TRU
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Formation of Ethers

Transcript

Instructor: Anujin

00:00:00:00 - 00:00:23:94
Instructor: So starting with the formation of an ether, we usually see three most common ways to form an ether, and our first way is the simplest and most straightforward method, we have a normal SN2 reaction. So SN2 reaction or more specifically, Williamson ether synthesis requires an alcohol and a primary haloalkane.

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Instructor: So the main concept behind normal SN2 while forming an ether is that we want to react alkoxide ion and a primary haloalkane together to form an ether. So now we don't have any alkoxide ion, but once we deprotonate this weak acid by using a strong base like sodium hydride, for example, we can get our alkoxide ion easily.

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Instructor: So I will use sodium hydride. Our negatively charged hydride ion will be attracted to our partially positive hydrogen atom over here.

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Instructor: So this will remove our hydrogen and give us our alkoxide ion. Once we have our alkoxide ion, this basically acts as our nucleophile.

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Instructor: So the step should be very familiar because this is a normal SN2 step. Our nucleophile comes and attacks carbon kicks off leaving group, so this forms our Butyl Propyl Ether.

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Instructor: And if we were to draw out our final product, it should look like this. So make sure to see that we have an asymmetrical ether over there.

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Instructor: And depending on what we have as our starting material, this can also be symmetrical. So make sure to count the carbons to see you have all the necessary carbons with you in your end product.

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Instructor: On tests, we usually go over in a fast pace, so small details like this could be missed out on. People usually add extra carbon or leave out carbons behind while they're doing it.

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Instructor: So make sure to notice that you have all your carbons in our end product, so that should be good enough. Moving forward, we have another Williamson ether synthesis, but this time, we're going to be using intramolecular SN2 reaction.

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Instructor: Intramolecular SN2 reaction is identical to our normal SN2 reaction in terms of mechanisms. And we also require alcohol and our primary haloalkane.

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Instructor: But this time we will see both of those on the same molecule. So now, since they're both on the same thing, we know we're going to form a stable five or six membered ring, which is a cyclic ether.

00:02:38:80 - 00:03:00:28
Instructor: Now the mechanism will be identical, so we also want to deprotonate our weak acid using a strong base sodium hydride, for example. So while doing that, we get our alkoxide ion, and if we were to draw that out, we get this.

00:03:00:28 - 00:03:18:32
Instructor: So the alkoxide ion now acts as a nucleophile and it attacks our carbon that is attached to bromine, kicks off our leaving group, and we're essentially forming a new carbon oxygen bond over here. And to draw the final product, we have to draw it in a cyclic form.

00:03:19:76 - 00:03:30:66
Instructor: So the new bond we just made is over here. So that is how we can do intramolecular SN2 reaction in order to form cyclic ether.

00:03:30:66 - 00:03:48:76
Instructor: These two methods have similarities and differences, so make sure to notice those small patterns while solving these reaction problems. For example, if we were asked to go forward on test from our starting material, make sure to distinguish between whether they're on the same molecule or on different things.

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Instructor: So depending on that, we can easily identify which reaction we're going to use in order to form our final product. Now, let's say in a case where we have a tertiary bulky haloalkane, for example, over here, in this case, we can't go over any SN2 reaction due to steric hindrance, but we know what is highly compatible with our tertiary haloalkane, and that is SN1, solvolysis reaction.

00:04:18:79 - 00:04:39:97
Instructor: On solvolysis reaction, we usually use ethanol and methanol in order to form our ether, and our SN1 will be different in terms of mechanism compared to our first two method. So first step we should take from here is that our leaving group will leave, and that will form our tertiary carbocation.

00:04:40:96 - 00:04:52:22
Instructor: Once we have our tertiary, carbocation, our solvent methanol comes and reacts with this carbocation. This forms an intermittent product.

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Instructor: That should look like this. Don't forget the positive charge over here.

00:04:58:14 - 00:05:19:64
Instructor: And whenever there is a positive charge on the oxygen, any hydrogen that is attached to that oxygen is highly acidic, and we deprotonate that once more by using our methanol. Methanol comes and grabs the hydrogen, and this will form our final product.

00:05:20:09 - 00:05:32:75
Instructor: So that is another way we can form ether based on tertiary haloalkane so these three are the most common ones. You will see throughout OCHEM 2.

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Instructor: They will be on tests, but on tests, you might not be required to draw out the mechanism. However, that does not mean you don't have to know the mechanism.

00:05:40:77 - 00:05:52:47
Instructor: So while doing practice problems for these reactions, try to draw out as many mechanism as you can. So in that way, you can notice the small patterns and see what makes them different and similar to each other.

00:05:52:47 - 00:06:25:01
Instructor: Now, since we saw how we can form ethers, now let's go over and look at how ether is useful in terms of alcohol. So for protecting alcohol, the reason why we protect alcohol in the first place is because our OH group is highly reactive and it reacts violently with specific reactions like our Grignard, and it also interferes with our oxidation and reduction step.

