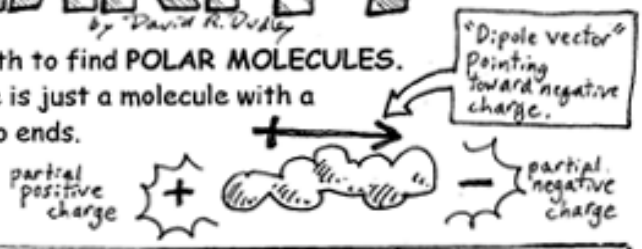
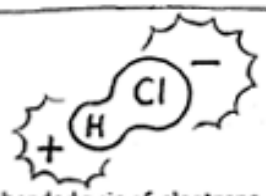
The BARE ESSENTIALS of POLARITY

by David R. Dudley

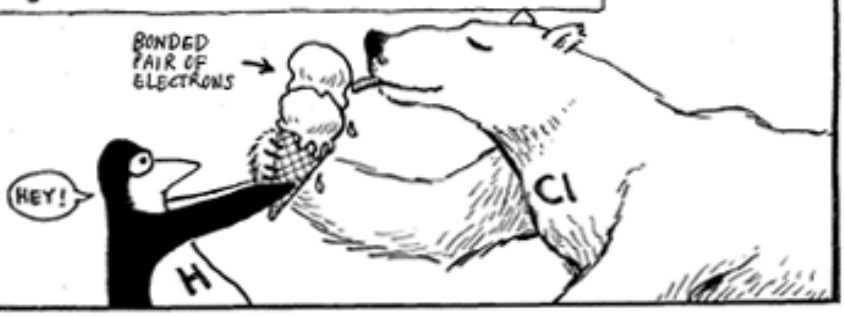
You don't have to go to the ends of the earth to find **POLAR MOLECULES.** They're all over the place. A polar molecule is just a molecule with a difference in electrical charge between two ends.



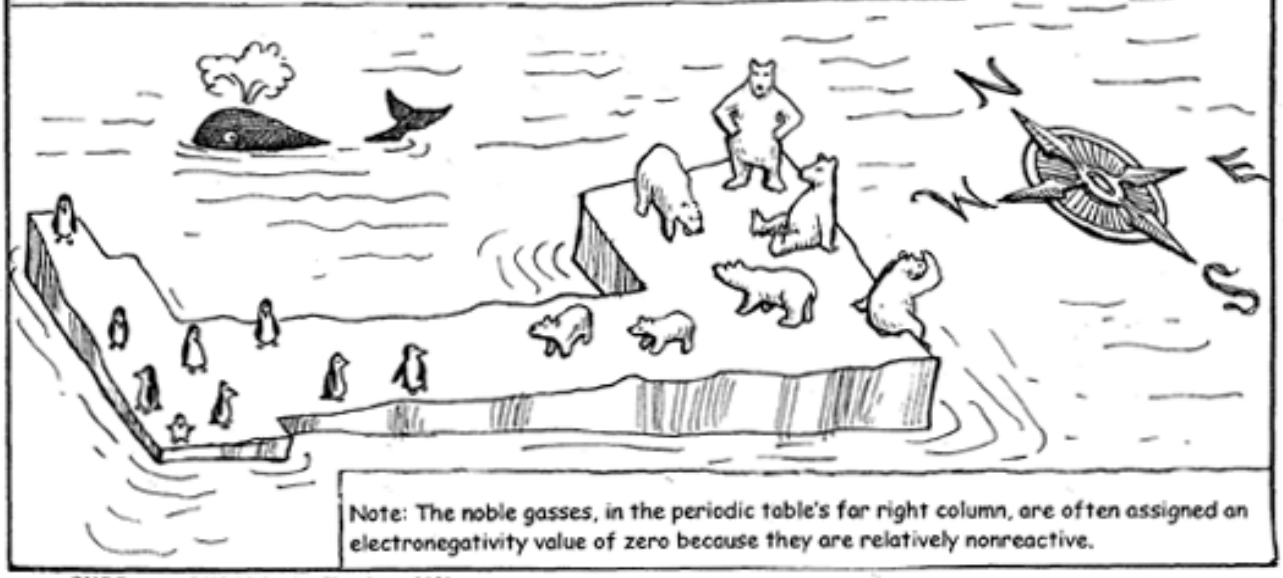
The electrical imbalance of **POLARITY** is caused by differences in **ELECTRONEGATIVITY** between atoms. Electronegativity is the ability of an atom/nucleus to attract bonding electrons toward itself.



