Predicting an Aldol Condensation Product

Transcript

00:00:00:00 - 00:00:12:00
Dr.Jessie Key: Hello again, Dr. Jessie Key here to talk to you about determining an aldol condensation product by solving a couple examples. Example 1: Predict the major condensation product expected.

00:00:12:36 - 00:00:31:98
Dr.Jessie Key: In this example, we're given an aldehyde starting material and aqueous sodium hydroxide in heat. We're specifically told to predict the major condensation product, but remember, in a quiz or test scenario, you may not be given as direct a hint as to the type of reaction. Feel free to pause and try the problem on your own.

00:00:31:98 - 00:00:51:87
Dr.Jessie Key: You can continue and fall along with my solutions when you're ready. There are two main ways you could go about solving this problem. You could draw the mechanism to get the major product, or you could use what you know about aldol condensations to get to the product.

00:00:51:87 - 00:01:20:14
Dr.Jessie Key: Let's explore both methods: 1. Drawing the mechanism is far more time consuming, but may avoid mishaps connecting pieces together. In the first step of the mechanism, the hydroxide base removes one of the alpha protons, so we start our arrow at the lone pair of the hydroxide oxygen and have it go to one of the alpha protons.

00:01:20:14 - 00:01:37:96
Dr.Jessie Key: This breaks the alpha C-H bond and those electrons go to form a new pi bond between alpha and carbonyl carbon. The carbonyl pi bond goes up onto the carbonyl oxygen as a lone pair. The resulting enolate can then perform a nucleophilic attack on another molecule of the starting material.

00:01:37:96 - 00:01:54:54
Dr.Jessie Key: We can start at the enolate lone pair reforming the pi bond. Which causes the enolate pi bond to act as a nucleophile and attack at the carbonyl carbon of the other molecule. The carbonyl pi bond of the other molecule moves up onto the oxygen.

00:02:01:21 - 00:02:34:77
Dr.Jessie Key: An alkoxide intermediate is formed, which will undergo a subsequent proton transfer with the water present to generate the beta-hydroxy aldehyde aldol addition product. Next, an elimination by E1 cb can be accomplished by first removing the alpha proton with the hydroxide shown by starting the arrow at the hydroxide oxygen and going to the alpha proton. The alpha C-H bond breaks and the electrons are moved to form a new pi bond between alpha and carbonyl carbon.

00:02:34:77 - 00:03:09:97
Dr.Jessie Key: The existing carbonyl pi bond moves up to the carbonyl oxygen. A final loss of leaving group step is performed by bringing the enolate lone pair back down to reform the carbonyl pi bond, which caused the alkene pi electrons to move over to form a new alkene pi bond between the alpha and beta position. This causes the Beta hydroxyl group to be ejected as a hydroxide leaving group, giving us the final alpha,beta-unsaturated aldehyde product.

00:03:16:53 - 00:03:48:97
Dr.Jessie Key: In the second method, start by identifying the alpha position in the starting material, which has two protons. Then draw two molecules of the starting material such that the alpha protons of one molecule face the carbonyl of the other. Next, predict the final product by removing water, the two alpha protons and the carbonyl oxygen, and joining the alpha and carbonyl carbon by a double bond.

00:03:58:20 - 00:04:11:12
Dr.Jessie Key: Example 2: Determine the starting material or materials which produce the following condensation product. Again, feel free to pause and work on your own. Join me afterwards for the solution.

00:04:16:80 - 00:04:36:14
Dr.Jessie Key: Okay, so you can approach this problem using Method two from the previous example just in reverse! First, identify the alpha position for each piece of the molecule. There's one alpha position adjacent to the aldehyde, and the other will be adjacent to the alkene.

00:04:36:14 - 00:04:57:20
Dr.Jessie Key: Then cut at the alkene bond and replace with a carbonyl on the end without one and two protons on the fragment which features the aldehyde. This shows that the starting material is the four carbon aldehyde butanal, which has undergone an aldol condensation with itself.