Electrolytes and Nonelectrolytes

Student Activity

Name _______________
Class _______________

In this experiment, you will discover some properties of strong electrolytes, weak electrolytes, and non-electrolytes by observing the behavior of these substances in aqueous solutions. You will determine these properties using a Conductivity Probe. When the probe is placed in a solution that contains ions, and thus has the ability to conduct electricity, an electrical circuit is completed across the electrodes that are located on either side of the hole near the bottom of the probe body (see Figure 1). This results in a conductivity value that can be read by a data-collection interface. The unit of conductivity used in this experiment is the microsiemens per centimeter, or µS/cm.

Figure 1.

SCIENCE OBJECTIVES

- Use Vernier Go Direct (GDX) Conductivity Probe to determine the conductivity values of common substances.
- Determine which substances are nonconductors, weak electrolytes, and strong electrolytes.

MATH OBJECTIVE

- Understand the principle that total charges on the anions and cations must equal zero for a compound

MATERIALS

- TI-Nspire CX II Handheld
- Go Direct Conductivity Probe
- Calculator Connection Cable (Mini-A to Micro-B USB)
- ring stand
- test tube clamp
- wash bottle
- distilled water
- sensor soaking solution
- tissues
- 250 mL beaker
- H_2O (tap)

- H_2O (distilled)

- 0.05 M NaCl

- 0.05 M $CaCl_2$

- 0.05 M $AlCl_3$

- 0.05 M $HC_2H_3O_2$
- 0.05 M H_3PO_4
- 0.05 M H_3BO_3
- 0.05 M HCl
- 0.05 M CH_3OH (methanol)
- 0.05 M $C_2H_6O_2$ (ethylene glycol)

PROCEDURE

1. Obtain and wear goggles! **CAUTION:** Handle the solutions in this experiment with care. Do not allow them to contact your skin. Notify your teacher in the event of an accident.

2. Assemble the Conductivity Probe, utility clamp, and ring stand as shown in Figure 1. Be sure the probe is clean and dry before beginning the experiment.

3. Turn on the TI-Nspire CX II.

4. Connect the GDX Conductivity Probe to the TI-Nspire CX II Handheld with the cable provided. The Vernier DataQuest App will automatically open.

5. Click on Mode on the left of the screen, choose Events with Entry , and click on OK.
6. Click on Event Name and enter **Compound** as the Name and leave the Units field blank.
7. Select the Average over 10 s option, then Select OK.

5. Obtain the Group A solution containers. The solutions are: $CaCl_2$, NaCl, and $AlCl_3$.

6. Measure the conductivity of each of the solutions.

a. Start data collection (▶).
b. Carefully raise each vial and its contents up around the Conductivity Probe until the hole near the probe end is completely submerged in the solution being tested. **Important:** Since the two electrodes are positioned on either side of the hole, this part of the probe must be completely submerged.
c. Briefly swirl the vial contents. Monitor the conductivity reading displayed on the screen for 6–8 seconds. Click the Keep button ( ), wait for the collection to complete, and enter the name of the solution, for example CaCl2. Select OK to store the data.
d. Before testing the next solution, clean the electrodes by surrounding them with a 250 mL beaker and rinse them with distilled water from a wash bottle. Blot the outside of the probe end dry using a tissue. It is *not* necessary to dry the *inside* of the hole near the probe end.
e. Test the remaining solutions in the group by repeating Steps 6 b–d.
f. Stop data collection (■).

7. Click the Store Data button (✓) to store the data from the Group A solutions. Obtain the four Group B solution containers. These include $HC_2H_3O_2$, HCl, H_3PO_4, and H_3BO_3. Repeat the Step 6 procedure.

8. Click the Store Data button (✓) to store the data from the Group B solutions. Obtain the five Group C solutions or liquids. These include distilled H_2O, tap H_2O, CH_3OH, and $C_2H_6O_2$. Repeat the Step 6 procedure.

9. Click the Table View tab ( ) to display the data table. Record the conductivity data in the data table.

DATA

Solution	Conductivity (μS/cm)
A – $CaCl_2$	
A – $AlCl_3$	
A – NaCl	
B – $HC_2H_3O_2$	
B – HCl	
B – H_3PO_4	
B – H_3BO_3	
C – $H_2O_{distilled}$	
C – H_2O_{tap}	
C – CH_3OH	
C – $C_2H_6O_2$	

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QUESTIONS

1. Based on your conductivity values, do the Group A compounds appear to be molecular, ionic, or molecular acids? Would you expect them to partially dissociate, completely dissociate, or not dissociate at all?

2. Why do the Group A compounds, each with the same concentration (0.05 M), have such large differences in conductivity values? **Hint:** Write an equation for the dissociation of each. Explain.

3. In Group B, do all four compounds appear to be molecular, ionic, or molecular acids? Classify each as a strong or weak electrolyte, and arrange them from the strongest to the weakest, based on conductivity values.

4. Write an equation for the dissociation of each of the compounds in Group B. Use ⊓⊓|⊓ for strong; $\longleftrightarrow$ for weak.

5. For H_3PO_4 and H_3BO_3, does the subscript “3” of hydrogen in these two formulas seem to result in additional ions in solution as it did in Group A? Explain.

6. In Group C, do all four compounds appear to be molecular, ionic, or molecular acids? Based on this answer, would you expect them to dissociate?

7. How do you explain the relatively high conductivity of tap water compared to a low or zero conductivity for distilled water?

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