

Hello everybody, my name is Doctor Richa Sardessai and today we're going to be talking about fundamentals of organic chemistry and the module of carbocations and its reactivity. This module is a part of Bachelor of Science Program of Chemistry. In the paper CHC 101 inorganic and organic chemistry. The outline of this module is that it illustrates the relative stability carbocations, and it explores the reactions of carbocations.

At the end of this module, the student will be able to understand the reactivity of carbocations compare the stability of various carbocations and comprehend the concept of rearrangement.

Now before we begin, we have to understand what are reactive intermediates. Reactive intermediates are nothing but short lived species that are never present in high concentration because they react as quickly as they are formed. Understanding the formation, stability and reactivity of reactive intermediates helps us

to understand the mechanism of a variety of organic chemistry reactions. Before we move on to understanding the chemistry of carbocations, we have to understand how many types of reactive intermediates are present. Reactive intermediates maybe divided into carbon, carbon radicals and carbenes.

In this module, we're going to be focused only on the reactivity of carbocations. Carbocations are basically positively charged species which are bonded to three other atoms. They have only 6 electrons in their valence shell and their sp^2 hybridized. Hence they are planar. They are also very powerful electrophiles and serve as intermediates for many organic reactions. Now coming to the reactivity of competence, we must understand that carbocations undergo 4 main type of reactions. First is a combination with the nucleophile, second is the elimination of a proton, third the addition to an unsaturated linkage and fourth the rearrangement of their structure. Out of this, the first 2 lead to the formation of stable end products whereas the next two reactions lead to formation of newer carbocations.

Coming to the first reaction of carbocations can behave as electrophiles to react with different types of nucleophiles as it is observed in this reaction. It is also commonly observed during your nucleophilic substitution reactions and Friedel Craft's alkylation, for example in this, this tertiary alcohol gets converted to a carbocation which then reacts with a nucleophile, bromine to give a haloalkane. Similarly, this benzyl alcohol here again generates a benzylic carbocation which reacts with the nucleophile bromine to give benzyl bromide.

Similarly, carbocations also undergo Friedel Craft's alkylation. That is, they react with carbocations. tertiary alkyl halides react with aluminium chloride to generate a carbocation which then undergoes a reaction with benzene which acts as a nucleophile to give this product. The second reaction of

carbocations, is the elimination of a proton. Carbocations behave as Bronsted acid to lose an H⁺ ion to yield alkenes as shown here. Here the carbocation is losing one hydrogen ion to yield an alkene like this.

Many examples of this type of reaction are known. This halo compound reacts with methanol to give a carbocation which on React, which, on reaction with methanol then reacts or loses an H⁺ ion to generate an alkene like this. Similarly, this compound will automatically undergo elimination to generate this carbocation, which again loses an H⁺ onto eldan alkene like this. The third type of reaction the carbocations undergo is the addition to an unsaturated linkage carbocations may add to an alkene to produce another carbocation possessing higher molecular weight. In the first example, we have observed that a methyl carbocation adds to an alkene group to give a propane or a higher carbocation. However, sometimes there is a double bond which is in close proximity to the carbocation. This leads to an internal alkylation to the double bond, as in this case the positive charge is very much close to this double bond here and hence it reacts with that double bond to give this type of a carbocation.

Finally, we move on to the last reaction of carbocation that is rearrangements. However, before going to that module, we have to understand the concept of rearrangement. Why does occur but an undergo rearrangement. Carbocations, being electron deficient species undergo structural changes called rearrangements to form stable carbocations. This is because as their electron deficient there, stabilized by alkyl substituents in two ways, one is the inductive effect, and two is the hyperconjugation.

The more highly substituted carbocations are more stable the order of stability of carbocations is: The tertiary carbocation is more stable than the secondary carbocation, which is more stable than the primary carbocation, which is more stable than the methyl carbocation. Hence any carbon curtain which is which has a lower stability will undergo rearrangement to form a cover written with a much higher and better stability.

This acts as a driving force for the 4th type of reaction, that is, rearrangement of their structure that is the primary and secondary carbons undergo rearrangement to form more stable, secondary, and tertiary cover times. This rearrangement can involve two types of rearrangement one is the 1,2- hydride shift and 2nd is the 1two methyl shift.

The 1 two hydride shift involves the migration of a hydride ion in a less stable carbocation to form a more stable carbocation. For example, this bromo alkene will generate a less stable secondary carbocation which will then undergo a 1, 2 shift of the hydrogen to generate a more stable tertiary carbocation.

Similarly, this alkene will pick up a proton to generate a less stable second recovery time and will change

which will undergo the 1,2 hydride migration to generate a more stable carbocation. A similar reaction is observed for the 1, 2 methyl shift instead of the hydride group we see here the methyl group, which shifts from one carbon to the other carbocations.

It involves the migration of a methyl group in a less stable carbocation to form a more stable carbocation.

For example, once the hydroxide is eliminated in this carbon molecule it generates a less stable carbocation which is secondary in nature. In this, this methyl group then undergoes a 1, 2 methyl shift to generate a more stable tertiary carbocation. This type of migration is frequently observed in the many important type of reactions like Pinacol- Pinacolone rearrangement, benzilic acid rearrangement etc.

So what have we learned today? To summarize, carbocations are powerful electrophiles that undergo an array of reactions understanding the carbocation and reactivity aids in predicting pathways as well as products of different reactions. Stability of the carbocation directly influences its reactivity. These are a number of references for which you may be interested in learning about carbocations. You can refer to these books.

Thank you.