good afternoon everybody

so today we will just continue our third class on coordination compounds ok and here we are just talking about the most important thing for all these coordination compounds is the corresponding coordination number that means we are just trying to look at the number of l groups which are surrounding the central metal ion or the metal atom species which is very important because whenever we write this on a plane piece of paper or on a black board what we see that we write everything very quickly on the board but the visualization of the thing is sometimes very difficult because it is basically a three dimensional structure and if we write nicely this octahedral structure for a coordination number of six we find that we can have a typical square plane

so just we have seen in our previous class that how we can have a coordination number of four for say c splatine where these two ligands are the ammonia ligands and two are the chlorine groups or the chloride groups attached to the platinum center

so here very simple thing is that the coordination number is four based on a typical square plane and that also gives rise to the corresponding theta values for all four angles now as we move which is very important as we move from a species of coordination number of four two species of coordination number six what we can do we simply bring two other groups one above this plane and another below this plane which is also true very much if we just know little bit about the corresponding hemoglobin or myoglobin which is present in our blood

so in the biomolecules also we have the same situation where this initially formed iron iron is attaching to four nitrogen donor atoms like this here we have two nitrogen and two chlorine groups but four nitrogens from a particular type of ligand and ligand is a very useful ligand which is a porphyrin ligand and this porphyrin ligand is very useful in that way because this gives rise to some coordination through nitrogen of a protein chain which is our globin chain

so you see slowly in the biological system also how we can develop this coordination part by initially giving a typical square planar ligand which is the macrocyclic ligand we call it as a macrocyclic ligand then the connectivity towards the protein chain the globin chain which is from the protein part and this protein chain is functioning as a monoodented ligand because it is providing one nitrogen from the immediate joule ring of the amino acid of the protein chain coordinating to the fifth coordination site of iron

so slowly we are changing the corresponding coordination number initially the ligand is providing four then the protein

so is basically a typically a complex situation where we can have the another side the sixth coordination site will be available to bind to the dioxygen molecule what we all know that for the oxyhemoglobin and oxymyoglobin we consume oxygen for our very survival when we breathe we take oxygen from air and the hemoglobin and the myoglobin present in the blood are getting saturated due to the coordination of this dioxygen to the iron center

so this typical example gives us all these idea to us that not only a coordination number six we are looking at but also in this particular part the dioxygen molecule which is a gas like your carbon monoxide what we have seen in case of nickel tetracarbonyl that this o2 which is coming from air is also functioning as a ligand occupying a particular position around the iron center to saturate it for its corresponding property related to that of our hemoglobin which is oxygenated that means the oxy hemoglobin species

so this coordination number four is therefore very important and how we get this coordination number six we can see from here that this coordination number for another example synthetically prepared molecule like this that we can have the cobalt center having four ammonia molecules bound to this cobalt so we have four cobalt nitrogen bonds and two of the covalent chlorine bonds and another molecule which is also in the two different other geometry which is the cis form where the formula is same the both of them are cationics cationic means is a cobalt trivalent state because the two other charge is satisfied by the chloride groups here also in similarly two other groups charges are satisfied by the chloride groups

so this is we are calling as the cis and the trans

so the knowledge what we know already from your organic chemistry study that these two will be at 180 degree apart

so the chlorine cobalt chlorine bond will be 180 degrees

so they are away from the center

so they are not 90 degree apart

so we get a trans situation

so if we consider this particular square plane and of with respect to that particular square plane what we are just now discussing that with respect to this square plane one chlorine is above this plane and another clone is below this plane

so it give rise to a trunk situation that will see in the case of studying isomerism but but the coordination number the other one where the cl cobalt cl bond is 90 degree not 180 degree this is giving rise to the corresponding cis configuration

so in coordination number six we can have two situation one is cis and another is trans

so that also brings some change in the properties of these two compounds similarly for a coordination number of 6 which is readily achieved when we get a bidentate ligand

so a bidentate oxygen oxygen ligand that means the o2 type of ligand which is nothing but when the molecule is

so nicely over here is our the oxalate anion

so oxalate anion through the two charges o minus o minus is giving rise to a bident chelation to the iron center and three of them can be surrounding the corresponding iron center

so it is tris oxalato species

so trees oxalate of species giving rise to its total sixth charge and iron is in the ferric state

so we have a three minus negative charge

so this particular complex part is ionic in nature which is counter balanced by the potassium ion

so we have three potassium ions there

so like that of our hexamine covalent three chloride where we charge neutralize with the three chloride ion similarly for the anionic complex we neutralize the charge by means of the presence of three potassium ions

so this situation

so this is the thing

so that the three dimensional structure will be like this and this basically gives us little bit some idea when we draw in a piece of paper is very difficult to understand that ah these if we consider that this particular metal center and these two groups are in the plane of the paper

