Structure, Stereochemistry and Reactivity of Organic Compounds and Intermediates: A Problem-solving Approach

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Lecture 16

Octant Rule: Application in Mono and Bicyclic Systems

Hello, welcome back. In the last lecture we showed the application of axial haloketone rule to be precise two axial haloketone rule, in determining the absolute configuration of a decalone system; and also the determination of the conformation of the A ring of a steroid system. And we showed that the A-ring occupied a twist boat conformation. Now, the actual haloketone rule is although it is good, but it is very narrow; because it is only applicable where you can do these actual halogenations to a cyclohexanone system; and then checked out the sign of the cotton effect. However, a better or more widely applicable rule which was which was also empirical was devised and proposed in the 50s, and that was called the octant rule, octant rule.

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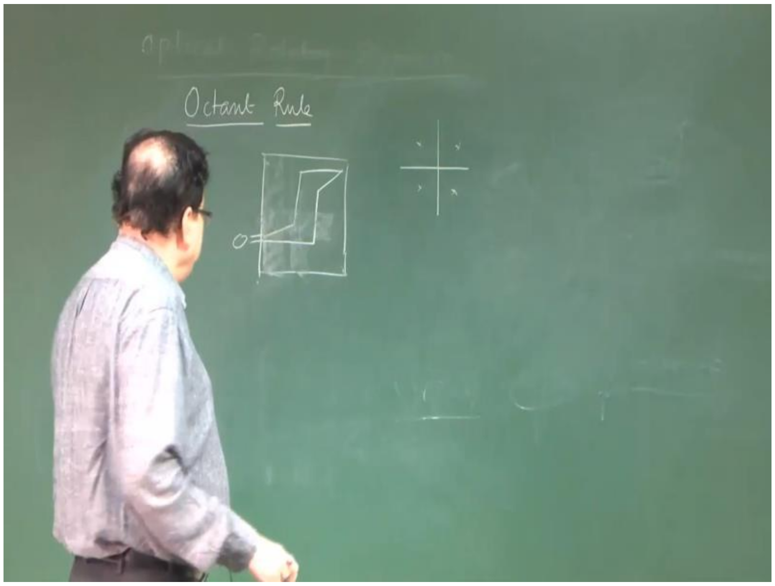

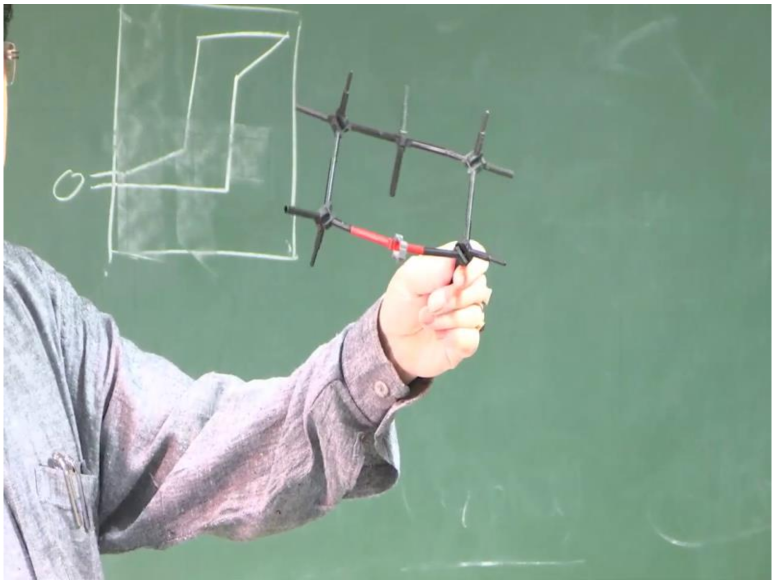

So basically, we had two rules; one was the actual haloketone rule and the other one was octant rule. The octant rule is it says that you have the cyclohexanone system; you place the cyclohexanone system in such a way see I am doing that; I am writing the cyclohexanone in this fashion. So, this is the cyclohexanone, again this is applicable for mainly cyclohexanone systems; and what you do? You take place the cyclohexanone in this fashion, and then think of several planes. Now, three dimensional mutually perpendicular are three planes: one is basically the plane that is presented in the in this green board; that is one, one of the plane.

The other plane is that, that is perpendicular to the through the green board, this is another one; and there is a third one. So, I can and there is a third one, so one is this; another is this one. And a third one which is perpendicular to the to this green board, which is perpendicular to this green board. Now, basically that means what you have is you have a plane if I show it in the model. So, this is your cyclohexanone system, I try to hold it in the fashion; I wrote it there. Sorry, no not this way, this way. So, what I am saying that if you have the cyclohexanone in this fashion; so you place 3 planes.

