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**Student Activity- Properties of Ionic and Covalent Compounds**

Ionic compounds are composed of cations and anions which are held together by electrostatic attractions. The result of these attractions cause compounds to have high melting points, crystalline structures and good electrical conductivity in water.

Covalent compounds (which are also called **Molecular** compounds) have bonds where electrons are shared between atoms. Due to the sharing of electrons, they exhibit characteristic physical properties that include lower melting points and poor electrical conductivity compared to ionic compounds.

Depending on the relative electronegativities of the two atoms sharing electrons, there may be a partial transfer of electron density from one atom to the other. When the electronegativities are not equal, electrons are not shared equally and *partial charges* develop. If two nonmetals with different electronegatvities share electrons in this manner, the bond is called **polar covalent.** If two atoms have the same electronegativity, then electrons are shared equally. This type of bonding is called **nonpolar covalent.**

We will test the electrical conductivity of different solutions.

**Procedure:**

* In beaker #1, dissolve a small amount NaCl crystals in approximately 25 mL of water.
* In beaker #2, dissolve a small amount sugar crystals in approximately 25 mL of water.
* Pour approximately 25 mL of the iodine solution into beaker #3.

Beaker #1 contains NaCl which is ionic compound. Beaker #2 contains sugar (C6H12O6) which is a polar covalent compound. Beaker #3 contains iodine (I2) which is a nonpolar covalent compound.

First, we need to test a control for this experiment. Our control will be distilled water, which contains no ions. Then we will test the conductivity of each of the three solutions with your conductivity tester. Lastly, we will test tap water, to see how well it counducts.

Fill in the chart below. (For conductivity, use terms like *good, poor* or *none*).

**Data:** Properties of Ionic and Covalent Compounds

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Color of Solid** | **Color of Solution** | **Conductivity** | **Type of Solution** |
| **Distilled Water** |   |  |  | Polar covalent (compound) |
| **NaCl** |  |  |  | Ionic |
| **C6H12O6** |  |  |  | Polar covalent |
| **I2** |  |  |  | Nonpolar covalent |
| **Tap Water** |   |  |  | Partially ionic |

What can you conclude about the conductivity of ionic solutions?

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What can you conclude about the conductivity of solutions containing covalent compounds?

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Why does tap water show some conductivity?

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Now we will examine how polarity can be observed. A burette has been set up on your table containing distilled water. When the valve is turned to the on position, the water will freely flow through the bottom of the burette. See the diagram below.



Thoroughly rub a plastic rod with the fur that you have been provided. This will create a significant amount of static electricity on the rod. Now turn on the burette and allow the water to flow out. Slowly bring the rod toward the water stream without touching the water. You may need to rub the plastic rod with the fur again. Then bring the rod toward the water stream again without touching the water.

What happens to the water stream as you bring the charged rod toward it?

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Why do you think this is happening?

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What do you think would happen if we tried the same experiment using a nonpolar liquid?

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Polar and Nonpolar Covalent Bonds

|  |
| --- |
| http://users.stlcc.edu/gkrishnan/PolarBonds.gif |

Nonpolar Covalent Bond

* A bond between 2 nonmetal atoms that have the same electronegativity and therefore have equal sharing of the bonding electron pair.
* Example: In Cl-Cl each Cl atom has an electronegativity value of 3.0, therefore the covalent bond between them is considered nonpolar because the electronegativity difference is zero.

Polar Covalent Bond

* A bond between 2 nonmetal atoms that have different electronegativities and therefore have unequal sharing of the bonding electron pair
* Example: In H-Cl, the electronegativity of the Cl atom is 3.0, while that of the H atom is 2.1. The electronegativity difference is 0.9, therefore the bond is polar.
* The result is a bond where the electron pair is displaced toward the more electronegative atom. This atom then obtains a partial-negative charge while the less electronegative atom has a partial-positive charge. This separation of charge or **dipole** can be illustrated using an arrow with the arrowhead directed toward the more electronegative atom.


The Greek letter *delta* (****) indicates "partially".

* Within a molecule each polar bond has a dipole.
* A polar molecule always contains polar bonds, but some molecules with polar bonds are nonpolar due to symmetry. In a symmetrical molecule, the pulls are cancelled, and the entire molecule is considered to be nonpolar.

Polar Molecule

* A molecule in which the dipoles present do not cancel each other out and thus results in a *molecular dipole.*

Nonpolar Molecule

* A molecule in which the dipoles present do cancel each other out and thus results in a nonpolar molecule.

Example: CO2 is a linear molecule with 2  bond dipoles that are equal and oppositely directed therefore the bond polarities cancel and the molecule is nonpolar.



Define these terms:

Polar covalent bond -

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Polar molecule -

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Dipole -

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Nonpolar covalent bond -

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Nonpolar molecule -

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