



### Science Objectives:

- Students will write equations for the dissociation of compounds in water.
- Students will use a Conductivity Probe to measure the conductivity of solutions.
- Students will determine which molecules or ions are responsible for conductivity of solutions.
- Students will investigate the conductivity of common drinks resulting from substituent compounds that dissociate to produce different numbers of ions.

### Vocabulary

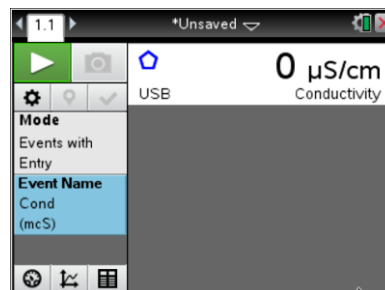
- conductivity
- electrolyte
- nonelectrolyte
- molecular acid
- molecular compound
- ionic compound
- molecule
- ion

### About the Lesson

- This lesson involves testing the conductivity of common solutions.
- As a result, students will:
  - Perform the preliminary activity, and then generate a researchable question of their own.
  - Plan their research, carry out the research plan, organize and graph the data, draw a conclusion, and communicate the results.

### TI-Nspire™ Navigator™ System

- Observe student progress by using Class Capture during student experimentation.
- Make students the Live Presenter when they are ready to make their research reports.



### TI-Nspire™ Technology Skills:

- Open a new document
- Move between pages
- Inserting new problems into a document
- Collect data using the Vernier DataQuest™ App
- Open a Data & Statistics page
- Create a colored bar graph of data

### Tech Tips:

Access free tutorials at

<http://education.ti.com/calculator/spd/US/Online-Learning/Tutorials>

### Lesson Files:

*Student Activity*

- Thirst\_Quenchers\_Student.doc
- Thirst\_Quenchers\_Student.pdf

### Activity Materials

- TI-Nspire™ CX handheld
- TI-Nspire™ Lab Cradle or Vernier EasyLink™ USB
- Vernier Conductivity Probe
- Vernier pH Probe
- Stirring rod
- Plastic cup
- Paper towels
- wash bottle and distilled water
- 100 mL graduated cylinder
- H<sub>2</sub>O (tap)
- Vitamin water
- Teaspoon
- H<sub>2</sub>O (distilled)
- Table salt
- Sucrose
- Aspartame
- Saccharine
- Sucralose
- Gatorade
- Powerade
- Pedialyte
- Bottled tea (sugar)
- Bottled tea (sugarless)
- Bottled water-2 different brands

### Discussion Points and Possible Answers

**Tech Tip:** Be certain that students set up the TI-Nspire CX and conductivity probe correctly. Also, be sure the probe is set to 0-20,000 microsiemens.

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 here:

- Be sure the probe is clean and dry before beginning the experiment.







3. Set the selector switch on the side of the Conductivity Probe to the 0–20000  $\mu\text{S}/\text{cm}$  range.
4. Connect the Conductivity Probe to the data-collection interface, and connect the interface to the TI-Nspire CX handheld.
5. Turn on the handheld, open a new document, and do not save the current document, if asked.
6. Add a *DataQuest* App. Select **MENU > Experiment > Collection Mode > Events with Entry**.
7. Type in **Cond** for the name and **mcS** for the unit.
8. Select **MENU > Experiment > Setup Sensors > Zero**. *Do this only once for the entire experiment.*










- Obtain ~100 mL of distilled water. Divide it equally between two plastic cups. Carefully raise the cup 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.

- Start data collection by clicking **play**  on your handheld.
- When the reading stabilizes, click the **keep**  button.
- Type in **diw** for *distilled water*, and record the conductivity in the data table on the last page of this worksheet.
- Add a level teaspoon of table salt to the ~50 mL of distilled water, and stir to dissolve the salt.
- Place the Conductivity Probe into the salt water, and press play  to collect more data.
- When the reading stabilizes, press the **keep**  button, type in **saltw** for *salt water*, and record the conductivity value in the data table at the end of this worksheet.
- Add a packet of sucrose to the other cup of distilled water, and stir until dissolved.

