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Organic Chemistry: Current Research

Short Communication

Short Communication on Chemical Bonding

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ABSTRACT

Chemical bonding is the basic fundamentals of chemistry which is used in understanding the basic concepts such as molecules and reactions. Without which, scientists wouldn't be able to explain how products are formed after a chemical reaction has taken place and how atoms are attracted to each other. The structure of atoms helps to understand the theory behind bonding.

Keywords: Atoms; Nucleus; Proton; Neutron

INTRODUCTION

A common atom contains a nucleus composed electrons of different energies revolving around nucleus, which consists of protons and neutrons. In this section, the main focus will be on these electrons. Elements are distinguishable from each other due to their "electron cloud," or the area where electrons revolve around the nucleus of an atom. Each element has a distinct electron cloud, which determines their chemical properties and their extent of reactivity (i.e., noble gases are inert/not reactive while alkaline metals are highly reactive). In chemical bonding, only valence electrons, electrons located in the orbitals of the outermost energy level (valence shell) of an element, are involved [1].

Lewis theory

Lewis theory is graphical representations of elements and their valence electrons. Valence electrons are the electrons that form the outermost shell of an atom. In a Lewis diagram of an element, the symbol of the element is written in the center and the valence electrons are drawn around it as dots. The position of the valence electrons drawn is unimportant. However, the general convention is to start from 12 o'clock position and go clockwise direction to 3 o'clock, 6 o'clock, 9 o'clock, and back to 12 o'clock positions respectively. Generally the Roman numeral of the group corresponds with the number of valance electrons of the element.

Lewis theory for molecular compounds/ions

To draw the Lewis diagrams for molecular compounds or ions, follow these steps below (we will be using H_2O as an example to follow):

1) Count the number of valance electrons of the molecular compound or ion. Remember, if there are two or more of the same element, then you have to double or multiply by however many atoms there are of the number of valance electrons. Follow the roman numeral group number to see the corresponding number of valance electrons there are for that element.

Valance electrons:

Oxygen (O)-Group VIA: therefore, there are 6 valance electrons

Hydrogen (H)-Group IA: therefore, there is 1 valance electron

Total: 6 + 2 = 8 valance electrons

2) If the molecule in question is an ion, remember to add or subtract the respective number of electrons to the total from step 1.

For ions, if the ion has a negative charge (anion), add the corresponding number of electrons to the total number of electrons (i.e., if NO_3- has a negative charge of 1-, then you add 1 extra electron to the total; 5 + 3 (6) = 23 +1 = 24 total electrons). A - sign mean the molecule has an overall negative charge, so it must have this extra electron. This is because anions have a higher electron affinity (tendency to gain electrons). Most anions are composed of non-metals, which have high electronegativity.

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3) Write out the symbols of the elements, making sure all atoms are accounted for (i.e., H_2O, write out O and 2 H's on either side of the oxygen). Start by adding single bonds (1 pair of electrons) to all possible atoms while making sure they follow the octet rule (with the exceptions of the duet rule and other elements mentioned above).

4) If there are any leftover electrons, then add them to the central atom of the molecule (i.e., XeF_4 has 4 extra electrons after being distributed, so the 4 extra electrons are given to Xe: like so. Finally, rearrange the electron pairs into double or triple bonds if possible.

Octet rule

Many of the elements follow the octet rule in chemical bonding, which means that an element should have contact to eight valence electrons in a bond or exactly fill up its valence shell. Having eight electrons ensures that the atom is highly stable. This is the reason why noble gases having valence electron shell with 8 electrons are chemically inert; they are already stable and tend to not need the transfer of electrons when bonding with another atom in order to be stable. On the other hand, alkali metals have a valance electron shell of one electron. Since they want to complete the octet rule they often simply lose one electron. This makes them quite reactive because they can easily donate this electron to other elements. This explains the highly reactive properties of the Group IA elements.

Hydrogen (H) and Helium (He) follow the duet rule since their valence shell only allows two electrons. There are no exceptions to the duet rule; hydrogen and helium will always hold a maximum of two electrons.

Ionic bonding

Ionic bonding is the process of not sharing electrons between two atoms. It occurs between a non-metal and a metal. Ionic bonding is also known as the process in which electrons are "transferred" to one another because the two atoms have different levels of electron affinity. In the picture below, sodium (Na) ion and a chlorine (Cl) ion are being combined through ionic bonding. Na^+ has less electronegativity due to a large atomic radius and essentially does not want the electron it has. This will easily allow the more electronegative chlorine atom to gain the electron to complete its 3rd energy level. Throughout this process, the transfer of the electron releases energy to the atmosphere.

Covalent bonding

Covalent bonding is the process of sharing of electrons between two atoms. The bonds are typically between a non-metal and a non-metal. Since their electronegativities are all within the high range, the electrons are attracted and pulled by both atom'snuceli. In the case of two identical atoms that are bonded to each other (also known as a nonpolar bond, explained later below), they both emit the same force of pull on the electrons.

CONCLUSION

Thus there is equal attraction between the two atoms (i.e., oxygen gas or O_2, have an equal distribution of electron affinity. This makes covalent bonds harder to break.

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