**Molecule Polarity PhET Lab**

A study of electronegativity, bond polarity, and molecular polarity

**Introduction:**

In this atomic-level simulation, you will investigate how atoms' ***electronegativity*** value affects the bonds they produce. When two atoms bond, a pair of electrons is shared between atoms. Electronegativity is a measure of a single atom's ability to hoard electrons shared in that bond. In this lab you will work diligently, at your own pace, to answer a number of questions. To begin, from what you've already learned about the protons and electrons in an atom, what would cause an atom to have a **high** electronegativity value? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why might an atom have a **low** electronegativity value?

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**Procedure:** 

* Turn on (check) all view options. ***GRAB*** *and spin the molecule with your mouse.*
* Take your time and investigate how the binary compound's bond behaves when the atom's electronegativity and orientation are changed. Do not rush through this step.

Describe the bond formed between two atoms with **similar, low** electronegativities.

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Describe the bond formed between two atoms with **similar, high** electronegativities.

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Describe the bond formed between two atoms with **very different** electronegativities.

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Describe (in your own words) what is meant by **partial charges**, **δ-** and **δ+**. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

δ- represents: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

δ+ represents: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What happens when the electric field is applied to a very polar molecule? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why do you think this is? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is **electron density**? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the density around a partial positive compare to the density of a partial negative? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What would bring about a higher electron density around an atom? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A bond is characterized as ionic or covalent by comparing the differences between two atoms' electronegativities. Describe an ionic bond in terms of the atoms' electronegativity values. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Describe a covalent bond in terms of the atoms' electronegativity values. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Additionally, we further separate covalent bonds into ***polar*** *covalent* and ***nonpolar*** *covalent*. What would have to be the case for a bond to be *nonpolar covalent*? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In this simulation realize that in addition to changing the electonegativities, you may also move individual atoms by dragging them with the mouse. Here, in addition to bond polarity (represented by the ***bond dipole***), the ***entire*** ***molecule may be polar*** (represented by the ***molecular dipole***). It is this molecular dipole that determines the polarity of the molecule and how it interacts with other molecules and its environment. For instance, molecules with high molecular dipoles tend to have high **intermolecular forces**. (Why?)

BTW: The molecular dipole is found using **vector addition**, adding the bond dipoles together; think a *tug-of-war*.

* Take some time and adjust each of the atom's locations and electronegativity values several times. Observe how the bond dipoles (between A-B and B-C) add to produce a molecular dipole.

How might a molecule with two strong bond dipoles have no molecular dipole at all? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How might a molecule have a very strong molecular dipole. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



"Like dissolves like" is a way to remember that molecules with ***similar molecular dipoles*** will tend to interact favorably and mix. For instance, **water (H2O) is a polar molecule**. It will mix well (dissolve) polar molecules, such as ammonia (NH3), a mixture often used in household cleaners. Both molecules possess strong molecular dipoles. A molecule such as methane (CH4) would not dissolve well into water. Why? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Draw water’s Lewis-dot diagram and show the dipole moment on the molecule with an arrow ( +--> )

**Prediction**: (***do this*** ***before checking each compound in the simulation***), complete the table below (with a √) to predict which of the following should dissolve into water.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H2 | N2 | O2 | F2 | HF | CO2 | HCN | O3 | NH3 | BH3 | BF3 | CH2O | CH4 | CH3F | CH2F2 | CCl3F | CF4 | CHCl3 |
|  |  |  |  |  |  |  |  | **√** |  |  |  |  |  |  |  |  |  |

Finally, what type of solvent would be required to dissolve **nonpolar** compounds? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In the boxes below, construct Lewis-dot diagrams (:Ӧ=C= Ӧ: ) for each of the compounds. For those that are polar, draw the dipole moment (arrow) on your diagram. For those that are nonpolar, write “***nonpolar***”

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| H2 | N2 | O2 | F2 | HF | CO2 |
|  |  |  |  |  |  |
| HCN | O3 | NH3 | BH3 |
|  |  |  |  |
| BF3 | CH2O | CH4 | CH3F |
|  |  |  |  |
| CH2F2 | CCl3F | CF4 | CHCl3 |
|  |  |  |  |