IR Spec

Transcript

Instructor: Levi

00:00:00:00 - 00:00:12:12

Instructor: Hello, everyone. In this video, we'll be talking about infrared spectroscopy. So, in organic chemistry, it's important to have methods and techniques in which you can identify if a compound you've produced is the one you've actually wanted.

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Instructor: In lecture, you'll be practicing many different forms of reactions, and in the lab, you'll actually be producing compounds, and you'll use infrared spectroscopy as a method in which to confirm if the compound you produced is the one that you do want. So, in this video, we'll look specifically at infrared spectroscopy, a technique used for compound identification and cover some basic tips and tricks on how to solve infrared spectroscopy related problems. Let's bring up an example IR spectrum, so you can see where common functional groups absorb, which will be on the right hand side here.

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Instructor: In this case, this IR spectrum is showing the absorbance range for ethanol specifically. The key here is being able to identify specific functional groups that will be absorbed in your specific spectrum. And once you know what functional groups are present in your IR spectrum, then you can then match it to a given compound.

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Instructor: We already know this one is ethanol, but we're going to take a look at what specific functional groups you should look out for in the next section here. Here's an example of an IR spectroscopy table which shows you the ranges in which function groups typically absorb. Now you can see that there are a lot of different ranges here.

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Instructor: For the purposes of this video and your studies in organic chemistry too, we're only going to focus on three primary ones that I found the most helpful when solving problems, IR spectroscopy type problems. So, the three main ranges that I find the most

helpful are going to be from an absorbance range of 3200 and 3600 inverse centimeters, from 1700 to 1725 inverse centimeters, and from 2850 to about 3000 inverse centimeters. So, using our original IR spectrum that we have on the right side here for ethanol, the first main absorbance range you want to look for in your IR spectrum is going to be 3200-3600, which essentially identifies the presence of an OH or hydroxyl group.

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Instructor: And so, in this range, you can see between about 3200 and 3600, you'll see that characteristic broad peak, and this is the one thing you're going to want to pick out here. The OH or hydroxyl group here, the peak will specifically look like a mountain range in effect. So, you're going to be looking for something along kind of that shape right there.

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Instructor: If it's any narrower, it generally won't indicate the presence of a hydroxyl group. So again, the key point for 3200 or 3600, indicating a hydroxyl, and I'll just clarify that here as well. An OH group is that it will be broad and strong.

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Instructor: So, think like a mountain range, like you can see in the ethanol spectrum here, it's strong and broad in its structure. The second peak you want to look for is going to be 1700-1725 inverse centimeters. And this indicates the presence of generally a carbonyl group.

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Instructor: And the key characteristic for this particular peak is that it will generally be quite sharp. It's kind of like a spike on the radar. So, it's going to look something kind of closer to this in comparison.

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Instructor: I'll write it just in front here. Quite a bit sharper. And it isn't pictured on ethanol here, but we will look at a different spectrum in a moment that will have that peak as well.

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Instructor: And so, this is characteristic of carbonyl or a carbon double bonded to an oxygen. Okay, so we're going to swap out this IR spectrum for ethanol to a different IR spectrum that can show our two other primary peaks here, which in this case is showing 2-butanone. So you can see that the OH, the hydroxyl peak, has disappeared, but we instead have two other characteristic peaks like we just spoke about.

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Instructor: The first one, if you look in the range of about 1700 to about 1725 inverse centimeters, you will see that sharp spike, and that is what indicates the presence of that carbonyl group. And now the other characteristic and third characteristic peak you want to look for is going to be from about 2850 to 3000 inverse centimeters. And there's no really characteristic shape for this one.

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Instructor: It does look kind of similar to carbonyl group, but this particular peak represents, and you can see it in the graph there, the presence of alkanes specifically. And alkanes are obviously present in all organics. So, it's less understanding that this peak specifically shows you have alkanes in your compound that's important, but it's more so understanding that that peak is an alkane and not mistaking it for something else.

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Instructor: And so, yes, there is no characteristic really structural look at here, but this one specifically does represent alkane, so carbon single bond to a hydrogen. Alright. So, using what we've just discussed, for those three primary peaks here, we're going to look at a couple of different practice problems.

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Instructor: So, for the first practice problem, we'll bring up a particular IR spectrum that shows us the absorbance ranges for one of the four compounds shown there, which I also have drawn out here. So, for this one, the first thing that I would take notice of is that there is no sharp peak around 1700 to 1725 inverse centimeters, which means we do not have a carbonyl group present. So immediately, knowing that we don't have that carbonyl group present, there's two options here that we can cross off and confirm that are not the right answer in this case.

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Instructor: So that would be acetic acid in this case because it does have a carbonyl group. That is not going to be the right answer as well as acetone here. Neither of these two will be the right answer because if they were, you would see that sharp spike around the 1700 to 1725 inverse centimeter range.

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Instructor: So, we're left with methanol and ethane for the two answers. And the question is, how do we figure out now between these two which one this IR spectrum is indicating? The answer is pretty simple.

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Instructor: Again, one of the other main peaks we should look out for is 3200-3600 representing or indicating the presence of a hydroxyl group. Now, which of these two options here contains a hydroxyl group? Ethanol or ethane, I should say, does not.

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Instructor: Obviously, it only consists of alkanes, whereas methanol does. So, from that information, we can safely confirm that methanol would be the right option here for this particular IR spectrum. For question 1.B, we are asked

00:06:37:86 - 00:07:11:26
Instructor: the same thing and using the same four compounds here, which is to analyze the spectrum and pick the compound that best fits it. Now, this one is quite interesting

because you can see there really is only one large characteristic peak here, and it is found within the range of about 2850 to 3000 inverse centimeters. We don't see that characteristic broad peak around 3200 to 3600, which means we do not have a hydroxyl group present, and we also don't see that sharp spike around 1700 to 1725 inverse centimeters, which means we also do not have a carbonyl group present.

