TITLE
Electrolyte and non-electrolyte solutions

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COURSE
Introductory / Preparatory Chemistry

TYPE
Interactive Lecture Demonstration Guide

TEACHING MODE
Lecture Demonstration

LEARNING GOALS
Students will be able to:

- Explain the difference between electrolytes and nonelectrolytes in terms of conductivity, the nature of the compound, and dissociation.
- Describe and visualize what happens at the atomic or molecular scale when an electrolyte or a nonelectrolyte dissolves in water

ELECTROLYTE AND NON-ELECTROLYTE SOLUTIONS

KEYWORDS

ionic compounds, molecular compounds, dissociation, conductivity, ionic bonding, covalent bonding, solute, solution, ion, electrolyte

COURSE

Introductory Chemistry
A 200-300 student first-year college chemistry course intended for students who feel that they are underprepared to undertake first-year general chemistry

PLACEMENT IN COURSE

- Week 5 of a 14-week semester

PRIOR KNOWLEDGE

- Distinction between ionic and molecular compounds according to the type of bonding
- Chemical composition (*metal + non-metal vs. non-metal only*) can be used to classify compounds as ionic or molecular.
- No prior knowledge of the composition of solutions on the sub-microscopic scale was assumed

LEARNING OBJECTIVES

After this activity, students will be able to…	Simulation Used
• Explain the difference between electrolytes and nonelectrolytes in terms of conductivity, the nature of the compound, and dissociation. • Describe and visualize what happens at the atomic or molecular scale when an electrolyte or a nonelectrolyte dissolves in water	*Sugar and Salt Solutions*

RESOURCES

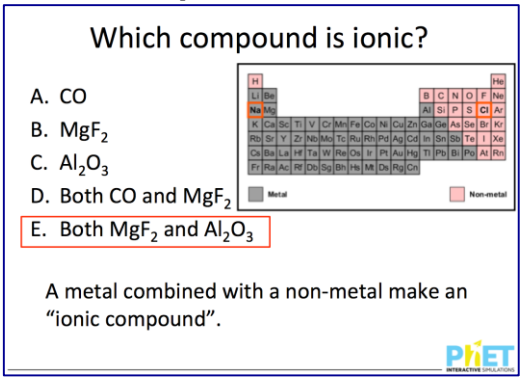
Sugar and Salt Solutions
http://phet.colorado.edu/en/simulation/sugar-and-salt-solutions

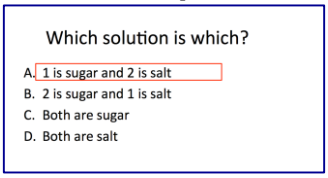
CONCEPTUAL CHALLENGES

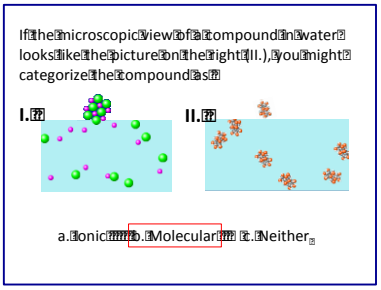
Students at this level have just been introduced to atoms, ions, and ionic vs. covalent bonding, and have difficulty determining what particles a given compound breaks up into when it goes into solution.

Activity Timeline and Details

Total time ~ 30-40 min

Section	Approx. Duration	Details
Conductivity (Sim demo)	**10 min**	**SECTION GOAL** • Relate conductivity observations to dissolved salt vs. sugar in solution **PREFACE** • Review definitions of ionic and molecular compounds discussed in previous lectures **REVIEW CONCEPT QUESTION** *individual response with discussion encouraged*  **SIM DEMONSTRATION (MACRO TAB)** • Close the concentration graph • Begin by placing the conductivity probe in the water, and then adding some salt to show the light bulb begin to glow. • Ask students for suggestions of experiments to try, as you demonstrate the available controls in the simulation (faucets, evaporation, salt shaker) • Reset all and switch to sugar to compare conductivity, asking for student observations. Mix both solutes and ask for student predictions. • Prompt students with challenges such as, "How could you prove that there is salt in a solution?"

Section	Approx. Duration	Details
Conductivity (benchtop demo)	**10-15 min**	**SECTION GOAL** • Connect the observations and inferences students made using the sim to conductivity measurement on the benchtop **BENCHTOP DEMONSTRATION** • Compare two unknown solutions labeled "1" and 2", highlighting that are the visibly the same (colorless, odourless, clear liquids) • Use a conductivity meter to test each (rinsing off the conductivity probe in between) and then ask: **CONCEPT QUESTION** *individual response with discussion encouraged*  *Sample response distribution:* 82% correct **BENCHTOP DEMONSTRATION (CONTINUED)** • Used the conductivity meter to test the conductivity of distilled water –it is zero within the precision of the meter. • Ask students why this doesn't mean it is safe to use electronic equipment when sitting in a bathtub – students recognized that tap water is not the same thing as distilled water, in that it contains dissolved ions. • Test the conductivity of tap water. • Return to the sim to demonstrate there that distilled water does not measurably conduct electricity. **FACILITATION NOTE** *The fact that even pure distilled water does, in principle, conduct electricity at a very low level because of the autoionization of water into H+ and OH- was alluded to briefly but not discussed since it lies outside the scope of an Introductory Chemistry course.* **FOLLOW-UP CLASS DISCUSSION QUESTION (OPTIONAL)** • What would happen if I didn't rinse the probe off between solutions? Does this depend on what order I test the solutions? **SUMMARY** Introduce the terms "electrolyte" and "non-electrolyte", relating these back to the sim and benchtop demonstrations

Section	Approx. Duration	Details
Atomic / sub-microscopic scale behavior of compounds in water	**10 min**	**SECTION GOAL** • Help students identify what ions an ionic compound breaks up into when dissolved in solution **CONCEPT QUESTION** *individual response with discussion encouraged*  *Sample response distribution:* 66% correct **FOLLOW-UP SIM DEMONSTRATION (MICRO TAB)** • Show students NaCl and sucrose dissolving using the micro tab of the sim, and prompt students to discuss with peers **RE-POLL CONCEPT QUESTION** *After class discussion and re-polling of previous question* *Sample response distribution:* 81% correct **SIM DEMONSTRATION (MICRO TAB)** • Present two contrasting cases: 1. NaCl (two monoatomic ions) vs. $NaNO_3$ (a monoatomic ion combined with a polyatomic anion) 2. NaCl vs. $CaCl_2$ – use the Concentration graph to show the differing ratios of ions **FOLLOW-UP CLASS DISCUSSION** • Ask students if they notice anything unrealistic about the sim – whether the sim was leaving something out. • If any students comment that water is not shown as molecules, move to the Water tab of the sim, which does show both solute and solvent as molecules.