so these two groups will be above the plane of the paper and the other two will be below the plane of the paper now if we realize in that fashion that where the ligand is then we can have something that is when the bident chelation is there

so if the first oxygen atom of the bidented ligand is in the plane of the paper or the plane of the board the second one will go behind similarly if this is in the plane of the board the then this one will come forward that means it is above the plane of the paper and in this case one is below the plane of the paper and other will be the above the plane of the paper

so we should have the typical visualization and this obviously this particular groups the presence of these groups is telling us because the oxygens are all red in color

so this is not the structure of this but it is something different compound what we discussed earlier also due to that of your acetyl acetone ligand which we have seen in the banana acetyl acetonite one

so it is tris manganese acetyl acetonate compound and this nomenclature which is related to the isomeric form that we will discuss in detail afterwards and also something we also consider that there is some elongation because elongation physically what we can consider that when we manganese bound to three of the acetyl acetonate ligands what do you see that the manganese is bound to six oxygen groups and if all the manganese oxygen bond distances are not alike not of same magnitude

so we can have the situation where we can have some of them are shorter and some of them are longer and if we find that four of them are in close range and two of them are in the longer situation

so if we consider that this particular plane is a tetragonal plane

so which is above the tetragonal plane is longer and which is below the tetragonal plane is all also longer

so the nature of the elongation is tetragonal elongation

so based on a tetragonal plane one bond is longer and the other bond is also longer with respect to that particular bonds of this manganese oxygen

so what we find then that this can thus give rise to some isomeric form the way we have seen the c trans isomerism

so how we get these isomers are formed when we can have a octahedral complex and two at least two two of or more of the different ligands are present

so if we can have a complex which is m l four and a two just now what we have seen that we can have the two chloride

so we are basically getting two ligands around the metal ion two types of ligand one is l and there is a

so when they are basically giving rise to things

so we can have two different compounds

so this is a clear observation and that is why these coordination compounds are very nice to handle that in case of organic compounds whatever we get most of the compounds are in solution and if we can isolate they are all colorless and white in color

so color wise we cannot distinguish these two things but what we see that in this particular case we can have the two isomeric form and if we see that in the same petritis that one of the isomer is pinkish in color and another is the greenish in color

so color wise we can also differentiate out that particular color is for one particular isomer and the other color is for the other isomer

so this is basically we are getting for the left one is the system in dichloro cobalt iii chloride

so the same compound where the cis compound is pinkish in color

so tetra amine dichloro compound but the trans compound which is trans tetramine dichloro covalent three chloride which is green in color

so the synthetic methodologies are there and the typical synthetic methodologies can be followed to prepare the cisco analog and the trans analog

so these geometrical isomers that means the positioning of these groups can also be included while we name these coordination compounds

so how we name these coordination compounds which is very easy to know because sometimes we give the formula and when we read that particular formula is not that the naming of all these thing but we have to order the name of the metal ion the name of the ligand this corresponding oxidation state and the anionic part or the cationic part which is required for the charge neutralization

so like that of our simple naming of the simple inorganic salts like sodium chloride we tell sodium first that means the cation is named fast and then the chloride

so we call them as sodium chloride similarly for these coordination compounds the cation is named first and then the iron

so if we have this k3 fec and whole 6 and co and h3 hold four cl2 cl this compound we are seeing for last two classes and all the time we are taking the example of this cobalt amine compounds containing some of the chloride groups

so depending upon the species what is present

so the cations in one case it is potassium in another case it is the complex species but we have to name both of them first as potassium is the corresponding cation and the complex species is also the corresponding cation

so this is potassium hexa iono extra cyano iron three which we call the common name obvious is the potassium ferry cyanide then within the complex what we see that the ligands are named first in alphabetical order

so if a b c d the naming of the ligand

so we should know the name of the ligand

so ethylene diamine when you name ethylene diamine we consider is that it has a then similarly ah diethyland triamine it has d and when that trithenium tetramine it has the t

so the preference in that particular alphabetical order in the names once we know the name of all these ligands similarly the o for the oxalita group and all other creating ligands as well as the non chelating ligands the name of the anionic ligands end with a letter o

so letter o is there

so whereas the neutral ligand is usually called the name of the molecule

so we do not change the name of the molecule if it is a neutral one like water molecule

so is aqua we just simply tell aqua when water is coordinated when six water molecules are surrounding the iron center in some hexa aqua compound

so we tell them the hexa aqua iron three similarly when amine groups are present in co nh3 whole six three plus cationic part

so we know that is the hexa amine cobalt three complex part and similarly the carbonyl part the carbonyl also named as carbonyl which is the corresponding ah the nico hol4

so tetracarbonyl compound the tetra carbonyl nickel zero but when more than one ligand is present like ammonia as well as the chloride