One is taking the carbonyl in which the carbonyl is occupying; the carbonyl carbon along with these two carbons, adjacent to it alpha to the carbonyl they are in the plane. So, that is one plane, the other plane is this one going perpendicular to this carbonyl; and a third plane which is along this carbonyl. So, one you can call x plane, the x xy plane, then another is zx plane or xz plane; and the third one was yz plane. So, what we are doing? You are placing three mutually orthogonal planes at the carbonyl carbon. So, if you do that that means you are now making, you are basically putting some substituents; or you are actually first of all when you put this second plane.

At this point you are basically having 2 types of space that you have created for this molecule. One is the space which is in front of this plane that I have I am holding that is one. That means going in this direction towards the observer; another is the space which is going behind the observer. So, this is the front plane, and this is the rear going behind. Now, when you put another plane like this then what will happen? Each of these planes which are front or the back; they will be now they will be dissected now. So, first of all if you have this plane, so you have a front space and you have a back space.

If you introduce this plane that means the front one is now divided into two, and the back ones are divided into two. So, one is upper front, another is lower front; another here it is upper upper the rear upper, another is rear below. Now, if you put a third plane like this, then each of these upper ones are divided into two spaces; each of the lower ones are divided into two spaces. Similar is the case for the back of the rear of the rear space. So, basically you are dividing the space into what is called 4 sorry 8 spaces, which are called octants. Like if you have a two-dimensional case, we know that two-dimensional case.

If you put two planes like this, then this will be quadrants; four spaces you are generating if it is two dimensional. But, when it becomes three dimensional, then you have a, you have a back space of a front space; that is number 1, and each back and front are again divided into 4 spaces. So, the total number of space becomes 8, so that is why this is applying this 3 mutually perpendicular planes; you divide the space into octants. Now, out of these octants, 4 will be called rear octants which are actually going backward on the back side, and 4 will be the front octants; so that is the case for front octants.

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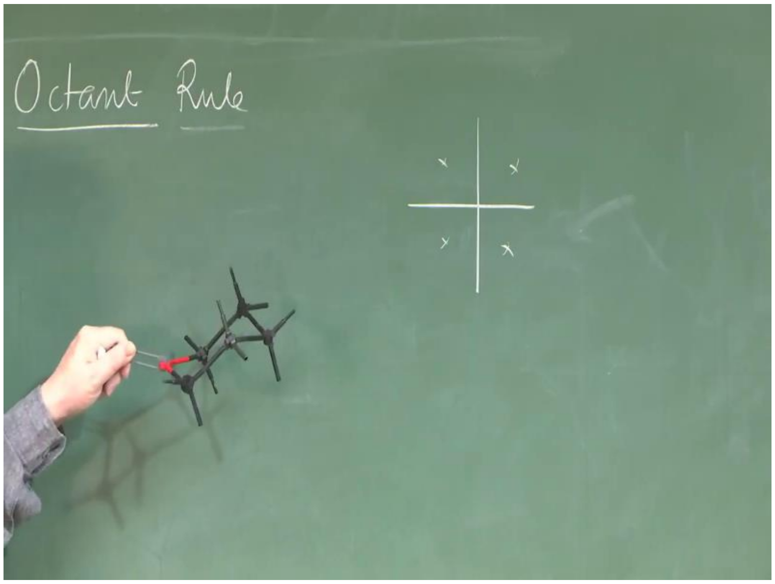

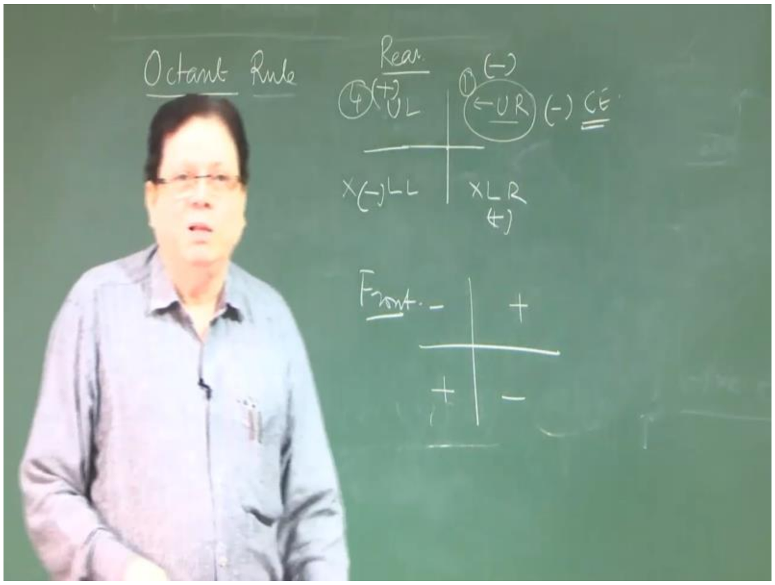

So, what will happen now? That when you have this carbonyl, and you hold the carbonyl sorry where was that molecule. You hold the carbonyl, if it you can see it; hold the carbonyl in this fashion, you hold the molecule in this fashion. So, this is the plane I am talking about and so the whole the most of the carbon atoms of the carbonyl are actually going backwards. That means they will be occupying the rear octants; on the other hand here, nothing is coming in the front octants. However, there are molecules if this molecule, you put more substituents and it takes a turn; and comes to the to the side of the rear octants.

