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8 - Ionic Bonding

Ionic Elegance: Crafting Stable Chemical Alliances

Video 8 - Transcript

Hi everyone. Welcome to video number 8 where we're going to be exploring the concept of ionic bonding. As we mentioned before, ionic bonding is one of the three main types of intramolecular bonding that occurs within molecules. Now, it's very important to note before we start all of this off, that ionic bonding is almost never observed to occur in biomolecules which make up life. However, it's still important to know about ionic bonds as they are responsible for the formation of salts, which are important in the practices of farming and in agriculture as well. Now, ionic bonding is typically described as the bond that occurs between a metal, which of course, as we know, metals occur in groups 1, 2 & 3 of the periodic table, and between a non-metal, which of course are the elements that occur in groups 5, 6 & 7 of the periodic table. Now the most common ionic substance that is normally used discuss ionic bonding is sodium chloride. Sodium chloride or NaCl is a salt, as we all know. I have drawn here a sodium atom. The atomic number of sodium is 11. Here we have 11 electrons in the neutral atom of sodium. I've also drawn a chlorine atom which has atomic number 17. Again, we have 17 electrons in the neutral atom. Now I'm showing my crosses as the electrons in sodium, and my dots as the electrons in chlorine. So that I can do this, and what's going to happen is my sodium atom is going to donate this electron in its valence shell to my chlorine atom. Therefore, I'm showing you this electron, extra electron as my pink x in the chlorine atom. What therefore happens after bonding is my sodium becomes a cation, and my chlorine becomes an anion, Cl- Notice now the Na+ ion has a full outermost shell of electrons - eight. Then notice now when the Cl atom forms the Cl- ion, it also has the full set of electrons in its outermost shell - eight. The electrostatic force of attraction between this positive ion and this negative ion is what's holding these two species together. This is an ionic bond. Now it is generally termed ionic bonding, if there's what we call a large electronegativity difference, a large electronegativity difference, between the two species. What is electronegativity? Now, electronegativity is the ability of an atom to draw a negative charge towards itself. If we think about groups 1, 2 & 3 - these are my metals - these are actually electropositive, because metals will have 1, 2 or 3 electrons in their outermost shell, and they will tend to donate electrons to other species. Metals are electropositive. Non-metals are electronegative, because, as we've seen here, non-metals tend to accept electrons from other species. If electronegativity is the ability of a species to draw negative charge towards itself, non-metals are highly electronegative and my metals are electropositive. If we think about how we were to define ionic bonding, we have what we call the Pauling scale of electronegativity. Pauling was this scientist that basically came up with this term - electronegativity. The scale is basically used by chemists to average the electronegativity of various atoms. The larger the difference in electronegativity between two atoms involved in an ionic bond, the more polar the bond will be. Fluorine, for example, Symbol F, is the most electronegative element; most electronegative element in the periodic table. Whereas caesium element, Cs is the least electronegative element in the periodic table. Now the strength of an ionic bond can be described using what we call Coulomb's Law, Which states that the magnitude of the electrostatic force between two point charges is going to be directly proportional to the scalar multiplication; Directly proportional to the scalar multiplication of the two charges, and is inversely proportional to the square of the distances between them. This little formula here represents Coloumb's Law, where is F = force, q1 and q2 represent my two charges, and r represents the radius, therefore, the distance between the two charges. The size of atoms and their charges - size and charges - will contribute to the overall strength of an ionic bond formed, whereby the greater the charge, and the smaller the radius or the distance between the charges, the stronger the force will be. Ionic compounds are generally called salts, as we mentioned, and these form lattice structures in the solid state. The main factors that determine the strength of the lattice structures is going to be the relative charges of the ions and their relative sizes. Ionic compounds are said to have crystal structures which contain many ions packed in a regular fashion. Again, the mutual attraction between the positive and the negative ions holds the lattice structure together. The large amounts of energy required to break apart these electrostatic forces of attraction is responsible for the high melting point - high melting point of ionic compounds. Sodium chloride, for example, NaCl, is said to have a giant ionic structure. Ionic compounds can, in the molten state conduct an electric current because they're able to have ions that are mobile or moving in the liquid state. However, in the solid state, the ions are not mobile, so that ionic substances do not conduct an electric current in the solid state. To round off, we'll just mention that ionic compounds are used commonly in agriculture and farming, as I mentioned. Sodium chloride is a good example of a salt that we use. We also use calcium and magnesium bicarbonates. We use potassium sulfates and sodium sulfates as well. That's all today for ionic bonding. In the next video, we're going to explore metallic bonding.