so we write them with great prefixes the dye tri tetrapentan hexa

so when we have

so is the tetra i mean when four amine groups are present we use tetra but when the ligand itself is having some diet part

so we use basically the greek nomenclature for bis

so dye will be then bis tri will be then trees and tetra will be then tetra case

so when two of the ethylene diamine groups are present we use the greek prefixes for bis ethylene diamine because already the dye part is there in the amine

so oxidation number next we will consider the oxidation number

so while we are considering the corresponding nature of the ligand whether they are charged or not and the identification of the metal ion will immediately tell

us that how the charge is utilized by looking at the overall charge on the complex species
so in this particular cationic complex is ah having one positive charge
so is the monocatonic complex
so chromium obviously in the trivalent state
so this basically we write using the roman numeral within bracket
so it will be tetra amine dichloro chromium 2
so amine a is alphabetical ordering is the first thing that amine is coming first before we go for the corresponding chloro compound the condemning of the chloro ligand around chromium which is in the trivalent oxidation state but when the complex is an iron we first try say that is the that is a potassium and the anionic part is named as the corresponding eight ending with eight and
so this hexa cyano function is there
so hexacynoferate two
so when it is k four f e c and hole 6 it will be potassium hexacyanoferate but if we consider the ion it would be hexanofara2 ion similar fashion in a similar fashion we will just see that if the corresponding species is present as the corresponding iron as the ferret the name of the metal in the anionic complex when six cyanide groups are attaching to the iron
so we are not saying that is iron three it would be ferret three
so we write this as the ferret similarly all other metal ions is changing with the name of the corresponding parent metal center
so the anions getting that particular nomenclature
so name of the metal in ionic complex will be if it is aluminium it will be aluminate likewise we have seen that if it is iron it would be ferret if it is nickel it is nickelette and if it is zinc it would be and all these things are very useful for very simple groups attaching to the thing that means we have just seen that in case of copper copper can be in the plus two oxidation state and the copper can be in the plus one oxidation state and what do you see that when we write it as the cube rate
so cube rate can be in the flask two oxidation state and cube rate can be in the plus one oxidation state
so we should specify that particular cube rate in ah in the roman numeral of one or in a roman numeral of two for the copper oxidation state similarly this ferret can be for both iron in the plus two and plus three oxidation state but we will specifically mention the corresponding oxidation number for the metal ion
so if we consider these these are the examples we have taken from your ncrd book that the typical names because this is some kind of practice it is not that this will be asked to you in exam or in some competitive examination also but how we consider
so this is some example of say four different types of complexes
so how we read these metal complexes nicely and when we write this formula because the formulas are also typically different here we see that these are the neutral ligand here we have the anionic ligand here also the anionic ligand here again neutral ligand but it is chelating and the chloride groups are there outside the coordinate sphere
so what how we write these for its corresponding synthe naming
so is neutral
so we do not bother about the corresponding naming but only that the carbonyl groups are there
so it is tetra carbonyl leakage zero
so four such carbonyl groups are attaching to that particular nickel in the zero oxidation state that simply tell us that then tetra carbonyl leakage zero

is there similarly when we will find ah again another example from your textbook is the corresponding iron compound which we are having more number of carbonyl functions surrounding the iron center which is again in the zero oxidation state which is therefore the feco hole five

so instead of tetra that would be penta the second one if we see that if we do not write the corresponding square bracket because this will be under square bracket sodium will be outside the quadrant sphere

so this one has not been given deliberately that we should not confuse where it is

so the cationic part is sodium plus and the ionic part is auf 4 minus

so it's a uf4 minus

so it is basically a sodium salt of the corresponding anionic complex which is tetrafluoroarat

so tetraflow from gold we get ah rh

so orate three sometimes we find also find that it can be orate one that means the gold ion is present in the monovalent oxidation state sole is like that of our tetrafluoroborate this we all know nicely

so bf4 minus similarly it is a 4 minus which is tetrafluoroborate and it is tetrafluoroorate and this already we have discussed here this is the potassium hexagon of ferret three similarly we can have the potassium exciano ferret two which is for the ah ferrocyanide and the last one is basically the tris complex that is ethylene diamine

so tris is ethylenediamine chromium three chloride like hexamine cobalt three chloride

so it is trees ethylenediamine

so this function is the cationic part we know is a trees one

so three of the bidented ligands surrounding the chromium center

so now in a reverse way if we understand all this thing nicely in a reverse way if we write in a running sentence we basically sometimes write the complex is like this

so is i mean tetragon chromium 2 sulfate

so when we read it

so reading will also immediately send the message the signal can be sent to you that we are seeing something the molecule is like this

so you have this corresponding one that means the amine then tetrachor chromium two sulfate

so this particular one we what we get that is not the correct one in this form that is you have ah i mean

