TEACHER INFORMATION

Conductivity of Solutions: The Effect of Concentration

1. Editable Microsoft Word versions of the student pages and pre-configured TI-Nspire files can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. We suggest that you set up the Conductivity Probes before the experiment. Set the selection switch on the amplifier box of the probe to the 0–2000 µS/cm range.

3. Distilled water and tissue can be used to clean the Conductivity Probe. See the Conductivity Probe booklet that comes with the Conductivity Probe for information on how the probes work, how to care for the probes, and calibrations.

4. All solutions are 1.0 M concentration. Have them available in dropper bottles (prepare all solutions in distilled water):

   1.0 M $CaCl_2$ (11.1 g of solid calcium chloride, $CaCl_2$, per 100 mL of solution) Hazard Code: D—Relatively non-hazardous. Alternatively, 14.7 g $CaCl_2 \cdot 2H_2O$, per 100 mL of solution. **HAZARD ALERT:** Toxic by ingestion. Hazard Code: D—Relatively non-hazardous.

   1.0 M NaCl (5.85 g of solid sodium chloride, NaCl, per 100 mL solution) **HAZARD ALERT:** Moderately toxic. Hazard Code: D—Relatively non-hazardous.

   1.0 M $AlCl_3$ (24.15 g of solid aluminum chloride, $AlCl_3 \cdot 6H_2O$, per 100 mL of solution). Hazard Code: D—Relatively non-hazardous. Alternatively, 13.35 g anhydrous $AlCl_3$ per 100 mL of solution. **HAZARD ALERT:** Reacts very violently with water; toxic by inhalation and ingestion; strong skin irritant. Hazard Code: A—Extremely hazardous.

   The hazard information reference is: Flinn Scientific, Inc., *Chemical & Biological Catalog Reference Manual*, (800) 452-1261, www.flinnsci.com.

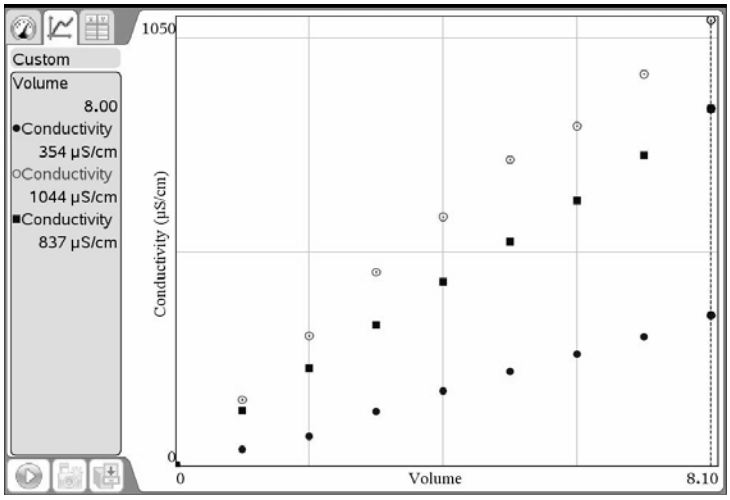
5. For consistent results, students should dispense drops with the dropper bottle held in a vertical position.

6. Conductivity readings are normally reported in microsiemens per centimeter, or µS/cm. This SI derived unit has replaced the conductivity unit, micromho/cm.

7. Note that the ratio of slopes of NaCl, $CaCl_2$, and $AlCl_3$ is quite consistent with the ratio of ions produced upon dissociation:

   - Ratio of slopes: 44.5 to 101.5 to 128.1
   - Ratio of moles of ions, upon dissociation: 2 to 3 to 4

SAMPLE RESULTS



Graph of Conductivity vs. *Volume of salt for NaCl* (●), *$AlCl_3$* (○), *and $CaCl_2$* (■).

Solution	Slope, *m*
1.0 M NaCl	44.5
1.0 M $AlCl_3$	128.1
1.0 M $CaCl_2$	101.5

ANSWERS TO QUESTIONS

1. At low concentrations, each curve is nearly linear. The slope value was different for each of the three solutions: $AlCl_3$ was highest, $CaCl_2$ second highest, and NaCl lowest.

2. Conductivity increases as concentration is increased. The relationship appears to be direct.

3. $NaCl \longrightarrow Na^+ + Cl^-$ (2 moles of ions per mole)
   $AlCl_3 \longrightarrow Al^{3+} + 3\ Cl^-$ (4 moles of ions per mole)
   $CaCl_2 \longrightarrow Ca^{2+} + 2\ Cl^-$ (3 moles of ions per mole)

4. $AlCl_3$ has the largest slope value, NaCl the smallest. Even though all three solutions have the same initial concentration, 1.0 M, $AlCl_3$ dissociates to yield the largest number of moles of ions per mole (4). This results in $AlCl_3$ yielding more ions in solution, and the largest slope in this series. $CaCl_2$ is next with 3 moles of ions per mole, and NaCl yields the fewest, 2.