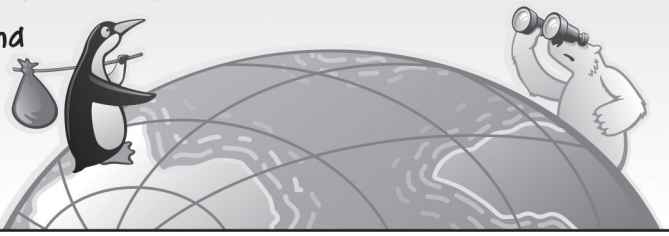
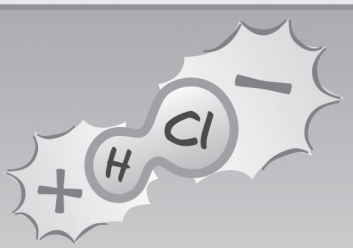
The BARE ESSENTIALS of POLARITY

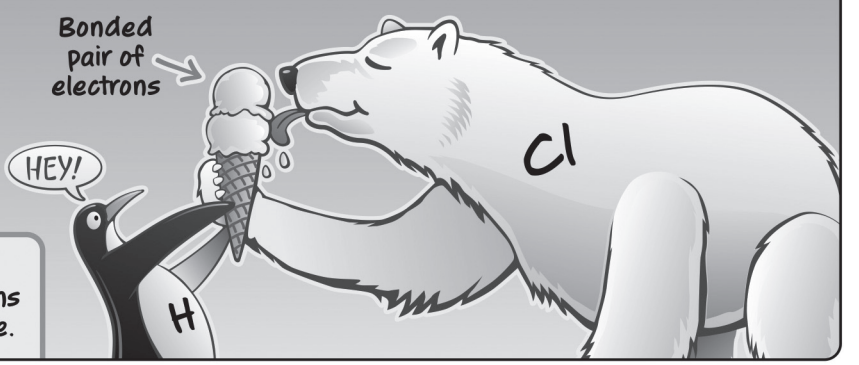
You don't have to go to the ends of the earth to find polar molecules. They're all over the place. A polar molecule is just a molecule with a difference in electrical charge between two ends.



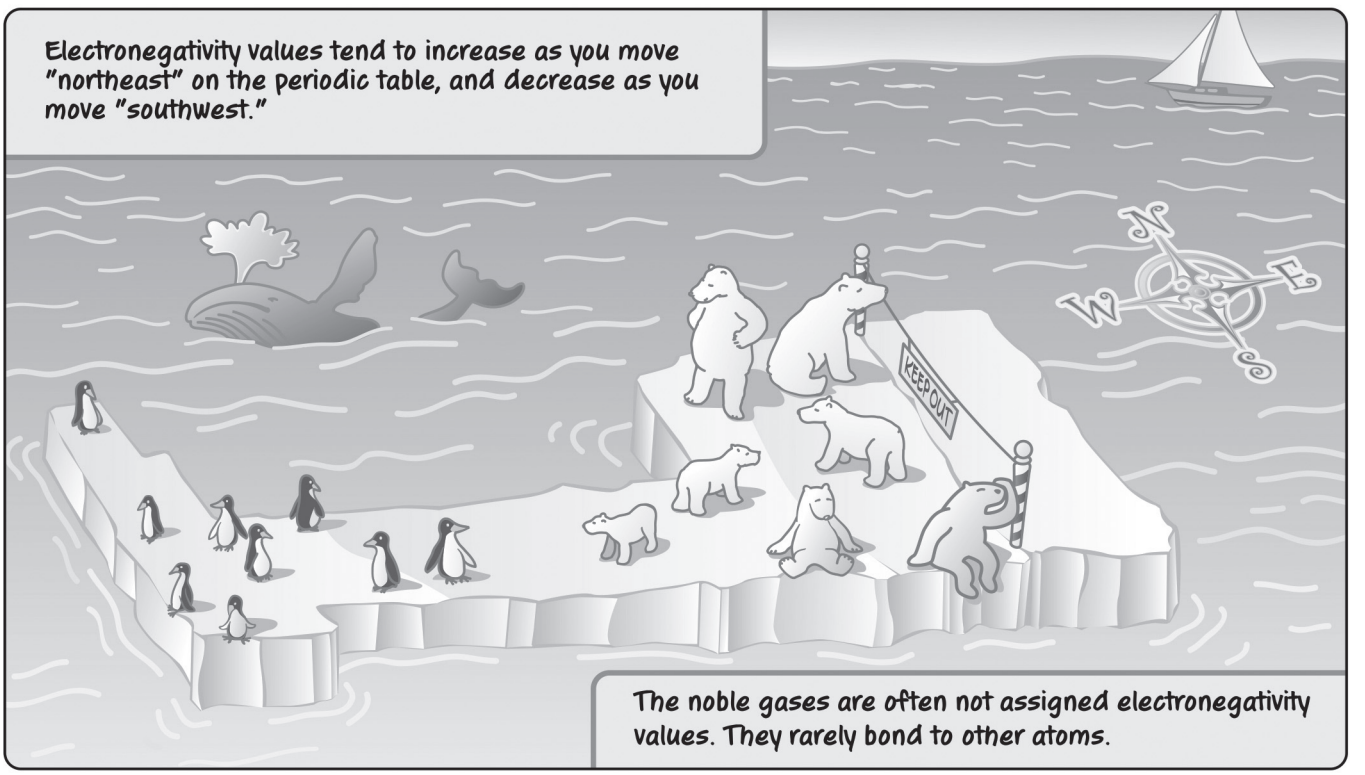
Polarity in molecules is caused by differences in electronegativity between atoms. Electronegativity describes the ability of an atom to attract bonding electrons toward itself.



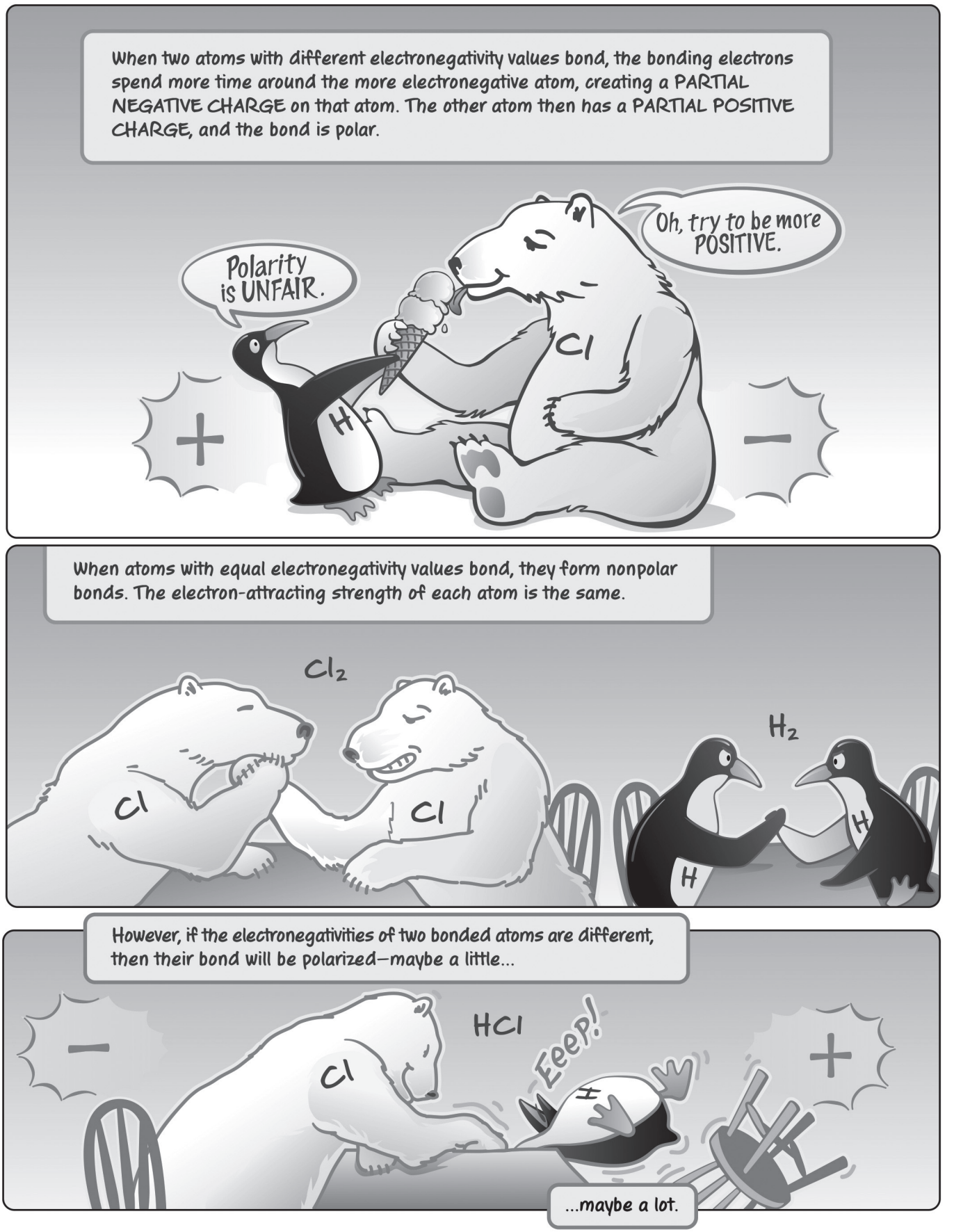
Chlorine is more electronegative than hydrogen. So the bonded pair of electrons in HCl spends more time near chlorine.



Electronegativity values tend to increase as you move "northeast" on the periodic table, and decrease as you move "southwest."

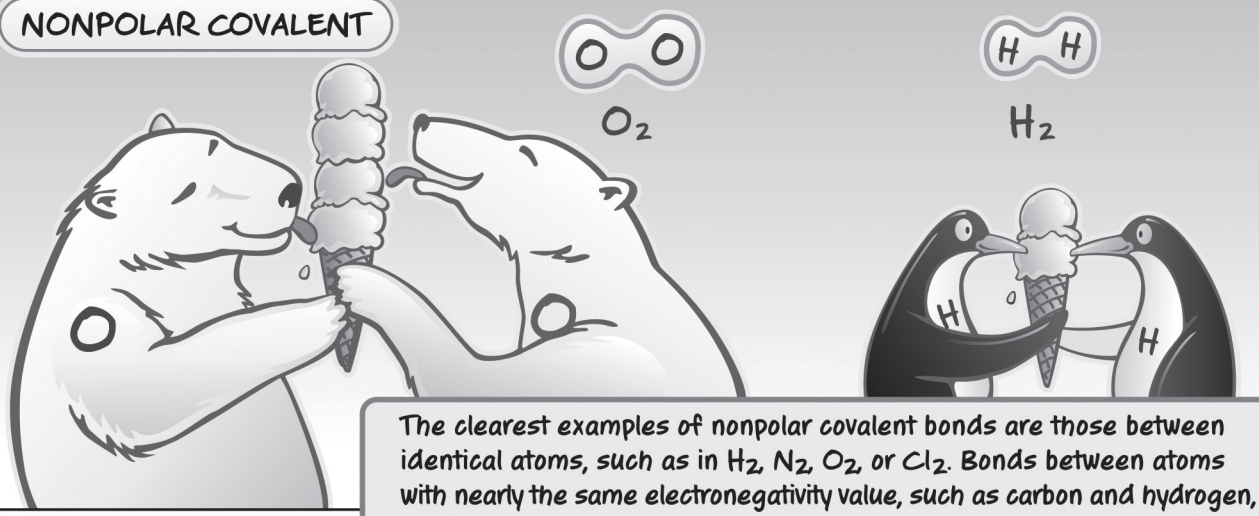


The noble gases are often not assigned electronegativity values. They rarely bond to other atoms.



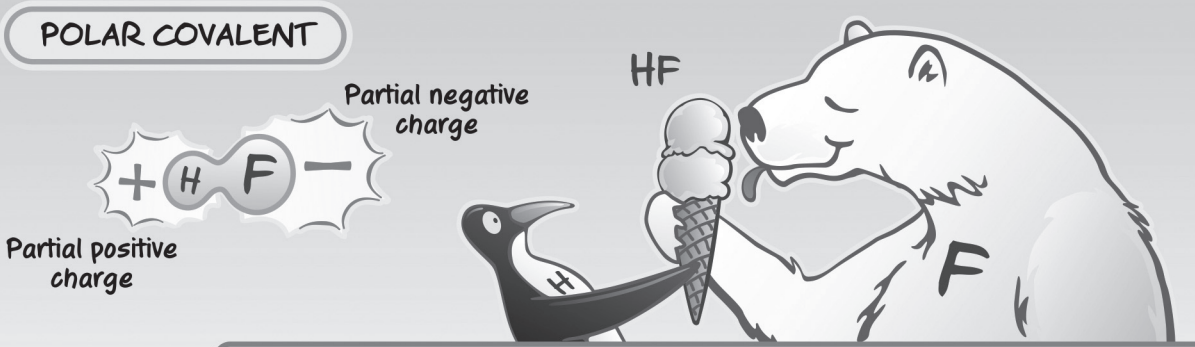
Because the elements have such varying electronegativities and can bond in many different combinations, there is really a continuum of polarity in bonding. We can break the continuum down into three categories.

NONPOLAR COVALENT



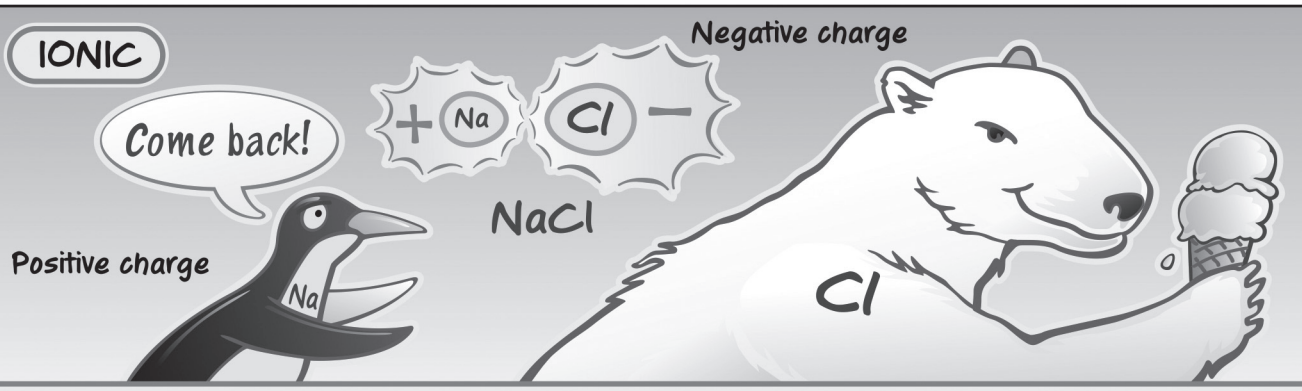
The clearest examples of nonpolar covalent bonds are those between identical atoms, such as in H_2, N_2, O_2, or Cl_2. Bonds between atoms with nearly the same electronegativity value, such as carbon and hydrogen, can also be considered nonpolar.

POLAR COVALENT



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

IONIC

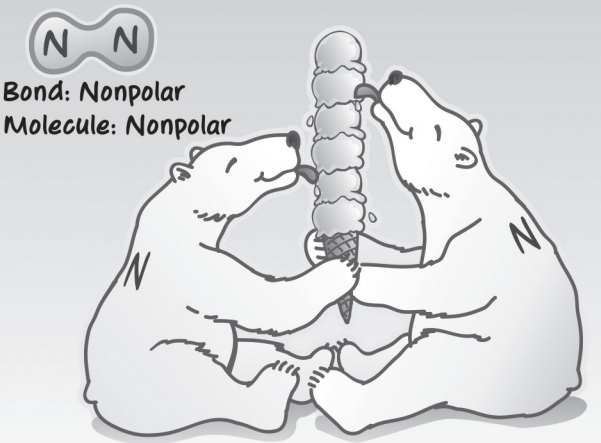


A large difference in electronegativity results in the winner-take-all situation of ionic bonding. The more electronegative atom takes the bonding electrons and becomes a negative ion, while the other atom becomes a positive ion. The opposite charges on the ions attract each other.