In HCl, the bonded pair of electrons spends more time near the chlorine's nucleus because chlorine is more electronegative than hydrogen.



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."

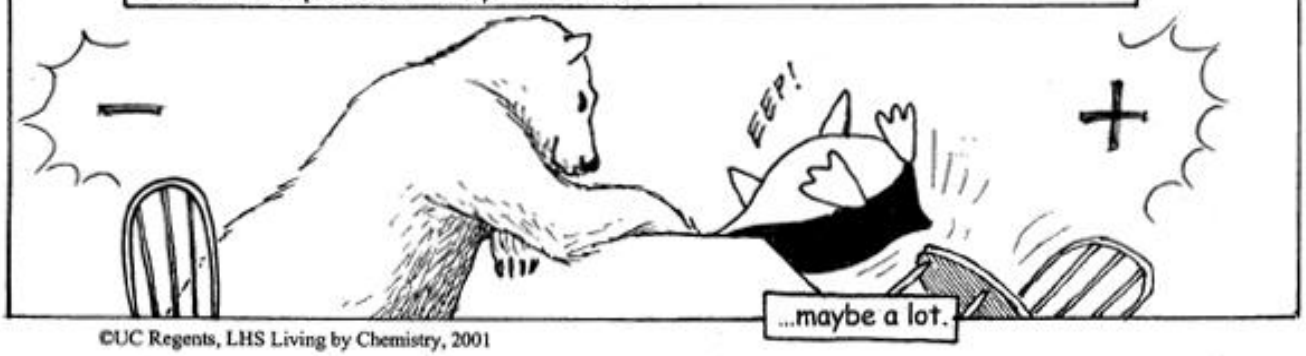


Note: The noble gasses, in the periodic table's far right column, are often assigned an electronegativity value of zero because they are relatively nonreactive.

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.

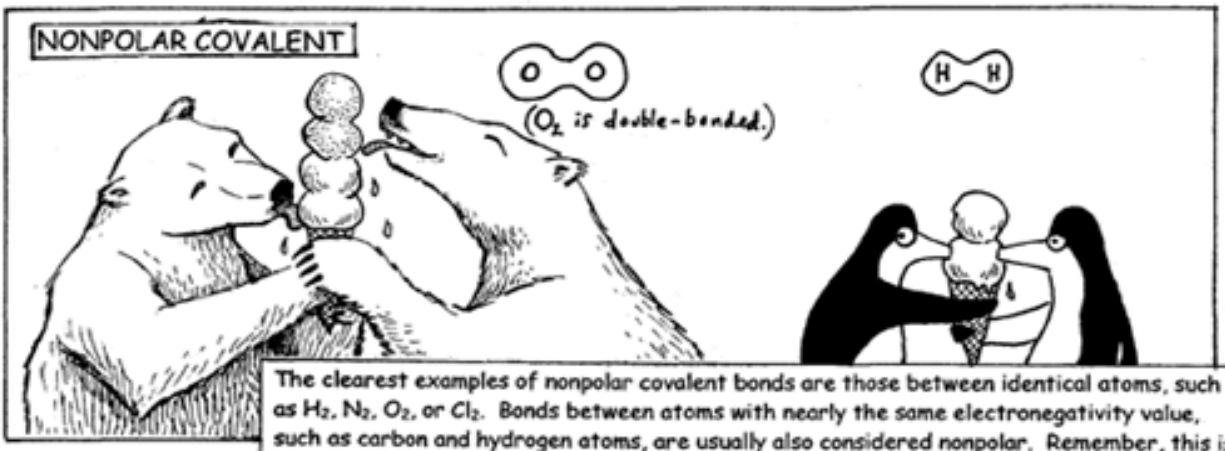
So the polarity of a bond is a function of the difference between the electronegativity values of two bonding atoms. Bonded atoms with equal electron-attracting strength will have nonpolar bonds.