Then you get groups which are occupying the rear octants. So, basically again coming back to this application of octant rule, first you divide the space around the carbonyl into octants; so, there are rear octants, there are front octants. For the rear octants, some substituents will occupy the rear octants; rear octants can be have to be have to be named. Like this is what is called U upper right upper right. We are considering the say the rear octants; that means the octant that means the space which is at the back side of the carbonyl. So, this is rear, so this is upper right; then you have a lower right upper right. Sorry, this is upper left, very sorry, this is upper left is still on the upside. But, on the left side, this is lower left, and this is upper this is lower right.

So, this is how the spaces are named; so, you have four rear octants: upper right, upper left, lower right and lower left. Now, the octant rule says that if the substituents are occupying the upper right of the rear octants, then those substituents contribute in a negative fashion to the sign of the cotton effect. So, substituents which are falling in the upper in the upper right; remember we are talking about only of the rear octants. So, that will contribute in a negative sense to the sign of the cotton effect. This will contribute substituents falling in the upper left will contribute in a positive fashion to the cotton effect.

And similarly, that will be negative, so it alternates negative-positive-negative-positive; so, this is for the rear octants. Again, I repeat what it says that substituents which are falling in the upper right; they try to generate a negative. They try to force it to have a negative (())(10:11) effect or their contribution towards the sign of the cotton effect is in the negative sense. Then substituents here will upper left will contribute in a positive fashion; this is negative, this is positive, this is for rear octants. For front octants, it is just the reverse; that means here it will be positive, here it will be negative. This will be positive that will be negative, just the opposite of the rear octant.

Fortunately, for most of the molecules the substituents fall in the rear octant; will definitely go through some systems where substituents can come up in the front octants. However, a majority of the molecules will be categorized by having substituents falling in the rear octants; so, that is the rule. Now, question is what will be the resultant sign of the cotton effect? What will be the resultant sign? Because we know substituents contribute in a differential way, depending on which space it is occupying.

The ultimate cot sign of cotton effect will depend, that the where is the, which space is occupied by the greater number of substituents. Suppose there is only one substituent that is falling here; there are four substituents which are falling here; there is no here, there is no here. So, if that be the case, you can say that it will show positive cotton effect; because major numbers of substituents are falling in the upper left of the rear octant. So, that way you can ultimately predict what will be the overall sign of the cotton effect; so, that is the that is the octant rule. Now, let us try to see what is the application of this rule.

But, before application of this rule you have to see the try to draw the projection, projection formula; because when you take a cyclohexanone molecule. And what you do is you have to see which carbon you have to draw; take the plane here, and then draw the projection of each carbons each substituent on this plane. And then ultimately decide that what type of whether it is occupying upper left, upper right, lower left or lower right; so, drawing the projection is very important. Now, if you have only cyclohexanone, things are easy; but if you have more cycles like decalone system or a per hydrophenanthrene system.

Those type of systems or a steroid system and so drawing this projection is little tricky, is little tricky. But the most important if you want to be very good in drawing the projection formula as per the projection on the octant of a cyclohexanone system; then the best way is to very start from the very beginning. Analyze the cyclohexanone system very carefully; if you can do that then it will not be a problem to draw the projection of even complicated molecules. So, we will analyze this cyclohexanone system very carefully.

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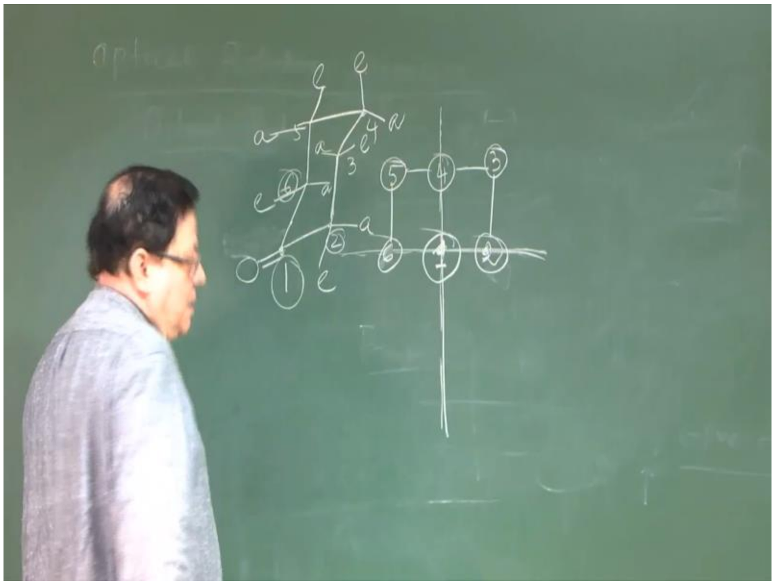

So, when so again I repeat this is the way you draw the cyclohexanone system; and actually may be little bit on the bias side, this should be the carbonyl. Now, if you look again I go back to the model. As I said that the when you draw the projection on the rear octants; so what will happen? You will have this one plane going through here, and the other plane mutually perpendicular. So, you have basically two axes, if you take the projection of the two planes, you will get two lines; one line is here, another line is there. Now, this central point is occupied by the carbonyl carbon.

