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11 - Hydrogen Bonding

Hydrogen Hugs: The Affectionate Side of Chemistry

Video 11 - Transcript

Hi everyone. Welcome to video number 11. Today we are going to explore hydrogen bonding. Now so far, we have looked at the three main types of intramolecular bonding. That's going to be ionic, covalent, and metallic bonds. Today we're going to focus on hydrogen bonds, which is one of the two main types of intermolecular forces of attraction. The definition of a hydrogen bond. Hydrogen bond is said to be the attraction between a hydrogen atom, which is itself attached to an electronegative species. and another electronegative species in a different part of the molecule or another molecule. As we see here. We set up a charge distribution across the hydrogen bond, where the hydrogen atom will display a slightly positive charge. It's attached to an electronegative atom, which will of course display a slightly negative charge. And then the hydrogen atom is then attracted to another electronegative center. This can be on the same molecule or in a different molecule altogether. X and Y are electronegative centers. X and Y are electronegative centers. We have my hydrogen being electropositive. Of course, if Y is electronegative, then Z, which is attached to Y, is also electropositive. The greater the electronegativity differences between X and Y is going to then determine the strength of my hydrogen bond. Okay, the more polarization is going to occur, if I have a higher electronegativity difference between X and Y. This is going to give me a greater bond strength in regards to my hydrogen bond that is being formed. Now, another very important fact about hydrogen bonds is that they have a bond angle of approximately 180 degrees. This means that hydrogen bonds are linear in nature. The bond angle is the angle that is formed between three atoms across at least two bonds. In this case, X, H, and Y. Or if we look at this case, Oxygen, Hydrogen, Oxygen - In the hydrogen bond of water. We can designate our electronegative centers and our electropositive centers, just as we did for the general example. The reason why hydrogen bonds form in this linear way, because when these three atoms are in a straight line, there is maximum overlap of my orbitals. When I have maximum overlap, the bond is stronger. The atoms generally tend to arrange themselves in a linear way so that I have maximal overlap, and the strength of my hydrogen bonds is at its greatest. The closer the bond angle is to 180 degrees, the shorter is the bond length. I have short bond length, and I have high bond strength. We usually use water to exemplify hydrogen bonding. Since water is so vitally important to life. One of the most important properties of water is its ability to be a solvent. In many cases, hydrogen bonding facilitates the solvation properties. Now when we studied the difference between inter and intramolecular forces of attraction, we mentioned that intermolecular forces of attraction, like hydrogen bonding, are responsible for the physical properties of substances. Now generally speaking, in a solid we have a high number of intermolecular forces of attraction, and in a liquid, for example, we have less intermolecular forces of attraction and that makes sense when we look at the properties of a solid versus the properties of a liquid. Now, ice and water, which is water of course - solid water and liquid water - displays anomalous behavior. And anomalous means different or strange behavior. Now, if you think of a solid substance, a solid substance will tend to sink in a sample of its liquid state. However, solid ice floats in a sample of liquid water, Solid ice actually turns out to be less dense than liquid water. This is strange - solids are generally more dense than liquids. The reason for this is because when water freezes, when we're moving from a liquid to a solid, The hydrogen bonds that are necessarily going to form when we're moving from a liquid to a solid, because we're increasing the number of intermolecular forces of attraction - because they're forming in a straight line, in this linear way, the number of molecules actually occupy a larger volume, because they have to spread out to facilitate the linear formation of the hydrogen bonds. If we have the same number of molecules occupying a larger volume, the density will decrease. Therefore, the bonds effectively spreads out the molecules to accommodate the linear formation - volume increases - this decreases the density. This accounts for example the ability of glaciers to float on our oceans, allowing marine life to continue to thrive underneath the insulated waters. Hydrogen bonds are extremely important to the role and function that biomolecules play in our cells. Especially in the three dimensional configuration of proteins and of DNA. You will continuously meet hydrogen bonding, as you go through your biology studies, and it's very important to be able to define hydrogen bonding, recognize where they will form, and also draw them. That's all for now. I'll see you in the next video where we're going to be exploring the other main type of intermolecular forces of attraction, which are Van der Waals forces.