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Instructor: So, from that, it's pretty simple to pick the right answer. Um these three options here will not be correct because methanol does have a hydroxyl group, which we don't have based on our IR spectrum. Acetic acid actually has both a carbonyl group and a hydroxyl group, neither of which are present, based on our R spectrum, and acetone also has a carbonyl group, which again is not present in this particular IR spectrum.

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Instructor: So, the only option we're left with, and this would make sense, considering it consists entirely of alkanes, which we'd expect to see in this range would be ethane. So, ethane is our correct answer for question 1.B.

00:07:49:77 - 00:08:03:05
Instructor: All right, so for question 1.C, we again are asked the same thing, which is to pick whichever compound best fits this IR spectrum shown here. Now, this one is a little bit trickier than the previous two, and I'll point out exactly why here.

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Instructor: So right off the bat, we can notice that there is still a sharp peak around 1700 to 1725 inverse centimeters, which will indicate and is indicating the presence of a carbonyl group. So immediately, we're able to X out ethane because it does not have a carbonyl group, as well as methanol, because it also does not have a carbonyl group, but does have a hydroxyl group. So, we're left with acetone and acetic acid.

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Instructor: And the question is, how do we figure out which is which? The reason with this one is a little bit trickier is because you do still see that characteristic broad peak around 3200 to 3600 centimeters. But you also do see that sharp peak as well around sharpish peak around 2850 to 3000 inverse centimeters.

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Instructor: So, it is a little bit tricky to see, like I said before, because it appears like that broad peak might not be exactly as easy to notice as in previous examples, but it is still there. It's just overlapping with our alkane region here. That's why you kind of see that broadish peak and then a little gap, and then slightly sharper peak right after that before it drops back down.

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Instructor: So, in this case, by looking at this, we need to identify that we do have a carbonyl group present from the characteristic sharp peak around 1700 inverse

centimeters, and we also have a broad…broadish peak though a little bit harder to identify 3200-3600 inverse centimeters. Now, the only option here that contains both a hydroxyl and a carbonyl group would be acetic acid. Acetone does not.

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Instructor: It only has a carbonyl group, so we can this off and we can choose acetic acid as our correct answer. Again, the key here is to notice that sometimes your functional groups and characteristic peaks will overlap and make it a little bit harder to pick out which is which. But you just need to quickly identify or specifically identify every functional hoop you have present in order to determine which compound is correct.

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Instructor: Alright, so for our final question, which is question one D here, once again, we're asked the same thing, which is to identify a compound that best fits this IR spectrum. Now, through process of elimination, we could easily just choose acetone as the correct answer since every other option has been chosen here. But if we didn't have that prior information, how would we determine this is, in fact, the correct answer?

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Instructor: And the key piece of information here is that we have two peaks that show the characteristic functional groups that are present in acetone, which is going to be the carbonyl group. The peak found around 1700 to 1725 inverse centimeters, as well as alkanes, which you'll see it kind of looks like a split peak on the spectrum there, that that does, in fact, represent alkanes specifically. Now, again, if we didn't have this previous information, one tricky thing would be seeing that small peak you see almost in the range of 3200 or 3600 inverse centimeters, which you might think would indicate the presence of a hydroxyl group.

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Instructor: But in this case, it does not. Obviously, we can see acetone does not have a hydroxy group present. The way that we can differentiate between this small peak being a hydroxyl group and not being one, is that it isn't broad.

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Instructor: Remember the mountain range analogy that I gave from the beginning, you want to look for that broad peak. And if you see that broad peak within that range, you then know it's a hydroxyl group. But because we don't see that broad kind of characteristic, in this case, we can confirm that does not represent a hydroxyl group.

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Instructor: Therefore, the only two functional groups you should worry about here are going to be for that carbonyl and for the alkanes here. So, we can confirm cross out everything else that is wrong here, can confirm that. Acetone is, in fact, the right answer for question 1.D. So, to summarize,

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Instructor: infrared spectroscopy is an important method in organic chemistry because it allows us to identify a specific compound based on its absorbance ranges and IR spectrum. Well, there are plenty of absorption ranges for many different functional groups, it's usually best, and I specifically found it easiest to find it best to focus on these three primary ones here. So, the first one is 3200 to 3600 inverse centimeters.

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Instructor: And what you need to remember here is that characteristic and strong broad peak. Again, to use the analogy, kind of like a mountain range, if you took a mountain range and flipped it on itself. This represents the presence of a hydroxyl group or an oxygen single bonded to hydrogen.

00:12:34:30 - 00:13:02:33
Instructor: The second one is 1700-1725 inverse centimeters, which is characteristic by a sharp spike. Remember, like a spike on the radar, again, you'll find that 1700-1725 inverse centimeters, and this represents the presence of a carbonyl group, carbon double bonded to an oxygen. And finally, well, it's not a specific function group that's going to be present in some organics and not others because it is present in all organics.

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Instructor: You have the range of 2850-3000 inverse centimeters, which tells you that you have alkanes present in your particular compound based on your IR spectrum. The important thing to remember with this range is that it's less important to know. Or to notice it and say, Okay, this is a unique particular peak in your IR spectrum, and more important to notice it, so you don't mix it up with something else like your 3,200 to 3,600 inverse centimeters range.