So, if it is suppose 1, this is 2, this is 3, this is 4, this is 5, this is 6; so the central carbon the central point is occupied by the number 1 carbon. Number 1 means here it is carbonyl; not always it is number 1, it could be number 2. But the carbonyl carbon will occupying at the central point; and you have these two, now axis created. Now, this number one carbon the carbonyl carbon, number 2 carbon, and number 6 carbon; because of the geometry hybridization of the carbonyl, they will also be in the same line. They will occupy the same plane, as the carbonyl carbon.

So, what will happen that your projection of two will be somewhere here; and projection of three will be somewhere there. Sorry, this is not 3 this is 6; so 6 will be here and 2 will be there. Again, I show you in the model; so, this is the situation, this is the situation. So, what I am saying is that if you take this carbonyl carbon and this is the carbon adjacent to it; and this is the other carbon adjacent to it. So, they are occupying the same plane. So, that means they actually basically form a line, if you look at this carefully; they are nothing but forming a straight line. The projection will be a straight line; so that exactly what we have done.

The projection is nothing but a straight line. Now, the question is you have to do this, so this is now going up as you can see from the diagram; number 3 is going up. So, the projection of this number 3 will be where? Will be somewhere there, and the projection of number 5 will be somewhere here. They are both going up and then because 1 and 4 there is this plane that the plane that I told, which is perpendicular, which is bisecting this carbonyl that is also going through the c 4. Again, I show you through the model, so of my one plane was this is one plane; another plane was going through this and the third plane was going like this.

So, the second plane like this which is actually going through 1 as well as that will go through this c4 in this case in the cyclohexanone. So, one plane which is going through this, another plane is going through this; and the other there is another plane, which is like this, so these are the 3 planes. So, we are talking about this one, because this is the plane which is bisecting it into rear and front octant, front and rear. And these 2 are the planes where I have drawn the 2 axis; so, this vertical axis will contain the c4 carbon. So, the c4 is nothing but at this point, so now you combine.

So, this is the projection of this, this is the projection of this. So, now you the next task is to show where are these axial and equatorial bonds? This is very important because this, if there are more substituents or if there are more rings; then you have to know where these axial equatorial bonds, where is the projection of this axial and equatorial bonds that is important. So, this axial equatorial, you have to now figure out where they are? What is the where is their projection point? So, this is equatorial and that is axial; so that is the next task.

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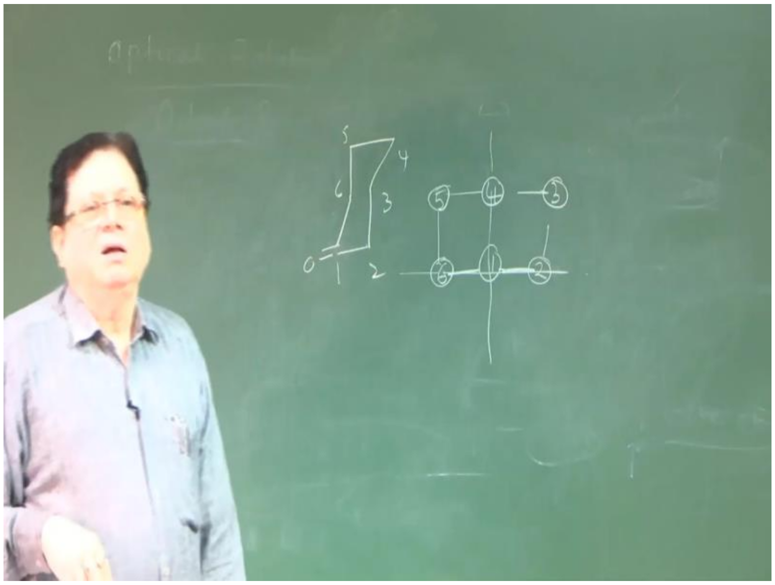

Now, let us do the try to show you the projection as it is formed if I shine light across the carbonyl carbon. If you do that you will see that the projection diagram that I have drawn here that for the cyclohexanone system. This was the kind of diagram that we get, this is 1, 2, 3, 4, 5, 6; so what will happen? 1 will be. So, these are 2 axis, one on the right side is two on the left side is 6; and then they go up. This is your 3; 4 is in the same fourth carbon is in the same line as the carbonyl carbon. So, then that is 4 and on the left side is 5, and then on the then it drops down and comes to 6.