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



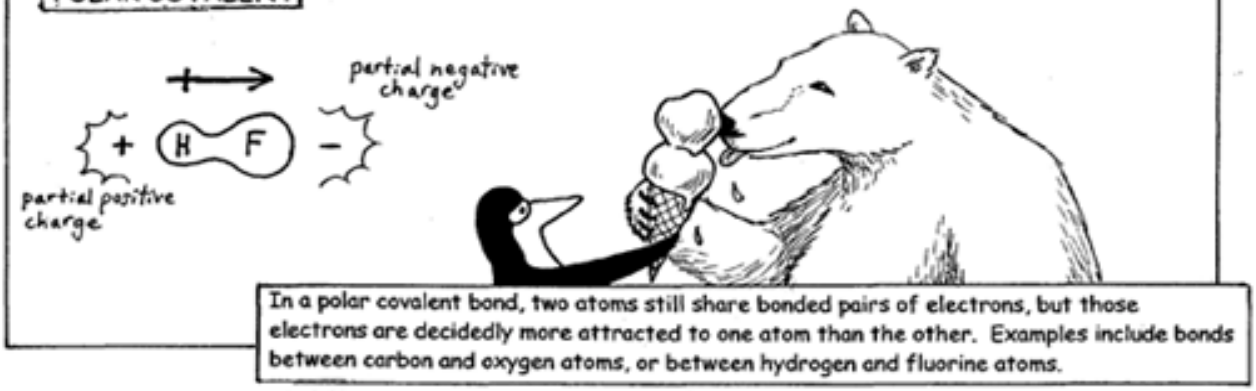
Because the elements have such varying electronegativities and can come together in so many different combinations, there is really a **CONTINUUM OF POLARITY IN BONDING.** For convenience, we can break the continuum down into three categories: (1) nonpolar covalent, (2) polar covalent, and (3) ionic.

NONPOLAR COVALENT



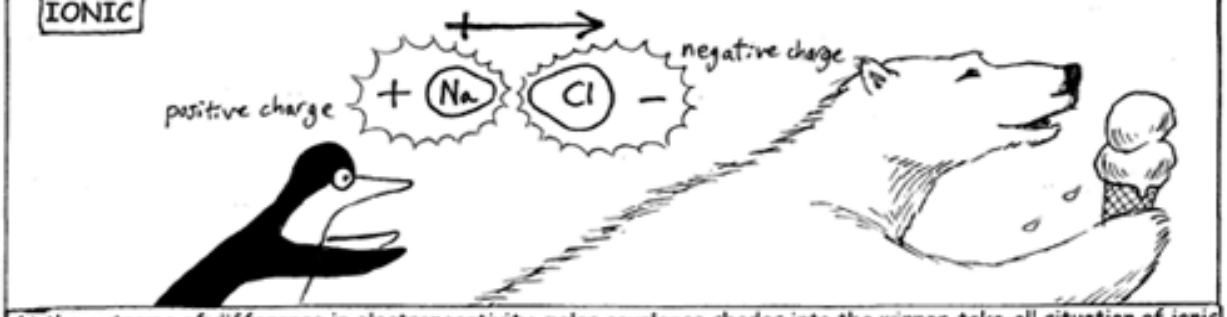
The clearest examples of nonpolar covalent bonds are those between identical atoms, such as H_2, N_2, O_2, or Cl_2. Bonds between atoms with nearly the same electronegativity value, such as carbon and hydrogen atoms, are usually also considered nonpolar. Remember, this is really a continuum, and conventional distinctions are somewhat artificial.

POLAR COVALENT



In a polar covalent bond, two atoms still share bonded pairs of electrons, but those electrons are decidedly more attracted to one atom than the other. Examples include bonds between carbon and oxygen atoms, or between hydrogen and fluorine atoms.

