

**Introduction to Ionic & Covalent Bonding**

**Pre-Lab Questions**

1. Define ionic bond:

Chemical bond where electron(s) are transferred from a cation (usually a metal) to an anion (a nonmetal or polyatomic). The resulting opposite charges attract and the bond gives the atoms involved a full octet.

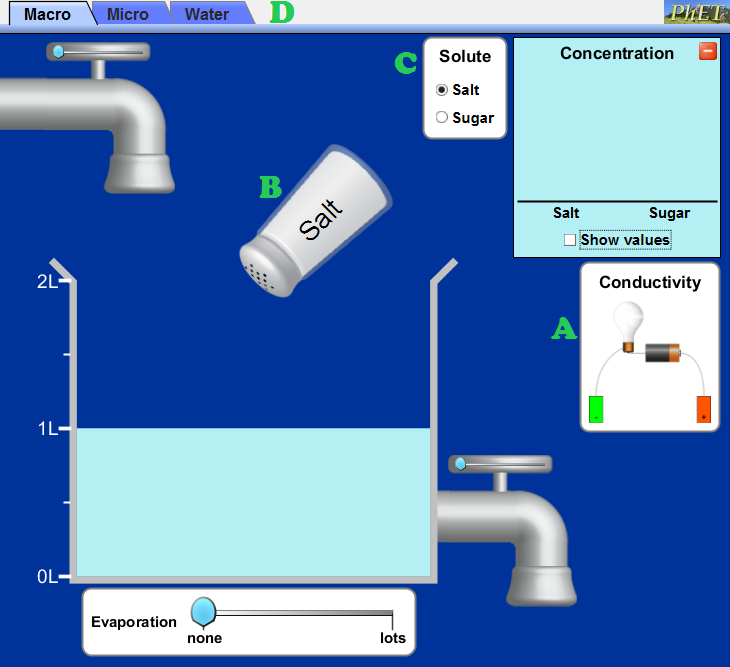
1. Define covalent bond:

Chemical bond where electron(s) are shared between two nonmetals, giving the atoms involved a full octet.

1. What types of atoms compose each type of compound – only metals, only nonmetals, or both?

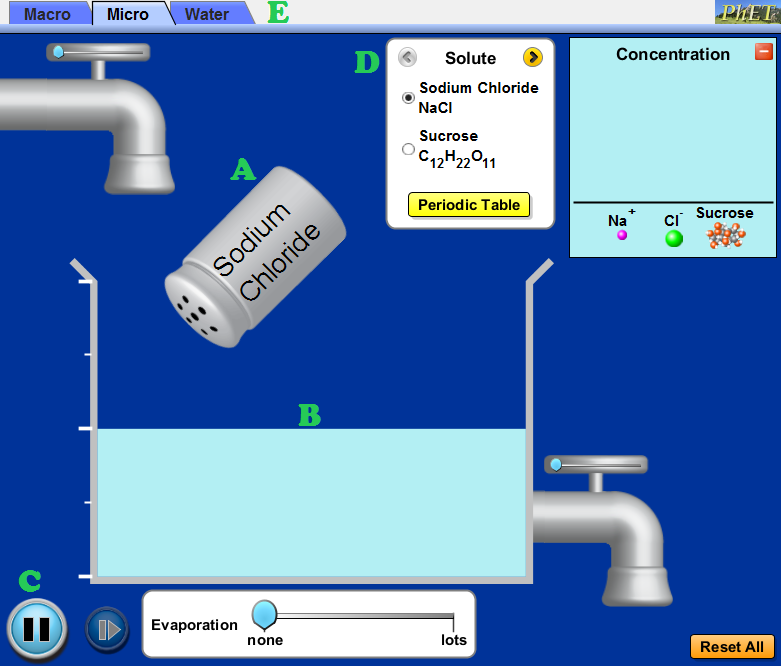
Ionic – metals + nonmetals Covalent – nonmetals only

**Procedure, Part A (Macro Tab)**



1. Open the “Sugar and Salt Solutions” simulation on the PhET website by following the link below and clicking, “Run Now!”: <http://phet.colorado.edu/en/simulation/sugar-and-salt-solutions>
2. Drag the conductivity tester, labeled A, into the beaker of water. Place the negative and positive electrodes into the water, but not touching the bottom of the beaker. When electricity is conducted by the solution, the light bulb will light up – the stronger the electric current, the brighter the bulb will glow. Record any observations.
3. Click on the salt shaker, labeled B, and drag your mouse back and forth. This will “shake” the salt into the water. As you add salt, pay attention to the light bulb on the conductivity tester. Continue to add salt until the shaker is empty. Record observations. Then click the “Remove salt” button to reset the simulation
4. Click the “sugar” bubble in the solute selector, labeled C, to switch from salt to sugar. Then repeat **step 3**, this time using the sugar shaker. Record observations.
5. Click on the “Micro” tab at the top of the simulation, labeled D, to switch to a new simulation for **part B.**

