Example of Nucleophilic Addition

Transcript

Instructor: Brett McCollum

00:00:00:00 - 00:00:41:72
Instructor: In this video, we're going to get practice with nucleophilic addition. The reagent that we're going to explore is a carbonyl group. We see that we have a carbon oxygen double bond and due to the electron negativity difference of those two atoms, we could represent this as a partially positive and partially negatively charged pair of atoms. That makes the carbon a good site for accepting electron density from something that will donate electron density. Or in the language that we use in this unit, the carbon is a good electrophile.

00:00:41:72 - 00:01:04:92
Instructor: So, we need to find what will be the nucleophile. We look at our reagents, and we see sodium borohydride, and our solvent below the arrow is ethanol. The sodium borohydride being above the arrow, that tells us it's our reagent. Now, the sodium is just a counter ion. It's not going to affect our reaction.

00:01:04:92 - 00:01:51:46
Instructor: But let's draw out the borohydride and see how it can act as our nucleophile. We have a boron atom with four hydrogens around it. Recall the sodium with its positive charge is just a spectator ion in this reaction. Formally, we're representing that negative charge on the boron. But it is actually a more accurate representation to say that there is a small negative charge on each of the hydrogens and that the boron is almost neutrally charged.

00:01:51:46 - 00:02:21:29
Instructor: The reason that is, is because boron is less electro negative than hydrogen. The electrons are more often found, the electron density is greater close to the hydrogen. That means that in this reaction, we could actually move the hydrogen with the electron pair. We're not transferring H plus, we're going to transfer H minus. Let's try doing that.

00:02:21:29 - 00:03:11:63
Instructor: We're going to draw our arrow going from one of the shared pairs of electrons, our nucleophile, to the carbon, our electrophile. When we do that, that's going to break this hydrogen boron bond with the electron pairs moving with the proton, forming a new chemical bond with that carbon, but the carbon already has four bonds on it. It's only allowed to have four bonds. For forming a new bond, we need to break one of the bonds that are currently existing with that carbon. The highest energy bond, the one that's easiest to break is the Pi bond between the carbon and the oxygen.

00:03:11:63 - 00:03:47:15
Instructor: We're going to break that and move the electron pair up onto the oxygen atom. Let's draw what forms as a result of this flow of electrons. We now have our five membered ring. We have a single electron pair up to the oxygen that has gained an electron pair and is now negatively charged. We have the waving arms, and methyl ketone has turned into an oxide.

00:03:48:14 - 00:04:21:64
Instructor: It has formed a new bond with a hydrogen. Now, as a result, this is going to be a stereochemical center. We need to represent that stereochemistry, and we could have that our oxygen is coming forward and that hydrogen is going back. We also still have in the system borane. This is our intermediate species, but we now need to stabilize it.

00:04:21:64 - 00:05:00:00
Instructor: What else is in the system that would allow us to deal with that negative charge and stabilize our intermediate? We need something that could give some positive charge like a proton to the molecule. Well, borane has protons, it's not going to be a good source of an acidic proton to balance out that charge. The other thing that's in our system is our solvent, ethanol, and ethanol can act as an acid, so it's our good source of protons in order to stabilize our intermediate. Let's draw that.

00:05:00:00 - 00:05:59:06
Instructor: We now have this reacting with ethanol, and we can draw the electron pair, but which pair is attacking, which pair is receiving? Here, it's the negatively charged oxygen, will donate an electron pair to abstract this proton and the bonding pair will move onto the oxygen resulting in our products. Let's draw those. We have our five membered ring. We formed our product, which is an alcohol, and a byproduct, ethoxide.

00:05:59:06 - 00:06:10:00
Instructor: When we look at this reaction, we can now see, what have we transformed? We turned a ketone into an alcohol.