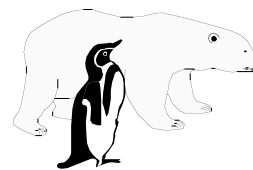


## Lesson Guide: Polar Bears and Penguins

### Investigation IV – Lesson 4



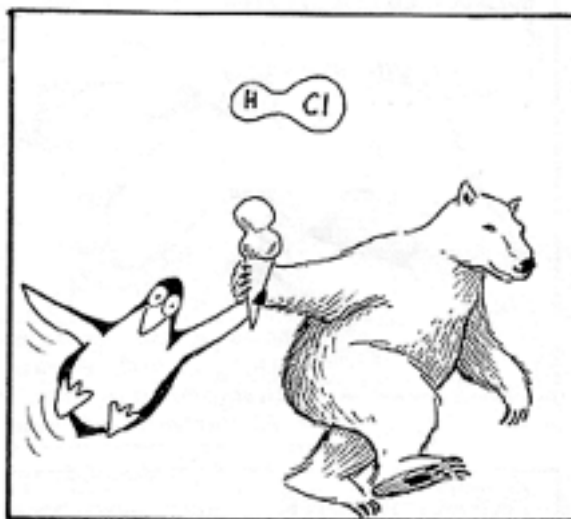
In this lesson you will be exploring polarity and bonding between atoms in greater detail. A comic book will provide new information about these topics and will introduce you to the concept of electronegativity, which helps us to understand partial charges.

### ChemCatalyst

Answer the following questions:

Consider the following illustration:


- Draw the Lewis dot structure for HCl.
- If the penguin represents a hydrogen atom and the polar bear represents a chlorine atom, what does the ice cream represent in the drawing? What do you think the picture is trying to illustrate?
- Would HCl be attracted to the charged wand? Explain your thinking.



### Activity

**Purpose:** In this lesson you will be exploring polarity and bonding between atoms in greater detail. A comic book will provide new information about these topics and will introduce you to the concept of electronegativity, which helps us to understand partial charges.

Use the comic book called “The Bare Essentials of Polarity” to answer the following questions.

1. How does the comic book define a “polar molecule?”
2. Define electronegativity as you understand it, after reading the first two pages of the comic book.
3. Interpret the picture at the bottom of page 1. Explain how the iceberg, penguins, and polar bears represent trends in electronegativity.
4. What is the artist trying to represent when there are two polar bears arm wrestling together, or two penguins arm wrestling together?
5. What three types of bonds are represented on page 3 of the comic book? What happens to the bonding electrons in each type of bond?
6. Explain why there are four scoops of ice cream in the illustration of  $O_2$  on page 3.
7. What do the six scoops of ice cream represent in the illustration of  $N_2$  on page 4?
8. Describe what you think is happening to the penguin in the  $CO_2$  molecule in the picture on page 4.
9. Name three things that the picture of  $CO_2$  on page 4 illustrates about the molecule.
10. Describe what you think is happening to the penguins in the illustration of  $H_2O$  on page 4.
11. Explain what you think the crossed arrow represents in the comic book. 
12. What are the two definitions of “dipole” given in the comic book?

**Making Sense Question:**

What does electronegativity have to do with polarity?

**If you finish early...**

Using polar bears and penguins, create an illustration showing a hydrogen sulfide molecule,  $H_2S$ . (Hint: You may wish to start with a Lewis dot structure.)

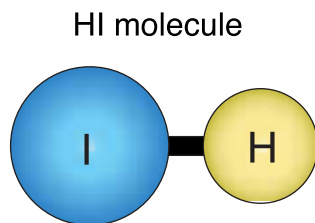
## Making Sense

When two atoms with different electronegativities are bonded together, they tend to attract the bonded electrons to different degrees. This causes the electrons to spend more time around one of the atoms, resulting in a partial negative charge on this atom. This tendency of an atom to attract electrons shared between two atoms is called **electronegativity**. An atom that strongly attracts the shared electrons is considered highly electronegative. The atom with lower electronegativity will end up with a partial positive charge on it. The result is a polar bond. Chemists have a specific name for a molecule that has two poles - it is called a **dipole**.