**TI-Nspire Navigator Opportunity: Class Capture**

**See Note 1 at the end of this lesson.**

- Measure the conductivity as above for the salt water, type in **sugw** for *sugar water*, and record the conductivity value in the data table.
- Repeat the data collection using ~50 mL of tap water, and type in **tapw** for *tap water*.
- Stop data collection by clicking **stop** .
- Click on the Table View tab () to view a table of the conductivity values you collected. Record these values in your data table.
- Press   to insert a *Data & Statistics* page.
- Move the cursor to the x-axis, press  , and select **Add X Variable with Summary Variable**.
- Tab to OK from the Summary Chart Dialog Box.
- Move the cursor to the first bar for distilled water. Press , and select **MENU > Color > Fill Color**, and choose a color for the distilled water bar.
- Repeat for the salt water solution and the sucrose solution, choosing a different color for each one.
- Compare and contrast the conductivity values for each.

It is now time to think about a researchable question to investigate. You have various substances to test. Read the discussion below before moving to procedure 27.



### Discussion:

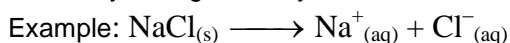
So far in this activity, you have learned some properties of strong electrolytes, weak electrolytes, and non-electrolytes by observing the behavior of these substances in aqueous solutions using a Conductivity Probe. When the probe was placed in a solution that contains ions, and thus has the ability 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. 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 microsiemen per centimeter, or  $\mu\text{S}/\text{cm}$ .

The size of the conductivity value depends on the ability of the aqueous solution to conduct electricity. Strong electrolytes produce large numbers of ions, which results in high conductivity values. Weak electrolytes result in low conductivity, and non-electrolytes should result in no conductivity.

In each part of the experiment, you are observing a different property of electrolytes. Keep in mind that you will be encountering three types of compounds and aqueous solutions:

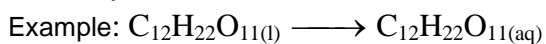
### 1—Ionic Compounds

These are usually strong electrolytes and can be expected to 100% dissociate in aqueous solution.



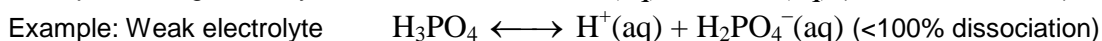
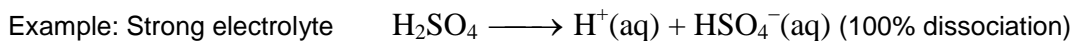
### 2—Molecular Compounds

These are usually non-electrolytes. They do not dissociate to form ions. Resulting solutions do not conduct electricity.



### 3—Molecular Acids

These are molecules that can partially or wholly dissociate, depending on their strength.



27. Now that you have read about electrolytes and nonelectrolytes, discuss with your partner an area that you would like to investigate regarding common soft drinks.

- Read the labels of the substances (**both solutions and solids**) provided to gather more information for your researchable question.
- Write up a hypothesis, and be prepared to share it with the group.
- Also, determine what materials and procedures that you plan to follow.
- **Do not begin your experiment until after the group discussion of researchable questions!**



28. Once the researchable question has been approved by the group, you will be given time to do complete your research, graph your data, and prepare a report to the group.

Your report will include:

- a) your original hypothesis
- b) pertinent data (Data table in the *DataQuest* App)
- c) a graph (*Data & Statistics* page)
- d) the conclusion to be drawn from your research—was your hypothesis borne out?
- e) suggestion(s) for further research



### Student Research

29. Press  and select **Insert > Problem** to add a new problem to your document.

30. Add a *DataQuest* App.

31. Follow the instructions above for setting up the data collection (the same way you have for your previous three experiments).

You are now ready to collect data for your researchable question.

32. Save your research as a TI-Nspire document on your handheld by pressing  .

33. When prompted, enter a file name.

- To make your report, the teacher will display your bar graph for the class.

34. When finished with your research, clean up your area, discard solutions in the bucket provided, and put equipment away.



### Wrap Up

Upon completion of the discussion, the teacher should ensure that students are able to understand:

- How to connect the TI-Nspire™ Lab Cradle to the TI-Nspire™ CX CAS handheld.
- How to connect a probe to the TI-Nspire Lab Cradle.
- How to gather and analyze data.
- How to make a colored bar graph.

### Assessment

The teacher will assess the students from their report to the class on their research. The student will save the TI-Nspire and the teacher will collect it at the end of the activity for further assessment.

### TI-Nspire Navigator

#### Note 1 Class Capture

Observe student progress throughout the activity by using Class Capture.