Or, if you can see that you go from you go 1, this is 6 and then goes to the 5 and then 4; so, that is what is the diagram. Now, my question is where the axial equatorial will also go? So, I want to show a projection against a light, which will clarify any any doubt that you have. And that will actually vividly represent the projection as is visualized against a light falling right at the against the carbonyl carbon.

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Let us see how the projection looks like. Now, this is the way the cyclohexanone has been held, and I am putting a light to illuminate it and try to have a projection at the back. You can see the projection and you see the carbonyl carbon and the two carbons carbonyl carbon; and the two carbons on the right side and on the left side they are forming a line. And then the carbon which is attached to the carbonyl carbon is 1, then on the right side it is 2; then on the then 3 goes up. And that you see the projection goes up, then 4 comes again horizontally; and the c4 is right on the top of the carbonyl carbon.

That means it is they are occupying the same axis and then on the left side is the c5 and then c5 coming down to c6; so that is what it is. Now, the next question is so you are convinced that this is the type of projection that you see, or the carbons that are making the cyclohexanone system. Now, the question is axial equatorial; the projection clearly tells that if we look at the white bonds; the white bonds on the on c3, and c3 is axial. You see the axial is going up and the equatorial is going on the, if we consider the carbon atoms on the right side; then the equatorials are going to the right side horizontally.

And the axial is going up and down; the axial is going up and down. At the c4 you see the equatorial is going up and the axial is going down; the equatorial is going up and the axial is going down. So, that is I think that gives beautifully the projection that what we are talking about. So, now let us draw some molecules or draw it in the blackboard.

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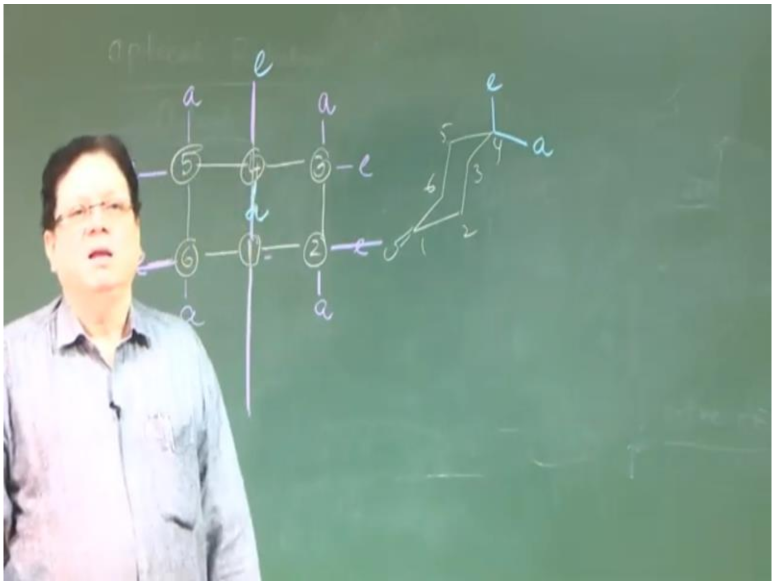

Now, as we have seen from that projection which has visualized against a light. That in cyclohexanone system this is the situation that 1 then 2; this is the projection that we are trying to draw 6-5-4-3. This is the cyclohexanone system again, I draw it here. So, this is the carbonyl 1, 2, 3, 4, 5, 6. Now, we have to put the axial equatorial; the projection of the axial equatorial points. So, now this is your axis, maybe another; this is your axis the two axis. So, this is actually in the plane 2-1-6 are lying in one plane; and 1 and 4 are also lying in the other orthogonal plane, so if other orthogonal plane.

And what we are seeing that the 5 is actually occupying the upper left and 3 is occupying the upper right. Now, let us have to we have to put the axial equatorial bonds; I showed in that in that projection that was generated against light. What happens that here the axial goes up and the equatorial goes to the right side. At the carbon 2, the axial goes down and the equatorial is almost in the line of that almost in that axial line. And so, you complete that on 6 that will be equatorial, this will be axial; at 5 this will be equatorial that will be axial. And at 4 now at 4 carbon, I told you that will be also apparent that this is that the one that goes up is this one; that is the equatorial and that is the axial.

So, at the fourth carbon this is equatorial and that is actual axial goes down. So, this is the complete picture of a cyclohexanone along with the actual equatorial bonds; what will be the projection look like. So, you have to remember this, you have to understand this one. And once you understand this one, so if you have any connection that is any other ring formation somewhere. Suppose I have a ring somewhere here, any cyclohexanone system or any substituent, then you will be able to put it at the proper perspective. And I think as we go through the problems that will be that will make the things more clear. So, our first problem remember this wordy this optical related dispersion is applicable to know the was applied to know the conformation of a molecule chiral molecule. If you have already known the configuration or if you do not know the configuration, then that is also possible. You can determine the configuration by applying the applying by measuring the sign of cotton effect; and then checking with these empirical rules.

