The Electron Pushing Formalization – Part 1

Transcript

Instructor: Brett McCollum

00:00:00:00 - 00:00:40:56
Instructor: Okay, we're going to look at a more complicated example now. We're still doing the electron pushing formalization, and in this case, I've given us the full reaction mechanism. Our objective is not to predict what will form, rather, our objective at this stage is to explain why it forms using electron pushing arrows and drawing lone pairs or formal charges as needed. Later, after we get a little bit more practice at the electron pushing formalization, you will use this to predict the reaction mechanism. I might feel a little daunting right now, but don't worry.

00:00:40:56 - 00:01:11:87
Instructor: You're going to keep getting practice as you move through problems. Let's start with our reagent here. What has changed as we go through the first step of our reaction mechanism? We can see that our bromine has come off of that carbon forming bromide and forming a positively charged carbon. We're going to call that a carbo cation, and we'll hear that language more in the next unit.

00:01:11:87 - 00:02:08:33
Instructor: To do that, we recognize the bromine originally had three lone pairs. Whereas bromide has four lone pairs, meaning that this bond, the shared pair of electrons between the carbon and the bromine, has moved onto the bromine atom breaking that bond forming our bromide. We have a reaction intermediate here, and we can draw square brackets and our charge on the outside to show that it's an intermediate it's a highly reactive species. We suspect that that formal charge is located on that carbon or close to it if we're looking at a more accurate model. But we're going to continue with that to see what happens in the next step of this reaction mechanism.

00:02:08:33 - 00:02:31:99
Instructor: We have our reaction intermediate and we're told that it's going to react with the water molecule. Let's see what it forms. There's actually two pathways that it can flow. We're going to start with that top path. Here we see what's changed is that water molecule has bonded to our positively charged carbon.

00:02:31:99 - 00:03:09:01
Instructor: Now, that carbon doesn't have a lone pair to form that bond, but the oxygen in the water molecule does. Let's draw that. It will attack our carbon our carbocation, forming a new chemical bond between the carbon and the oxygen. Then in the next step, the bromine is going to do something to form an eventual product. But let's pause and think about the stereochemistry that's happened here.

00:03:09:01 - 00:03:44:87
Instructor: This bond is coming forward out of the plane. Originally, this had only three bonds to it. If there's only three bonds, we know that carbon is going to be trigonal planar. When the water attacks, it can attack from above or below the plane. If it attacks from above, the bond will show as coming out of the plane, and it will push that phenyl group that was originally in the plane, it'll push it out of the way, and that's why the phenyl is now pointing down.

00:03:44:88 - 00:04:26:95
Instructor: The other reaction pathway looks very similar, except here, the water is pointing down. Because now when you had the plane of our positively charged carbon, the trigonal planar arrangement, the water molecule has attacked from below pushing the phenyl group up out of the way. We had two possible intermediates that form as a result of the attack of the water molecule. Now, let's try and analyze how this goes to our final product. We see that we have a negatively charged bromine.

00:04:26:95 - 00:05:00:77
Instructor: We have our positively charged oxygen. When you have a molecule that has a positively charged oxygen in it, we call that an oxonium ion. We need to stabilize that to get to our product, and we do that by removing one of the protons from that oxygen. Initially, this oxygen would have one, two, three bonds, and a lone pair. In this product, we have two lone pairs on the oxygen.

00:05:00:77 - 00:05:51:37
Instructor: We can tell that the oxygen has received the electron pair when it lost the proton. Bromide will attack that proton, and this bond will break, move onto the oxygen forming our product, and we have a byproduct, hydrogen bromide. To do the same representation here in the bottom and we can put our square brackets here to say this is a reaction intermediate. Here we have it again. In this case, the bromine, we can draw our curved arrow, is taking a bit of a detour, maybe it's going to attack that proton, causing this bond to go onto the oxygen, generating our product.

00:05:51:37 - 00:06:17:27
Instructor: There we have it. We can now analyze how a reagent transforms into two different products by drawing the electron pushing arrows. As you get more practice with this, soon, like I mentioned, you're going to start predicting what those products are using patterns in chemical reactivity.