

ELECTROFYING BEVERAGES

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Annotation

In this demonstration, the average conductance of several common beverages will be determined. Students will relate the conductance of the beverages to ion concentrations inferred from beverage nutritional labels.

Primary Learning Outcome:

Students will be able to define the terms *conductivity*, *ion*, and *electrolyte*.

Students will be able to describe how conductance is measured.

Students will be able to calculate the average conductance of each beverage.

Students will be able to describe how beverage ingredients affect conductance values.

Assessed GPS:

SCSh3. Students will identify and investigate problems scientifically.

- Suggest reasonable hypotheses for identified problems.
- Develop procedures for solving scientific problems.
- Collect, organize and record appropriate data.
- Graphically compare and analyze data points and/or summary statistics.
- Develop reasonable conclusions based on data collected.
- Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

- Develop and use systematic procedures for recording and organizing information.
- Use technology to produce tables and graphs.
- Use technology to develop, test, and revise experimental or mathematical models.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

- Trace the source on any large disparity between estimated and calculated answers to problems.
- Consider possible effects of measurement errors on calculations.
- Recognize the relationship between accuracy and precision.
- Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.
- Solve scientific problems by substituting quantitative values, using dimensional analysis, and/or simple algebraic formulas as appropriate.

SCSh6. Students will communicate scientific investigations and information clearly.

- a. Write clear, coherent laboratory reports related to scientific investigations.
- b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
- c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
- d. Participate in group discussions of scientific investigation and current scientific issues.

SPS6. Students will investigate the properties of solutions.

- a. Describe solutions in terms of
 - solute/solvent
 - conductivity
 - concentration

Duration:

Preparation: 30 minutes

Introduction: 20 minutes

Conductivity Demonstration: 30 minutes

Conclusion: 15 minutes

Total Class Time: 65 minutes

Materials and Equipment:

Per Class:

1. Gatorade
2. PowerAde
3. Propel Sports Water
4. Orange Juice
5. Apple Juice
6. Tap Water
7. Distilled Water
8. 8 Clean, dry 250 mL beakers
9. Conductivity Meter (YSI 30 Salinity/Conductivity/Temperature Instrument or similar)
10. Light bulb conductivity tester

Safety:

Ensure that students do not drink beverages in the laboratory. Use caution when using the light bulb conductivity tester to prevent electric shock.

Technology Connection:

Not applicable.

Procedures:

Teacher Preparation:

Using the attached template, make a copy of the *Electrofying Beverages* student handout for each student. Calibrate the conductivity meter according to manufacturer's recommendations. Label one beaker for each of the seven test solutions and one beaker for a distilled water rinse for the conductivity probe. Add approximately 50 mL of each solution to the appropriate beaker. Set up solutions, conductivity meter, and conductivity tester at demonstration table.

Estimated Time:

30 minutes

Introduction:

Explain to students that this demonstration will explore the conductivity of seven common beverages: Gatorade, PowerAde, Propel Sports Drink, orange juice, apple juice, tap water, and distilled water. Ask students to define conductivity, ion, and electrolyte as they relate to solutions and to record this definition in their lab notebooks. Next, ask students to categorize the seven beverages as either conductive or non-conductive and record these lists. Next ask students to rank the "conductive" beverages in order from least conductive to most conductive. For each "conductive" beverage, students should list a brief, hypothesized explanation for the conductivity. Briefly discuss student predictions.

Estimated Time:

20 minutes

Conductivity Demonstration:

Begin by explaining how conductivity is measured using the conductivity meter and tester. In each case, two electrodes are placed in a solution. If that solution is conductive, electric current is able to pass from one electrode to the other, completing the circuit and registering a response on the tester or meter. The tester is a qualitative instrument that responds only above a minimum current determined by the specific setup. The meter is a quantitative instrument that will give an accurate conductivity measurement over a wide range of values. In order to establish the credibility of the conductivity meter readings, perform an initial demonstration in which the conductivity of orange juice is evaluated using both the tester and meter. Students will see that the bulb lights when the tester electrodes are immersed in orange juice. When the probe of the conductivity meter is immersed in orange juice, students will see that a relatively high conductivity value (approximately 2000 μS) is reported. This can be compared to tap water which will exhibit weak or no lighting of the bulb and a low conductivity reading (approximately 50 μS).

Students should use the attached data table found on the *Electrofying Beverages* student handout to record conductivity readings for each of the beverage samples. Measure and record triplicate conductivity readings for each beverage. For each reading, ask a student to assist in immersing the probe into the beverage and reading the conductivity value. For each beverage, ask students to calculate the average conductivity reading. As readings are collected, briefly discuss student predictions regarding each beverage. Upon completion of the demonstration, review the final

results, highlighting which beverages are conductive and the relative conductivities of the beverages.

Estimated Time:

30 minutes

Conclusion:

Review with students the definitions of conductivity, ion, and electrolyte and what factors contribute to the conductivity of a solution. Present to students the nutritional labels of each of the beverages. Using the collected data, in addition to the information found on the nutritional labels, students should write a paragraph in their lab notebook explaining the results of the demonstration.

Estimated Time:

15 minutes

Assessment:

Assessment should be based on completion of the lab write up. Emphasis should be placed on the concluding paragraph. Conclusions and explanations of results should accurately reflect the data collected, be based on sound scientific reasoning, and accurately incorporate the concept of conductivity in solutions.



Name:

Date:

Class Period:

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Student Handout

Data Table:

Beverage	Conductivity			
	Reading 1	Reading 2	Reading 3	Average