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7 - Types of Bonding

Chemical Handshakes: The Language of Molecular Bonding

Video 7 - Transcript

Hi everyone, welcome to video number 7. Today we're going to be exploring the different types of bonding that occur within and between molecules. When we think about intermolecular forces of attraction and intramolecular forces of attraction, we have to be able to differentiate between these two and identify the different types of bonds that are associated with these two terms. Generally speaking, all of the forces of attraction that can occur within and between molecules are divided into two main types. We have intramolecular bonding, which comprises of our ionic, covalent, and metallic bonds. These are the bonds that are going to occur within molecules. The second type of force of attraction, main type, are called intermolecular forces of attraction, and these are the forces that occur between molecules. The two main examples of these are hydrogen bonding and what we call Van der Waals forces. Generally speaking, intramolecular bonds are very strong. Intermolecular bonds are relatively weak. But that does not mean to say that intermolecular bonding is not important. Collectively, hydrogen bonding and Van der Waals forces are responsible for a wide variety of physical properties of substances that are very vital to life. Now, van der Waals forces can be further broken down into three main types. We have what we call ion- dipole, we have instantaneous dipoles, and We also have dipole - induced-dipole. Now in another video, further down the line, we're going to be looking at these types of forces in great detail. Now we mentioned that intermolecular forces of attraction are weak, but collectively strong. To demonstrate the difference in the magnitude between the strengths of an intramolecular and intermolecular, for example, covalent bonds are about 400 times stronger than a typical Van der Waals force. Let us demonstrate the difference between inter- and intramolecular bonding using water, as an example. I have drawn here two water molecules. I have one up here and one here. Now the solid lines represent my covalent bonds, which is my intramolecular bonding. The dotted line represents what we call a hydrogen bond, which is an example of intermolecular bonding. When water changes state, for example, we know the three basic states of matter, liquid, solid, and gas. If I have liquid water that is being converted to solid water, let's say when we freeze it and it becomes ice, we are looking at an increase in the number of my hydrogen bonds or my intermolecular forces within the substance. If we think about the changing the physical property of a molecule, the physical property of a substance, versus changing the chemical property of a substance that is related to which bonds are being affected within the process. If we're changing state, which is a physical property we're going to be looking at or we're only going to be dealing with my intermolecular forces of attraction. We're either going to be making more of them or we're going to be breaking them. If we're turning my liquid water into gas, we're going to be breaking the hydrogen bonds that the molecules are able to be free to form a gas. If we're turning liquid water into solid, then I'm bringing my molecules closer together and I'm going to form more of my hydrogen bonds to facilitate the formation of a solid. Changing state involves a change in the number and the magnitude of the intermolecular forces of attraction in a compound. But it does not affect the intramolecular forces of attraction. If we are affecting my intramolecular forces, the chemical bonds, that's where we're going to start affecting the identity of the compound itself, meaning that we're changing the chemical nature or we're decomposing the substance to break apart into atoms. We already know that solids, for example, have a very packed regular state - solids; liquids a little bit less regular, and then gases are pretty much independent molecules moving without my intermolecular forces of attraction present. We have relatively strong intermolecular forces within solids. Solids have definite shape, volume, boundaries and are very difficult to compress. In liquids, we have intermediate strength of my intermolecular forces of attraction, which is why liquids have a definite volume. But they do take the shape of the vessel that they're placed in. Liquids aren't very compressible, but they can move around within the container that they're placed in. Unlike a solid, where the molecules are within a fixed equilibrium position. In gases, we have negligible forces of attraction that are present. And therefore, the molecules in a gas are free to move independent of each other. Gases also take the shape and volume of the vessel that they're placed in. If you think about a soft solid, let's say for example, candle wax versus hard solid, let's take, for example, a sample of iron. Obviously, it's going to take a lot more energy to convert a hard solid into a liquid versus a soft solid into a liquid. Because a soft solid is going to have a lot less intermolecular forces of attraction than a hard solid. Similarly to this, if we have a viscous liquid, if we think about motor oil for example, this is going to require a lot more energy to be vaporized than compared to a more volatile liquid such as propenol. The variation between melting points and boiling points of substances is directly related to the relative strengths of the forces that exist amongst the molecules of these substances. If you think about iodine, for example, and carbon dioxide, what do we know about iodine and carbon dioxide? These molecules are known to sublime, which means that they move through from the solid straight to the gaseous phase. Or from the gaseous phase back to the solid phase. They skip the liquid phase altogether. The reason is because the intermolecular forces of attraction that exist between iodine molecules and between our carbon dioxide molecules are so weak that if I have iodine in a solid form, any small application of heat is going to be sufficient to allow my iodine molecules to move into the gaseous state. And the same with carbon dioxide, otherwise known as dry ice. A substance with a lower melting point will have lesser and smaller forces of attractions amongst its molecules than a substance with a higher melting point. The number and the magnitude of intermolecular forces depend on the identity of the atoms in the molecule. Various other characteristics such as electronegativity, the size of the atoms, the regularity of the packing, as well as the overall shape of the molecules. Intermolecular forces of attraction govern physical properties such as boiling and melting points, vapor pressures, viscosities, surface tension, and solubility properties. Intramolecular forces of attraction are concerned, as we said, with the identity of the molecules themselves. The chemical properties that they may exhibit during chemical reactions where the formal intramolecular bonds are being broken and formed. That's all that we're going to talk about today. In the subsequent videos, we're going to go a little deeper into each one of these intra- and intramolecular forces of attraction and describe how they are formed.