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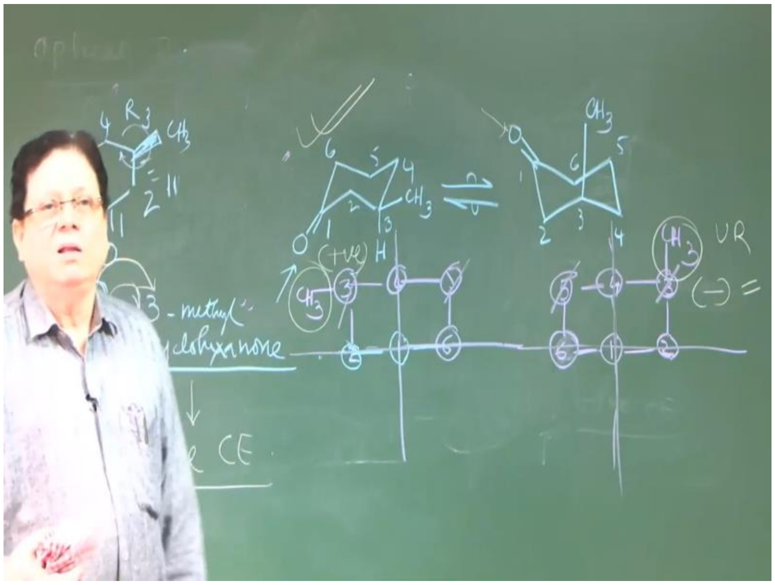

So, let us take one problem now that is the conformation of a molecule, which is this molecule 3R. See this is what 1, this is 2, this is 3; so that is R configuration. So, what is known is that R, this is R plus 3-methyl cyclohexanone; its absolute configuration is known. The absolute configuration of the plus 3-methyl cyclohexanone is R; so that is known.

The question is now what is the conformation of this molecule? So, we are now trying to talk about the conformation of a molecule, where the configuration is already known. Absolute configuration is already known like in the steroid case, that bromosteroid we have seen; configuration was known. But the conformation was determined by axial haloketone rule.

So, similar configuration is known, we have to know the conformation. Now, you can always say that if you draw the cyclohexanone system in the chair form, the methyl is likely to occupy the equatorial orientation; because that is the bulkier one compared to the hydrogen. But what is the experimental proof for that, so let us see that whether sign of cotton effect can prove that. First of all what sort of cotton effect it shows? What is the sign of cotton effect? Experimental, it shows a positive cotton effect; it shows a positive cotton effect.

So, now let us try to draw the various conformations that are possible for this molecule. So, suppose this is your carbonyl, this is number 1, 2, this is 3, 4, 5, 6; so, this is 1 and then 3 is methyl. So, if you want to make it beta, so that will be equatorial; so, this is one conformation. The other conformation is definitely the the flipped form and that will be the carbonyl is now here. This is the number 1 carbon, this is 2, 3, 4, 5, 6, so you put that 1, 2, 3, 4, 5, 6; so, your methyl will be like this at the 3 position axial. The question is which one is correct; which one is predominant one.

If both the both of them give the same sign of cotton effect, then it is not possible to determine; they preferred conformation. But fortunately if you apply octant rule, you will see that one will give one type of cotton effect; the other will give the other one, other one means the sign will be reversed. Let us try to draw the projection, the projection of this cyclohexanone system on the rear octant. This projection will be take place at the rear octant; so let us see. Now, you have to look through this, you are looking because you have to place the carbonyl in that plane. So, if you do that, the very similar as I told you that always the carbonyl carbon in the in this cross point between the two axis.

That is number 1 and then on the right side and the left side will be the alpha carbons attached to the alpha to the carbonyl; the carbons alpha to the carbonyl. Now, which one goes to the right? Which one goes to the left that is the question? Here also you have to be careful, the carbonyl carbon should occupy the head of a chair; when you visualize against the carbonyl against the carbonyl carbon. Or against the carbonyl as you look into the carbon oxygen bond or oxygen you are looking in the direction of oxygen to the carbon. Then you have to make sure that the carbon is occupying the head of a chair, and not the leg of the chair.

In this case this is occupying the leg of a chair; but as I that means you have to now either turn it upside down to make it the head of a chair. But actually one does not need to do that what just you apply your intelligence, and then you know that if it is occupying the leg of a chair. What comes to the right is actually will be the left, if it had occupied the head of a chair. So, what will happen? 1 is there on the right side is 2, but it will be 2 on the left side. And what will be on the right side then? Right side will be 6; and then you complete it. This is 5, this is your 4, this is your 3 and now you have an equatorial methyl.