Polar molecules are also called **dipoles**. The prefix di- means two. A dipole is a molecule with two partially charged ends, or poles. Chemists refer to polar molecules *as* dipoles and they also say that molecules with polar bonds *have* dipoles. These multiple definitions can be a bit confusing.

## Check-in

Answer the following questions:

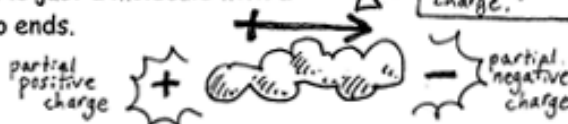


- Is the bond between these atoms polar? Explain your reasoning.
- How would the atoms be portrayed in the comic book – as polar bears, penguins, or both? Explain.

# The BARE ESSENTIALS of POLARITY

by David R. Deley

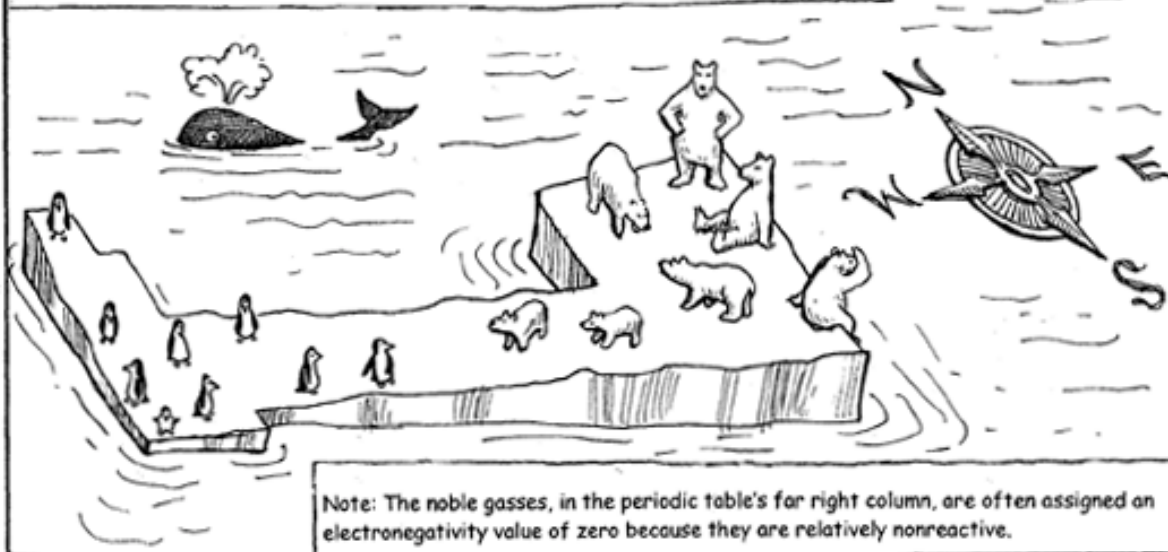
You don't have to go to the ends of the earth to find POLAR MOLECULES. They're all over the place. A polar molecule is just a molecule with a difference in electrical charge between two ends.



The electrical imbalance of POLARITY is caused by differences in ELECTRONEGATIVITY between atoms. Electronegativity is the ability of an atom/nucleus to attract bonding electrons toward itself.



The periodic table shows a general trend in the electronegativity of the elements. Electronegativity tends to rise as you move "northeast" on the periodic table, and fall as you move "southwest."



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When two atoms with unequal electronegativity values bond, they do not share the bonding electrons evenly. The bonding electrons spend more time around the more electronegative atom, creating a **PARTIAL NEGATIVE CHARGE** on that atom. The other atom then has a **PARTIAL POSITIVE CHARGE**, and the bond is polar.



So the polarity of a bond is a function of the difference between the electronegativity values of two bonding atoms. Bonded atoms with equal electron-attracting strength will have nonpolar bonds.



