

Lab 1. Bond Character and Molecular Polarity: How Does Atom Electronegativity Affect Bond Character and Molecular Polarity?

Introduction

Chemists often classify chemical compounds into one of two broad categories. The first category is molecular compounds, and the second category is ionic compounds. Molecular compounds consist of atoms that are held together by covalent bonds. Ionic compounds, in contrast, are composed of positive and negative ions that are joined by ionic bonds. Covalent bonds are formed when atoms share one or more pairs of electrons. An ionic bond is formed when one or more electrons from one atom are transferred to another atom. The transfer of one or more electrons from one atom to another results in the formation of a positive ion and a negative ion. The ions then attract each other because they have opposite electrical charges.

The term *electronegativity* refers to a measure of an atom's tendency to attract electrons from other atoms. Atom electronegativity affects the nature or the character of the bond that will form between two atoms. The electronegativity of atoms also affects the electrical charge of a molecular compound. In some molecules, the electronegativity of the atoms that make up the molecule results in one side of the molecule having a partial negative electrical charge and the other side having a partial positive charge. When this happens, the molecule is described as being polar. Water is an example of a polar molecule because the oxygen side of the molecule has a partial negative charge and the hydrogen side of the molecule has a partial positive charge. Nonpolar molecules, in contrast, do not have electrical poles. Carbon dioxide is an example of a nonpolar molecule because both sides of the molecule have the same charge.

In this investigation, you will explore the relationship between the electronegativity of the atoms found within a chemical compound and the character of the bond that holds that compound together. You will also explore how atom electronegativity and molecular polarity are related.

Your Task

Use a computer simulation to explore the effect of atom electronegativity on bond character and molecular polarity.

The guiding question of this investigation is, **How does atom electronegativity affect bond character and molecular polarity?**

Materials

You will use an online simulation called *Molecule Polarity* to conduct your investigation. You can access the simulation by going to the following website: <http://phet.colorado.edu/en/simulation/molecule-polarity>.

Safety Precautions

Follow all normal lab safety rules.

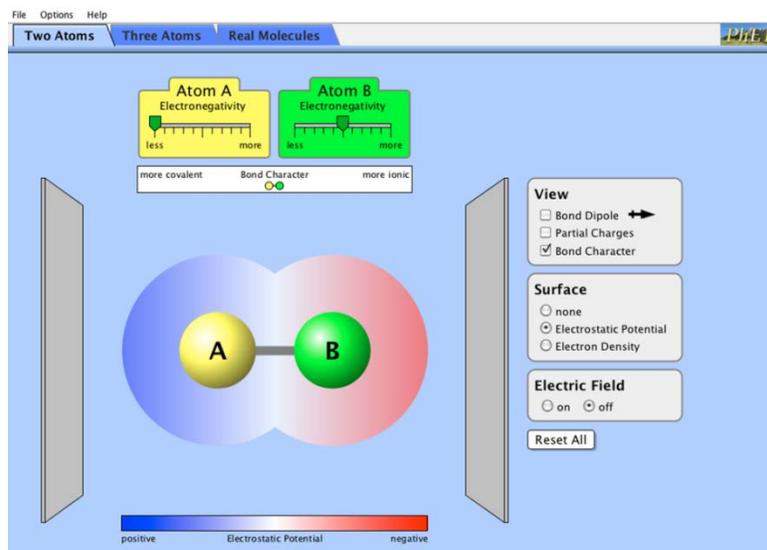
Investigation Proposal Required? Yes No

Getting Started

The *Molecule Polarity* simulation (see Figure L1.1) enables you to create molecules with different numbers of atoms in them and to adjust the electronegativity of each atom in the molecule. You can also view the partial charge of each side of the molecule, the electrostatic potential across the molecule, and the bond character. This information will allow you to explore how atom electronegativity affects bond character and molecular polarity.

FIGURE L1.1

A screenshot of the *Molecule Polarity* simulation



To configure the simulation for this investigation, click on “Bond Character” in the View box and on “Electrostatic Potential” in the Surface box. This will allow you to explore how changing the electronegativity of atoms affects the nature of the bond that forms between them. It will also allow you to examine how atom electronegativity affects the electrical charge of a chemical compound. The other options, such as “Bond Dipole” and “Partial Charges” in the View box and “None” and “Electron Density” in the Surface box, should not be checked. Once the simulation is ready to use, you must determine what type of data you will need to collect, how you will collect the data, and how you will analyze the data to answer the guiding question.

To determine *what type of data you need to collect*, think about the following questions:

- What type of observations will you need to record during your investigation?
- When will you need to make these observations?

To determine *how you will collect the data*, think about the following questions:

- What types of molecules will you need to include in the simulation (i.e., molecules made up of two atoms, molecules made up of three atoms, or both)?
- What range of electronegativity values will you need to investigate?
- What types of comparisons will you need to make?
- How will you keep track of the data you collect and how will you organize it?

To determine *how you will analyze the data*, think about the following questions:

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- the importance of looking for and identifying patterns,
- how models are used to study natural phenomena,
- how the structure of an object is related to its function,
- the difference between laws and theories in science, and
- the difference between data and evidence in science.

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a *claim*, which is your answer to the guiding question. Your argument must also include *evidence* in support of your claim. The evidence is your analysis of the data and your interpretation of what the analysis means. Finally, you must include a *justification* of the evidence in your argument. You will therefore need to use a scientific concept or principle to explain why the evidence that you decided to use is relevant and important. You will create your initial argument on a whiteboard. Your whiteboard must include all the information shown in Figure L1.2.

FIGURE L1.2

Argument presentation on a whiteboard

The Guiding Question:	
Our Claim:	
Our Evidence:	Our Justification of the Evidence:

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group stays at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the initial arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. To critique an argument, you might need more information than what is included on the whiteboard. You might therefore need to ask the presenter one or more follow-up questions, such as:

- What did your group do to analyze the data, and why did you decide to do it that way?
- Is that the only way to interpret the results of your group's analysis? How do you know that your interpretation of the analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before deciding on that one? Why did you abandon those alternative ideas?
- How confident are you that your group's claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!