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Instructor: And it also gets protonated during acidic condition. So in order to go through these reactions, but once we have alcohol present with us in our starting material, we can't go effectively because it will interfere in the later steps and turn the reaction to a completely different direction.

00:06:46:21 - 00:07:10:18
Instructor: So we want to protect this alcohol in the first step by turning it into a dibutyl ether, and in order to do that, we use dibutyl alcohol and acid. Once we mask this OH group under the presence of an ether, we can go through all these reactions without worrying about the OH group we had in the first place.

00:07:10:18 - 00:07:24:92
Instructor: So once we're done with all these reactions and we want our original OH group back, we can easily do that by turning dibutyl ether into OH using water. And acid. So this is

00:07:24:92 - 00:07:30:22
Instructor: the only way we're going to protect alcohol in OCHEM 2. There is no mechanism that they show us.

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Instructor: So make sure to know what you use in order to protect and what you get from that. So from my experience, we don't usually get asked to directly protect alcohol or deprotect them, but they are seen in synthesis problems where we have to identify the OH group ourselves and decide whether to protect that OH group or not.

00:07:50:34 - 00:08:09:66
Instructor: So that's why let's go over a synthesis problem that highlights our protection. In our starting material, we have one bromo, two propanol, with propyl magnesium bromide, and we want to form two hexanol.

00:08:10:63 - 00:08:27:49
Instructor: The first thing to notice in synthesis problem is to identify which new carbon carbon bond you're going to be making. And on this example, we're going to make a new bond between our third and fourth carbon by using a grignard addition since we already have a propyl magnesium bromide with us.

00:08:27:49 - 00:08:42:63
Instructor: In any scenario where you're stuck with going forward from our starting material, then try going backwards because that helps a lot. And to go backwards in this problem, we said we're going to do grignard addition in our probably last step.

00:08:42:63 - 00:08:58:25
Instructor: So before doing grignard addition, we know we need a carbonyl group, and in order to get carbonyl group, we got to do oxidation step. So by finding those small things that's going backwards, we can easily go forward from our starting material now.

00:08:58:25 - 00:09:14:67
Instructor: Before beginning those reactions, since we said we're going to do grignard oxidation, we have to protect this OH group. So now we have our protected OH group under the presence of an ether.

00:09:14:67 - 00:09:24:53
Instructor: So let's shift focus to our bromine over here. We said we're going to do oxidation step, and in order to oxidize something, we need an OH group.

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Instructor: But OH group should be where bromine is at right now, and our bromine is a primary haloalkane, so we can do SN2 reaction to get rid of it. Use sodium hydroxide in water.

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Instructor: We can also use DMF and DMS, since they're all compatible with SNT reaction, and this step gives us our OH. Now we have our OH group where bromine is at, so we can go through our oxidation step.

00:09:55:21 - 00:10:10:07
Instructor: And on synthesis problem, I highly advise you to use PCC and dichlomethane while you're oxidizing. Now, this gives us our carbonyl group, aldehyde.

00:10:10:43 - 00:10:29:62
Instructor: Now, once we have our aldehyde, we can add our grignard reagent propyl magnesium bromide, in ether. Don't miss out on the small solvents like that because they all have specific marks and we don't want to make silly mistakes like that on test.

00:10:29:62 - 00:10:38:96
Instructor: So this forms our new carbon carbon bond between our third and fourth carbon. So our new bond over here.

00:10:38:96 - 00:10:53:38
Instructor: Now, we're almost about to finish, however, we still have a dibutyl ether here, but we want OH group back in our final product. So in order to do that, we said we're going to use water and acid, and so that is our last step.

00:10:56:48 - 00:11:18:96
Instructor: So now we have our two hexanol, and that is exactly what we wanted. The reason why we protected alcohol on the synthesis problem was because if we didn't protect it in our first step, by the time we move on to second and third step, this reaction would go to different direction, and we probably had to start all over again or do multiple steps in order to get our final product.

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Instructor: So just to make life simpler, if you see an OH group in your starting material and you know you're not going to oxidize it, then just protect that in the first step so it doesn't interfere in the later steps or cause any confusion. On synthesis problem like this, we have to notice the small patterns.

00:11:37:04 - 00:11:47:80
Instructor: So by noticing we have OH group and we're going to do a grignard addition, we successfully completed the synthesis problem. So this was a fairly simple and straightforward problem.

00:11:47:80 - 00:11:59:58
Instructor: So I hope that was understandable. So to wrap up the video, we went over three most common ways to form an ether and saw what made them similar and different from each other.

00:11:59:58 - 00:12:13:02
Instructor: We also went over how we protect alcohol by going over a simple synthesis problem that highlighted the protection of an alcohol. So while studying for the test, try to practice all those mechanisms.

00:12:13:02 - 00:12:28:96
Instructor: And while doing those mechanisms, try to time yourself since we're going to be under time pressure on tests. Try to figure out how we go forward and also backwards because in any scenario, those two really help us solve effectively on the test.

00:12:28:96 - 00:12:33:10
Instructor: Thank you for watching the video, and I hope it was understandable.