Equatorial methyl means equatorial goes to the right and left side; so, this is your octant projection, so that is the case. You do not draw the hydrogen, when there are hydrogen's you do not need to draw the projection of those; so, only the substituents other substituents. If you do this, the same thing here the carbonyl is occupying the head of a chair if you look carefully. Then what will happen? Whatever you see from this side, you have the projection formula will be d two of that. So, 1 will be on this side, so as you are seeing from this side; so, 2 will be on the left. Sorry, 2 will be on the right I am very sorry; 2 will be on the right. This is the way you are seeing it; let us again do it.

So, it is shown like this, it is basically shown like this; so, I am looking from this direction. So, this carbon comes to the right and the other carbon here comes to the left; so, you complete that. So, 2 will be here and this will be your 6; then you complete 2 is joined to 3; 3 joined to 4; 4 is joined to 5, and 5 is joined to 6. And where are the 2 axis? These are 2 two axis; where is the substituent? The substituent is at the 3 position, and that is the axial substituent. So, the axial substituent will be pointing up, so this is the projection formula the projection. So that so that means here see 3 will cross out 5; the contribution of 5 and 5 will cross out the contribution of 3.

Now, some points which I did not mention at that time while describing the octant rule; because there are several important points. First of all, the octant rule says that the atoms which are in the on the axis; which are on the axis or if you think of the plane, which are near these planes. They have minimal contribution to the sign of the cotton effect; that means number 6 1 and 2 as well as 4 they do not have much contribution to the sign of the cotton effect. And the greater number of substituent's present in a particular octant that will dictate the sign of the cotton effect. So, what is happening? The contribution of 5 cancels 3; but methyl remains.

So, that means it will show, it will show what? Positive cotton effect; because upper left is rear octant shows positive cotton effect. And here it will show negative cotton effect, because the methyl is occupying the upper right. So, now it is clear that which (con) this is showing positive cotton effect. So, if it is showing positive cotton effect that means this is the preferred conformation of the of this molecule; namely, R plus 3-methyl cyclohexanone. Plus is difficult to predict, but what we know is R 3-methyl cyclohexanone exist preferentially in the conformation; where the methyl is equatorial, which is means logically that you have concluded already.

Because, you have told that bulky substituent's occupied equatorial; but it is been proven by applying the octant rule and checking the sign of the cotton effect. Now, let us proceed further, let us do another where the conformation is also determined, which is even little bit more trickier in terms of the projection, into the rear octants. As I said most of the molecules will have their projection, or will have their the substituent's present in the rear octant, and not the front octants.

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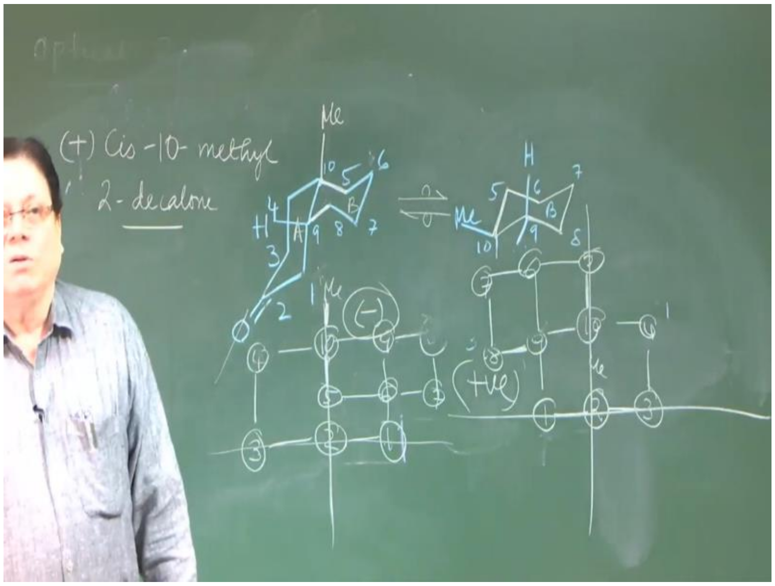

This next problem is there is a compound which is plus Cis, what is that Cis? 10-methyl; 10-methyl 2-decalone, 10-methyl 2-decalone. And we and you are asked to determine the preferred conformation of this system. Remember Cis decalone system is flappable; any Cis decalone system is flappable, trans is the rigid one. So, there is no question of two conformations, if you flip the one type of Cis decalone; then you get the other one. And so there are two possible conformations; so, let us try to draw that. So, one is, see this is Cis decalone, now the question is where do you put the carbonyl? Where do you put the methyl all these things.

If I put the carbonyl here that helps me in drawing the projection very easily; because it is the right way the carbonyl is positioned at the right right point. That means it is occupying the head of a chair and the way the octant, the carbonyl is present in the octant rule; that is exactly the situation here, so I put the carbonyl here deliberately. So that means this will be one that will be two; because it is a 2-decalone system; you cannot have 1 here because that will make it 3. So 1, 2, 3, 4; and then sorry 5, 6, 7, 8, 9, 10; so 10 is what? The 10 you have a methyl group; so the methyl is like this.

