**TITLE**

Electrolyte and non-electrolyte solutions

**AUTHORS**

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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

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**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*  Macintosh HD:Users:ysquaredPHET:Desktop:Screen Shot 2014-11-05 at 3.08.17 AM.png  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?” |
| 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*  Macintosh HD:Users:ysquaredPHET:Desktop:Screen Shot 2014-10-31 at 5.27.16 PM.png  *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 |
| 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. NaNO3 (a monoatomic ion combined with a polyatomic anion)   2. NaCl vs. CaCl2 – 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. |