicarbonate.
- Pour the sodium bicarbonate into a 1 L volumetric flask. Dissolve it in a small quantity of water.
- Add enough water to bring the total volume to one liter.

In this lab you will make several solutions of sucrose (table sugar) and salt which have different molarities (concentrations). Below are diagrams of salt and the sucrose molecule. Use these diagrams to find molecular masses.

INCLUDE DIAGRAM OF SALT AND SUCROSE MOLECULE HERE

Equipment

triple beam balance
evaporating dish
volumetric flask
red drinking cups

bag of table sugar (sucrose)
container of salt (non-iodide)
1 gallon container of distilled water

plastic gallon container
piece of plain paper
plastic funnel

Procedure

Use the preceding example of a liter of 1 M solution of sodium bicarbonate to make 4 different solutions:

- 1 L of 0.25 M sucrose (table sugar) solution
- 1 L of 1.0 M sucrose (table sugar) solution
- 1 L of 1.0 M salt solution
- 1 L of 2.0 M salt solution

Make the solutions one at a time. Taste the solutions using the red drinking cups. When finished with a solution, pour the solution down the drain and rinse the plastic gallon container thoroughly with water.

Example: to make a 0.25 M solution of sucrose, first find the molecular mass of sucrose. Next, since you want a 0.25 M solution, weigh out 0.25 moles of sucrose using the evaporation dish and triple beam balance. Use the piece of plain paper as a funnel and pour the sucrose into the plastic gallon container. Lastly, use the plastic funnel and the volumetric flask to measure out a total of one liter of distilled water (not tap water!) and pour into the plastic gallon container. Put the cap on, shake and stir, then taste.

Questions

1. How much does one mole of table sugar (sucrose) weigh?
2. How many moles of sucrose are there in a 5 pound (2.26 kilogram) bag of table sugar?
3. How much does one mole of salt weigh?
4. How many moles of salt are there in a 1 pound 10 oz (737 gram) container of salt?
5. (a) Which molecule, salt or sugar is bigger/more complex? (b) Which molecule, salt or sugar, weighs more? (c) A mole of which chemical weighs more?
6. Compare the tastes of the 0.25 M sucrose solution and the 1.0 M sucrose solution. Which is sweeter? Why?
7. Compare the tastes of the 0.25 M and 1.0 M sucrose solutions and the 1.0 M and 2.0M salt solutions. Which two have about the same strength of flavor?
8. Relate the comparisons in 5 & 7 to the amount of sugar you must put in a glass of ice tea to make it sweet and the amount of salt you must put in soup to make it salty. Why does it take a lot of sugar to sweeten tea?
9. Which is a better value in terms of "flavoring power": the bag of sugar or the container of salt?
10. Find the molarity of the following solution: 120 grams of LiCl in 1.5 L of solution.

Example

We measured 250 grams of MgSO_4 and dissolved it in enough water to make 2 L of solution. What is its molarity?

Solution

First we must find out how many moles of MgSO_4 there are in 250 g of MgSO_4 .

The molar mass of MgSO_4 is: $24.3 + 32.1 + (4 \times 16.0) = 120.4 \text{ g}$.

$$\frac{250 \text{ g of } \text{MgSO}_4}{120.4 \text{ g of } \text{MgSO}_4} \frac{1 \text{ mole of } \text{MgSO}_4}{120.4 \text{ g of } \text{MgSO}_4} = 2.08 \text{ moles of } \text{MgSO}_4$$

Next we find molarity.

$$\text{Molarity (M)} = \frac{\text{number of moles of solid}}{\text{number of liters of solution}} = \frac{2.08 \text{ moles of } \text{MgSO}_4}{2 \text{ L of solution}} = 1.04 \text{ M}$$

The whole story:

The solid that is dissolved in a solution is called the *solute*. The water which dissolves the solute is called the *solvent*. Instead of comparing the molarity of solutions in this lab, we are actually comparing the molality of solutions. Molality is slightly different from molarity. When making a one molar solution (1 M), enough water is added to make the total volume of the solution equal to one liter. When making a one molal solution (1 m), like we technically did in this lab, exactly one liter of water is added to the solid solute. The total volume of a one molal solution will be more than one liter.