Molarity versus Molality

Concentration of Solutions

Introduction

Simple visual models using rubber stoppers and water in a cylinder help to distinguish between molar and molal concentrations of a solute.

Concepts

- Solutions
- Concentration

Materials

Graduated cylinder, 1-L, 2
Rubber stoppers, large, 12
Water, 2-L

Safety Precautions

Watch for spills. Wear chemical splash goggles and always follow safe laboratory procedures when performing demonstrations.

Procedure

1. Tell the students that the rubber stoppers represent "moles" of solute.
2. Make a "6 Molar" solution by placing six of the stoppers in a 1-L graduated cylinder and adding just enough water to bring the total volume to 1 liter.
3. Now make a "6 molal" solution by adding six stoppers to a liter of water in the other cylinder.
4. Remind students that a kilogram of water is about equal to a liter of water because the density is about 1 g/mL at room temperature.
5. Set the two cylinders side by side for comparison.

Disposal

The water may be flushed down the drain.

Discussion

Molarity, moles of solute per liter of solution, and molality, moles of solute per kilogram of solvent, are concentration expressions that students often confuse. The differences may be slight with dilute aqueous solutions. Consider, for example, a dilute solution of sodium hydroxide. A 0.1 Molar solution consists of 4 g of sodium hydroxide dissolved in approximately 998 g of water, while a 0.1 molal solution consists of 4 g of sodium hydroxide dissolved in 1000 g of water. The amount of water in both solutions is virtually the same. As the concentration increases, however, the difference between molarity and molality becomes extreme. For example, a 10 Molar sodium hydroxide solution consists of 400 g of sodium hydroxide in approximately 700 g of water compared to a 10 molal sodium hydroxide solution which contains 400 g of sodium hydroxide in 1000 g of water.

Differences between molarity and molality also depend upon the density of the solvent. In general, the greater the density of the solvent, the greater the difference between a solution's molarity and molality (e.g., a 0.1 Molar cupric chloride solution in ethanol vs. a 0.1 molal cupric chloride solution in ethanol.)

This demonstration allows students to actually see the different relationships between solute and solvent amounts.

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Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Molarity versus Molality* activity, presented by George Gross, is available in *Concentration of Solutions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Molarity versus Molality* are available from Flinn Scientific, Inc.

Catalog No.	Description
GP9090	Graduaded Cylinders, 1-L

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.