So, this is one conformation, what is the other conformation? In the other conformation, you flip the ring. If you flip the ring, the methyl is axial with respect to this; suppose this is the A ring, this is the B ring. Methyl is axial with respect to the B ring; as you flip, it will be just a methyl will become equatorial with respect to the B ring.

Now, remember I told you earlier that if you try to flip it; and because you know that by flipping the B ring appears to be like the mirror image ring. But if you do that the problem is your depiction of the cyclohexanone system; the other ring. The other ring looks like a plane chair, it is a plain hexagon; sorry plane hexagon.

So, in order to avoid that what you do? You give it a hundred twenty degree turn, and make the chair look like whatever it was earlier. That is the original original chair, and if you do the original chair; then you can draw it like this. Now, you have to check whether the methyl is equatorial? Yes, methyl is equatorial with respect to the B ring, and hydrogen is axial with respect to the with the B ring. So, that means this is the flipped form no doubt about that; so this is your B ring and this is your a ring. So, the numbering where is the carbonyl? The carbonyl is now here; so this is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

So, now you have to draw the you have to draw the projection, the octant projection. So, this carbonyl is occupying the head of a chair, no problem; so you try to draw it. This is your 2 carbon, this is on the right side will be 1; whatever you are seeing is correct, because it is occupying the head of a chair. This is 3 and then 1 goes to 9; 9 goes to 10, 10 goes to 4 and this; so, you have complete the projection of A ring. Now, this is your axis and that is your axis, now you have to complete the other ring projection of the other ring. So, how to do that? Now, this is the A ring, this c5 that 5 carbon is axial with respect to the A ring.

Remember at this carbon, the equatorial goes up that means this is the methyl; let me just have a quick check. This is the this is the methyl, this is the methyl equatorial, and 5 will be at the down; because 5 is equatorial at c10. Then at c9 this is equatorial, the equatorial here goes on this side; so that will be 9 so that will be 8 that will be 8. And then you have 5 here, so the you can complete it; once you have the 4, the representations of 4 atoms you can complete the ring very easily. Because that has to be like this 8, then 8 is 7, 7 goes to 6; so, this is the formula projection; this is the projection of the system.

Again, I repeat what happens the first, this is how head of the chair, you look from this; on the right whatever you see is correct 1, 3. 3 is your to your left and then you complete it 9, 10, 4, 3; that is the standard projection of the cyclohexanone. Then you have to add the axial equatorial in order to complete the other ring, the B ring. So, 10-5 is axial to the A ring, so it will go down; and at 9, you have equatorial, c8 is equatorial to 9. So, you have to put the 8 here and then you complete the whole system. Once again I repeat once you have four dots available for a cyclohexanone, which comprises of 6; so you can always basically what happens if you see the four dots like this.

Then you know that the projection will be like this, if the four dots are like this; then the projection will be like this that what I am saying. So, it is this is the position, so according to this the cotton effect should be negative; it should show negative cotton effect. What is the experimental? Yes, it has negative cotton effect. Now, the what about this one, the projection of this one. Here the carbonyl is occupying the not the head of a chair; it is at the leg of the chair. So, let me again quickly try to draw it to as it is going to the right; but actual case if it occupies the head of a chair, when you turn upside down.

Then the left will become right, right will become left, so that is the only trick; so, 1 will be here and 3 will be there. Now, you complete 3 is connected to 4, 4 is connected to 10, and 10 is connected to 9, 9 is connected to 1. So, now you have to see that at 10, this bond is equatorial; so equatorial goes up at c10 and methyl will be down. So, this is your this will be your 5; that is clear that will be your 5. And then you have to see the 9 where is the; the equatorial this is equatorial, the 8 is c8 is equatorial to the 9. So, that will go in this direction, now you can complete I can just erase this. Now, you can complete the whole thing as I said once you have 4 at points; now you complete 8 is connected to 7, 7 is connected to 6; so, this is your complete diagram.

Remember where are the axis, do not forget that the two axis. So, if you draw this, you are seeing that this is showing positive cotton effect; this is giving the negative cotton effect. Experimental observation is negative, so that means this is the conformation of this molecule; that 10-methyl Cis 10-methyl 2 decalone. By the way, this is what is called a steroidal conformation, and this is by the way called a non-steroidal conformation. Simply because that if this conformation is a steroid has this conformation; then only you can complete the chair form of the other c ring.

But, if you start with this non- steroidal, then it will be it is not possible to complete the c ring by that way. So that is why this is called a steroidal conformation, and this molecule exists in the steroidal conformation by applying this octant rule. I think we can do more problems in the next lecture; we will definitely do that. But, for the time being, we are closing here; wait for the next class for more problems; problem solving for this application of octant rule. Thank you.