Effect of Concentration on the Conductivity of Solutions

Concentration of Solutions

Introduction

If an ionic compound is dissolved in water, it dissociates into ions and the resulting solution will conduct electricity.

Concepts

- Concentration
- Conductivity
- Ionic Compounds

Materials

Calcium chloride solution, 1.0 M, $CaCl_2$, 1 mL
Sodium chloride solution, 1.0 M, NaCl, 1 mL
Water, distilled or deionized
Wash bottle containing distilled water
Beakers, 100-mL, 2
Conductivity sensor or meter
LabQuest™ or LabPro™ with computer or calculator interface
Pipets, disposable, 2
Paper towels or Kim wipes®

Safety Precautions

Although calcium chloride and sodium chloride are considered to be non-hazardous, unpredictable reactions among chemicals are always possible. Prudent laboratory practices should be observed. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Add 70 mL of distilled or deionized (DI) water to a clean 100-mL beaker.
2. Measure the conductivity of the DI water.
3. Add one drop of 1.0 M sodium chloride to the DI water and stir.
4. Measure the conductivity of the solution.
5. Add another drop of 1.0 M sodium chloride to the DI water and stir.
6. Measure the conductivity of the solution.
7. Add a third drop of 1.0 M sodium chloride to the DI water and stir.
8. Measure the conductivity of the solution.
9. Add a fourth drop of 1.0 M sodium chloride to the DI water and stir.
10. Measure the conductivity of the solution.
11. Repeat steps 1–10 with 1.0 M calcium chloride solution.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Sodium chloride and calcium chloride may be flushed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

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Tips

- Conductivity readings are normally reported in microsiemens/cm, or μS/cm. This SI derived unit has replaced the conductivity unit, micro-ohm/cm. Because the Vernier Conductivity Probe has a cell constant of 1.0 cm–1, we simply refer to this unit in student experiments as microsiemens, or μS.
- Rinse the probe with distilled water between samples. Blot the probe dry—the sensor does not need to be completely dry as a drop or two of distilled water does not significantly dilute the next sample.
- Flinn Scientific offers a complete student laboratory kit that delves into the same topic. Please see Properties of Solutions: Electrolytes and Non-Electrolytes (Catalog No. AP4513) in the *Flinn Scientific Catalog/Reference Manual* for additional information.

Discussion

Electrical conductivity is measured using a conductivity electrode. When the electrode is placed in a solution that has the ability to conduct electricity, an electrical circuit is completed across the electrode. The result is a voltage value that can be measured. The unit of conductivity used to express this voltage is microsiemens, or μS. The conductivity value depends on the ability of the aqueous solution to conduct electricity. Strong electrolytes dissociate to produce large numbers of ions, which results in high conductivity values. Weak electrolytes produce few ions in solution which results in low conductivity, and non-electrolytes produce no ions when in solution and should result in no conductivity.

Ionic compounds are usually strong electrolytes and are expected to completely dissociate in aqueous solution. The ions in solution give it its electrical properties. The moles of ions do not necessarily equal the molar concentration of the solution. For example, in a 1.0 *M* sodium chloride solution both the Na^+ and the Cl^- dissociate creating 2 moles of ions in the solution. The same concentration of calcium chloride, $CaCl_2$, dissociates into Ca^+ and $2Cl^-$ creating 3 moles of ions in the solution. Adding a single drop of an ionic compound is enough to change the electrical conductivity of a solution.

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 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure of atoms, structure and properties of matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Effect of Concentration on the Conductivity of Solutions* activity, presented by Mike Heinz and Penney Sconzo, is available in *Concentration of Solutions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *The Effect of Concentration on the Conductivity of Solutions* are available from Flinn Scientific, Inc.

Catalog No.	Description
TC1500	LabPro™
TC1421	LoggerPro™ software
TC1157	LabQuest™
TC1507	Conductivity Sensor
C0233	Calcium Chloride Solution, 1 M, 500 mL
S0347	Sodium Chloride Solution, 1 M, 500 mL

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