

Lab Handout

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.

LAB 1

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.

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:

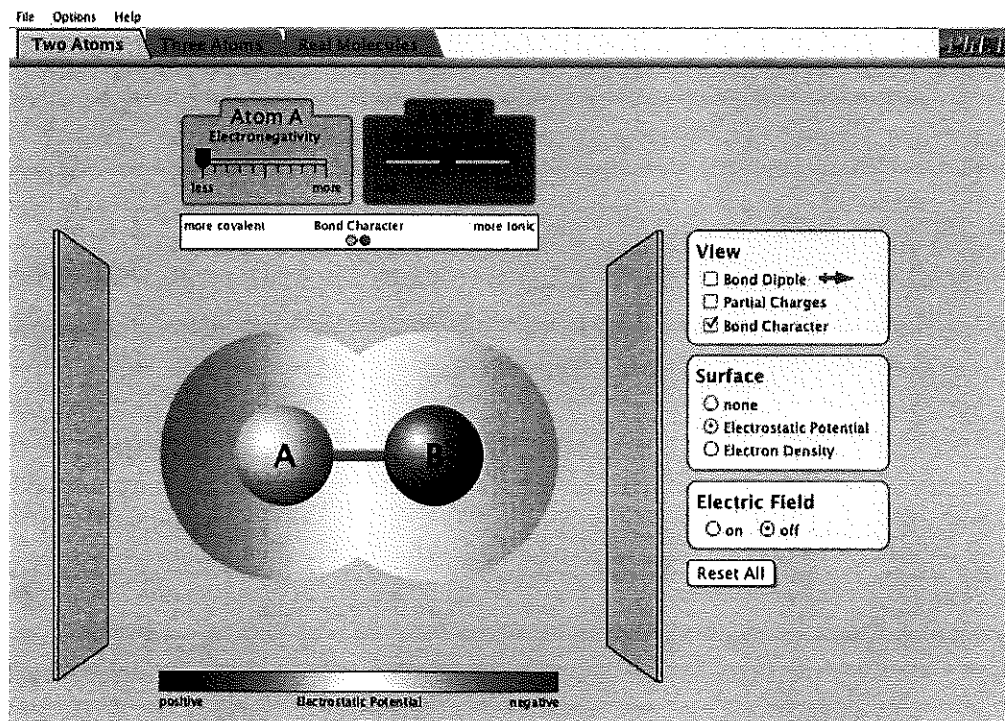
- What type of observations will you need to record during your investigation?
- When will you need to make these observations?

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?

FIGURE L1.1

A screenshot of the *Molecule Polarity* simulation



- 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.

APPENDIX 3

Names:

Period:

Investigation Proposal A

The Guiding Question ...

← Hypothesis 1
→ Hypothesis 2

IF ...

IF ...

The Test

AND ...
Procedure

What data will you collect?

How will you analyze the data?

What safety precautions will you follow?

Predicted Result if hypothesis 1 is valid

Predicted Result if hypothesis 2 is valid

THEN ...

THEN ...

The Actual Results

AND ...

I approve of this investigation. _____
Instructor's Signature
Date

The development of this investigation proposal was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A100909 to the Florida State University. The format of the proposal is modeled after a hypothetical deductive-reasoning guide described in *Exploring the Living World* (Lawson 1995) and modified from an investigation guide described in Macquire, Myerowitz, and Sampson (2010).

Names:
Period:

Bond Character and Molecular Polarity Argument

Directions: Fill in the following with the claim or argument that your group has developed. In the evidence box you will include the data or information that supports your claim. In the reasoning box you must justify and explain how your evidence is supporting your claim. If there is additional information that will further support your claim include it in the place provided below.

CER Graphic Organizer



Question: State the question you are trying to answer using CER.



Claim: Make a claim about why something occurs:



Evidence

List Data to support your claim:



Reasoning

Describe how or why the evidence supports your claim.

Any additional information that supports your claim/argument: