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14 - Polar vs. Non-polar bonds

The Bonding Kaleidoscope: Exploring Continuums

Video 14 - Transcript

Hi everyone. Welcome to video number 14. Today we're going to be looking at polar versus non polar bonds. So far, we've looked at all of the various types of both intra- and intermolecular forces of attraction within and amongst molecules. To end off our discussion on bonding, we need to recognize that there is a range that exists across the spectrum of all molecules, which is as follows. On one end we have completely non polar covalent bonds. Here I have two examples, hydrogen or H2 two methane CH4. Within non polar covalent bonds, we have fairly equal sharing of electrons. In the case of hydrogen, both atoms share the two electrons within this covalent bond equally. That is because both hydrogen atoms possess the same electronegativity. In the case of methane, carbon, and hydrogen has a very small electronegativity difference. We consider C-H bonds to also be non-polar. In the middle of this continuum, we have polar covalent bonds. Polar covalent bonds are still covalent bonds, but there is a significant electronegativity difference between the atoms that make up the bonds. In the case of ammonia, nitrogen is a fairly electronegative atom. Nitrogen, as shown by its lone pair here, is going to possess a delta negative charge, with the hydrogen atoms possessing a delta positive charge. Of course, we all know water by now. Water is our universal polar solvent. Oxygen is highly electronegative. Therefore, the oxygen atom of water will develop a slightly negative charge, with our hydrogen atoms developing slightly positive charges. On the very other end of this continuum, we see ionic bonds. With ionic bonds, there is no sharing of electrons, like in our covalent bonds. But we have complete transfer of electrons to form ions. The degree to which electrons are shared in a chemical bond forms this continuum. From equal sharing in non-polar covalent bonds to unequal sharing in polar covalent bonds, to complete transfer of electrons in ionic bonds. This is all due to electronegativity and electronegativity differences between our atoms. Now just to remind us, electronegativity is the strength with which a species pulls electrons towards itself, and it is determined by the number of protons and the distance of the valence electrons from the nucleus. In general, moving up and to the right of the periodic table means that the atoms will have a higher electronegativity. Oxygen has a higher electronegativity, for example, than nitrogen. Nitrogen has a higher electronegativity than sulfur, carbon, hydrogen, phosphorus, and all these other atoms. The differences in electronegativity dictate how electrons are distributed in covalent bonds. In a non-polar covalent bond, electrons are evenly shared; in a polar covalent bond, they're shared unevenly, and ionic bonds result when electrons are transferred completely from one atom to another. Let's consider a polar covalent molecule such as HCl. HCl is a combination of hydrogen, which is a non metal, and chlorine, which is also a non metal. This is of course, covalent bonding, as we've learned - Non-metal and non-metal. Of course, they're sharing electrons, but because the electronegativity difference between these two atoms is significant enough, this bond is a highly polar covalent bond, and therefore it's very soluble in water. We know HCl, hydrochloric acid, dissolves easily in water. If we think about the types of van der Walls interactions that are at play when HCl dissolves in water, we might imagine that these are solvated by ion-dipole interactions. In biomolecules. as we mentioned many times before, covalent bonding predominates. The presence of polar covalent bonds is paramount to the ability of molecules to react with one another so that the metabolic reactions which support life, can be facilitated. If you think about the cell, the cell itself has an aqueous system. Water, and its ability to solvate polar molecules and polar compounds create reactive centers within molecules. That brings us to the concept of functional groups, which we're going to look at in our next video.