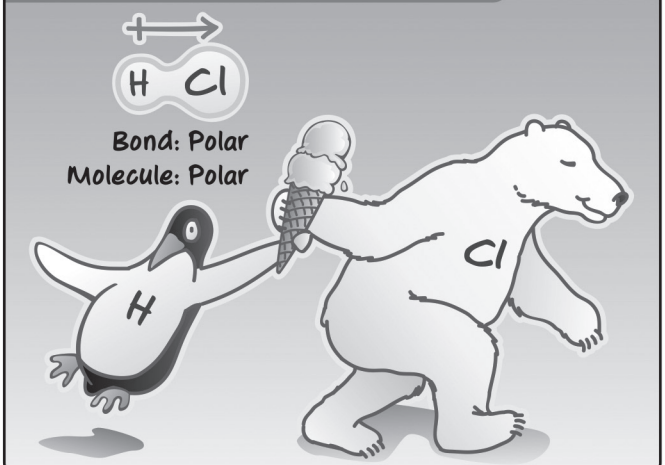
Polar bonds between atoms create dipoles. The word dipole can refer to (1) the polarity of an individual polar bond between atoms, (2) the net polarity of an individual polar molecule that may have several polar covalent bonds within it, and (3) the polar molecule itself.

Confusing? Here are some examples:

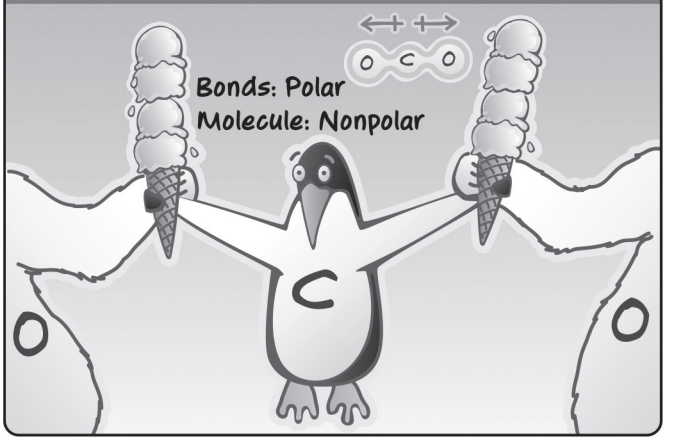
An N_2 molecule isn't a dipole and it doesn't have any dipoles.



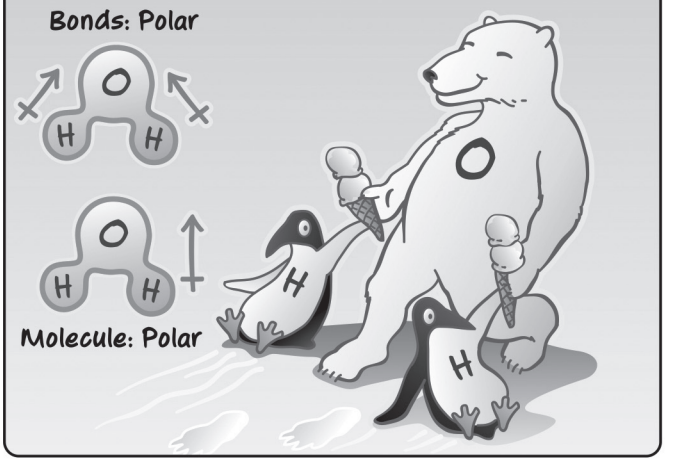
HCl has a dipole and it is a dipole.



CO_2 has two dipoles but the CO_2 molecule itself is not a dipole. Its polar bonds balance each other out and make the molecule nonpolar overall.



H_2O has two dipoles. Because of its bent shape, it also has a dipole in the sense of an overall polarity.



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