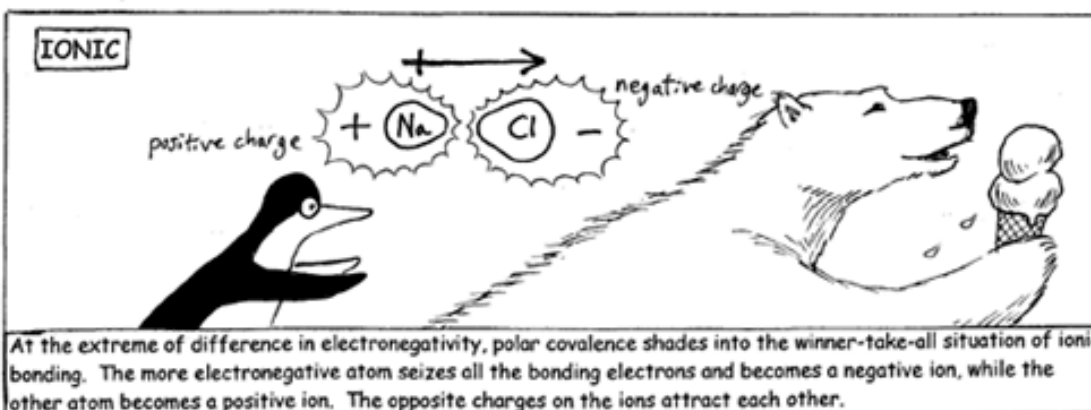
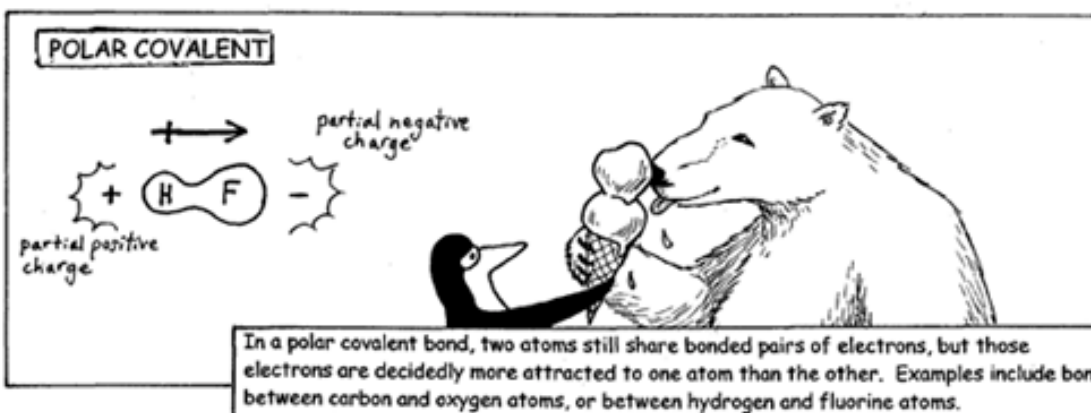
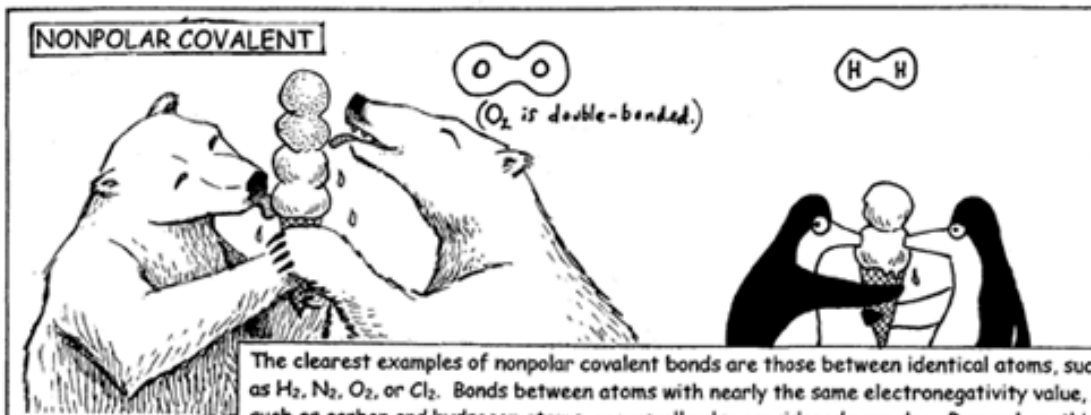
However, if the electronegativity of two bonded atoms is unequal, then their bond will be polarized—maybe a little...