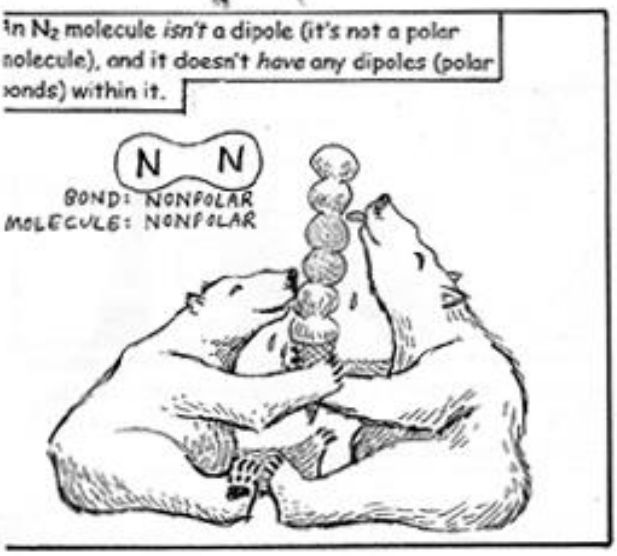
IONIC

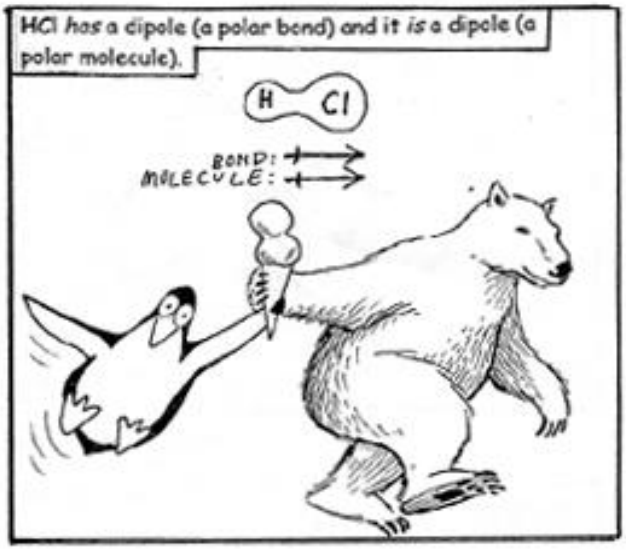


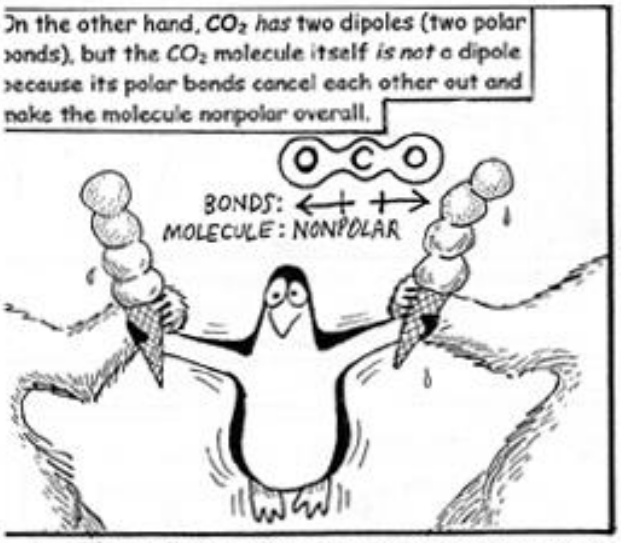
At the extreme of difference in electronegativity, polar covalence shades into the winner-take-all situation of ionic bonding. The more electronegative atom seizes all the bonding electrons and becomes a negative ion, while the other atom becomes a positive ion. The opposite charges on the ions attract each other.

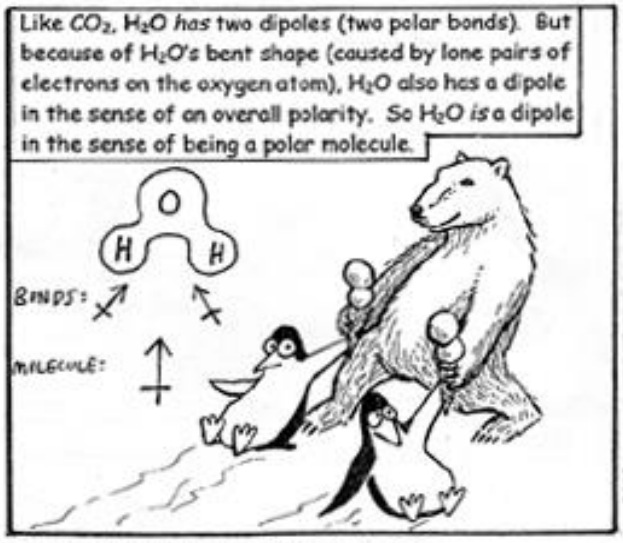
Polar bonds between atoms constitute **DIPOLES**. Actually, the word "dipole" can refer to several different things that are relevant here: (1) the polarity of an individual polar bond between atoms, (2) the net polarity of a polar molecule that may have several polar covalent bonds within it, and (3) the polar molecule itself.

Confusing? Let's look at some examples:









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

The Bare Essentials of Polarity

After reading the cartoon, 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?