**Procedure, Part B (Micro Tab)**



1. Click on the salt shaker, labeled A, and drag your mouse back and forth. This will “shake” the salt into the water. Pressing pause, labeled C, will stop the salt crystals mid-air so you can see them before they dissolve.
2. Observe how the crystal behaves once in the water. Record observations in the “Ionization in Water” section of the data table.
3. Click the “sucrose” bubble in the solute selector, labeled D, to switch from salt to sugar. Then repeat **steps 6 and 7**, this time using the sugar shaker. Record observations.
4. You can test other solutes by clicked the right arrow in the solute selector, labeled D.
5. To get an even further “zoomed in” view, click on the water tab, labeled E and repeat the simulation by dragging salt and/or sugar into the water.

**Procedure, Part C**

1. Use the Flinn MSDS search to locate the MSDS for “sodium chloride” (salt) and “sucrose” (sugar): <http://www.flinnsci.com/msds-search.aspx>
2. Using the MSDS sheets for salt and sugar, locate their melting points. Record in the data table below.
3. Using the MSDS sheets for salt and sugar, locate the information on solubility. Record in the data table below.

**Data Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Melting Point** | **Solubility in Water**  **(yes or no)** | **Electrical Conductivity**  **(yes or no)** | **Ionization in Water**  **(yes or no)** |
| Pure Water  *H2O* | 0°C | N/A | **No** | N/A |
| Salt  *NaCl* | 801°C | **Yes** | **Yes** | **Yes** |
| Sugar  *C12H22O11* | 185 - 187 °C | **Yes** | **No** | **No** |

**Analysis Questions**

1. Based on their chemical formulas, state whether the substances tested above are covalent or ionic.

**Water and sugar are covalent Salt is ionic**

1. A data table is provided below with information on substances not tested in the simulation. Complete any missing information by looking up the MSDS sheets for each chemical using the same link provided in step 11 of the procedures (for part C).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Substance** | **Phase at 20°C (solid or liquid)** | **Melting Point** | **Solubility in Water** | **Electrical Conductivity in Water** | **Type of Bond** |
| potassium chloride  *KCl* | solid | 772°C | Yes | Yes | ionic |
| benzoic acid  *C6H5COOH* | solid | 122°C | slightly | None detected | covalent |
| ethyl alcohol  *C2H5OH* | liquid | -114°C | Yes | None detected | covalent |
| iron (III) sulfate  *Fe2(SO4)3* | solid | 480°C | Yes | Yes | ionic |
| oleic acid  *C18H34O2* | liquid | 13.4°C | No | None detected | covalent |
| nitrogen  *N2* | gas | -210°C | Slightly | None detected | covalent |

1. Using the data you gathered during the simulation, as well as the data table from the previous question, what are some properties exhibited by covalent (molecular) compounds?

Covalent –

* can be solids, liquids, or gases at room temperature
* have much lower melting points than ionic compounds
* can be soluble or insoluble in water but most appear to be only slightly soluble
* do not conduct electric current

1. What are some properties exhibited by the ionic compounds tested in the simulation and/or shown in the data table in question 2?

Ionic –

* are solids at room temperature
* have much higher melting points than covalent compounds
* are soluble in water
* conduct electric current

1. Although both sugar and salt are soluble in water, the way in which they dissolve is not shown the same in the simulation. How is their dissolving process different? Explain why these differences exist.

The salt compound breaks into two pieces – one positive and one negative ion. The sugar, on the other hand, stays together when it dissolves. Ionic compounds (that transfer electrons) will break apart into ions; whereas molecular compounds (that share electrons) will stay together.

1. What would the simulation have shown if oleic acid was added to water? Would it look different than what was shown for sugar and/or salt? Explain.

Oleic acid is insoluble in water, so the simulation would have shown two separate layers, rather than showing the compounds mixing in with the water (like the salt and sugar).

1. When some ionic compounds dissolve, not all of their bonds dissociate. What kind of conductivity would you expect such a solution to have? Explain.

Weaker conductivity or slight conductivity. The electric current is carried by the ions in solution. If there are fewer ions, there is a weaker current.

1. Based on the formula, predict whether each of the following compounds is primarily ionic or primarily covalent.
   1. sodium iodide (NaI) Ionic d. ammonia (NH3) Covalent
   2. methane (CH4) Covalent e. glucose (C6H12O6) Covalent
   3. calcium chloride (CaCl2) Ionic