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...maybe a lot.

Because the elements have such varying electronegativities and can come together in so many different combinations, there is really a **CONTINUUM OF POLARITY IN BONDING**. For convenience, we can break the continuum down into three categories: (1) nonpolar covalent, (2) polar covalent, and (3) ionic.



POLAR BONDS BETWEEN ATOMS CONSTITUTE DIPOLES. ACTUALLY, THE WORD "DIPOLE" CAN REFER TO SEVERAL DIFFERENT THINGS THAT ARE RELEVANT HERE: (1) THE POLARITY OF AN INDIVIDUAL POLAR BOND BETWEEN ATOMS, (2) THE NET POLARITY OF A POLAR MOLECULE THAT MAY HAVE SEVERAL POLAR COVALENT BONDS WITHIN IT, AND (3) THE POLAR MOLECULE ITSELF.

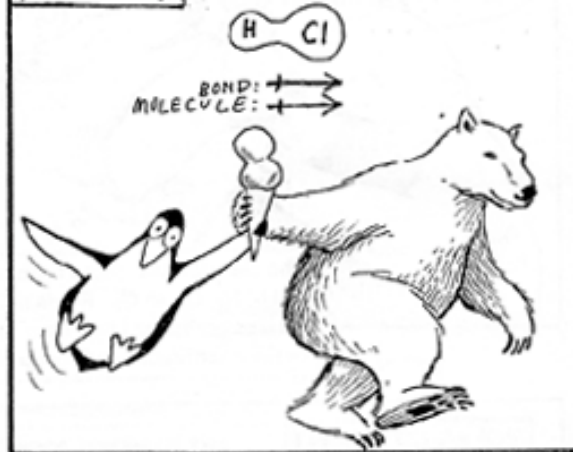


Confusing? Let's look at some examples:

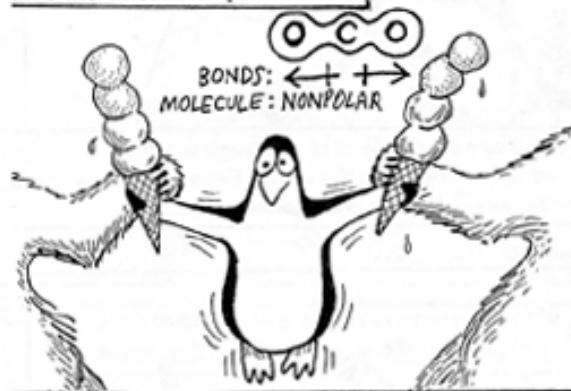
In  $N_2$  molecule isn't a dipole (it's not a polar molecule), and it doesn't have any dipoles (polar bonds) within it.



HCl has a dipole (a polar bond) and it is a dipole (a polar molecule).



In the other hand,  $CO_2$  has two dipoles (two polar bonds), but the  $CO_2$  molecule itself is not a dipole because its polar bonds cancel each other out and make the molecule nonpolar overall.



Like  $CO_2$ ,  $H_2O$  has two dipoles (two polar bonds). But because of  $H_2O$ 's bent shape (caused by lone pairs of electrons on the oxygen atom),  $H_2O$  also has a dipole in the sense of an overall polarity. So  $H_2O$  is a dipole in the sense of being a polar molecule.



The polarity of molecules can affect many of their other properties, such as their solubility, their boiling and melting points, and their odor.



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## Homework

Complete the following for homework:

1. Using polar bears and penguins, create an illustration showing an ammonia molecule,  $\text{NH}_3$ . (Hint: You may wish to start with a Lewis dot structure.)