so what we require for octahedral compound we require two of them in function

so it is not amine tetragon or chromium two sulfate it should be diamine

so amine should be two in number or water molecule should be five in number because you can have some regular geometry which is readily achievable which we get it because the penta coordination in this form is not

so easy to get for chromium because once you get the chromium chromium if can be stabilized in tetrahedral geometry and immediately it can go to the octahedral geometry

so once we try to get this sort of corresponding penta nuclear ah that penta coordination it immediately attract the water molecule from the other side to complete it and the octahedral form but the charge neutralization is very simple two charges from the sulfate ion and one charges from the ammonia

so if sulphate is there the logic is very simple if sulphate is there an ammonia is the monoodented ligand

so the number of water molecules surrounding this would be five the

so the right name would be amine penta echo chromium two sulfate then potassium hexagonal ferret we have just seen this all these are example likewise once we know that these naming can also be lead to something to which is cis platin that means platinum compound something is there in this position and which is very important as the corresponding one we know that is the corresponding cancer drug

so we know that the corresponding drug penicillin is also there

so cisplatin is the proper name because it has been one of the most commonly prescribed as well as the first and successful treatment of many cancer diagnosed

so this basically gives us some idea that this is the compound where the two positions that means whether we call about the two amine function and the two chloride functions they are in cis position and is a coordination number of four and a square planar compound we get then we just move to the isomerism what we are just seeing that the two examples we have seen that we can have a cis compound or we can have a trans compound

so since we just now we are naming for this and similarly we can have the transplatine but this platine nomenclature is very common name it is not a iupac approved name

so once we write the corresponding one the hyphen is not there this is platinum

so correspondingly we can also some idea what should be the corresponding transplanting

so in this isomerism case what we see that isomers are there what is the isomer we know that they are having same chemical formula but a different arrangement of atoms

so only the arrangement of the atoms we know that the arrangement of atoms will be different if the compound is a cis compound and if the compound is a trans one its arrangement is totally different the way we are just now considering as the two bonds with they are one eighty degree apart and that other two bonds which are ninety degree apart

so the bonding which is one eighty degree apart will be the trans isomer and the bonding which is ninety degree apart for two similar groups of ligands which are cis isomers

so we can have two types of isomerism one can be considered as the structural isomerism that means we just looking about a coordination compound and that coordination compound what we see that this coordination compound have certain coordination number which is directly related to its geometry and geometry means is three dimensional structure and that three dimensional structure will give out something which is a polyhedral arrangement or a polyhedron as we all know that a particular carbon center where in methane it is attached to four hydrogen atoms and the geometry is we all know that is a tetrahedral geometry

so this is basically a corresponding polyhedral arrangement

so this tetrahedral arrangement in space where carbon is at the center we get that polyhedral arrangement

so once the particular coordination geometry is known that means the corresponding number of atoms which is surrounding the central part

so if it is four

so we can have a particular polyhedral arrangement for this

so this geometry is therefore is related to the structure

so the structure of that particular coordination compound and if there is some variation in all these in related to the connectivity in related to the coordination nature ionization and the presence of the solvent molecules what we will find will find something which we can call as the corresponding isomer

so these isomers will get for the structures the different structures what we get here is that once the first one it can be your linkage isomer that the linkages are different so we should read the name very carefully that the connectivity is different we get a linkage isomerism then coordination isomerism that the coordination sphere is different depending upon its position around the metal ion like c's and trans

so that will come to under the geometry for the geometrical isomerism but the coordination isomerism that means something is coordinating and something is not coordinating that will give rise to the coordination isomerism and you should not confuse between these two obstetric isomerism and structural isomerism then ionization isomerism nothing related to the stereoisomer that means the isomers in space and the corresponding solvent i i solved isomerism and this stereo isomerism is much more common and important and we can mix up these two together where we can find that the geometrical isomerism is there and within that geometrical isomerism whether something is showing corresponding optical isomerism or not

so we have

so this flow chart is very useful to remember also you can remember it nicely for this flowchart why we are talking about these isomers these isomers will be having the same formula but different properties and we go for the corresponding structural isomer then structural isomers we not only two we have just discussed is the four types the linkage coordinate ionization and solvent

so this is the four types of this isomerism we can have and on the right hand side we have the stereo isomer stereo means the space special part that means the same bonds but the different spatial arrangements

so bonds are there we cannot have the linkage type of thing or the coordination type of thing but the arrangements are different like that of your c splatting and transplanting those are geometric isomers because the spatial arrangement is there and as we have just seen that the corresponding color of these compounds are also drastically different one was we have just now seen one is pink is in color and another is green in color similarly the another most fundamental property that means the optical isomerism

so that basically tells us okay color is fine physically we can characterize one particular compound as the size variety and the other compound as the trans variety but afterwards when we consider their application and other physical as well as chemical or the biochemical aspects whether we can apply them as some good medicine like your cis platinum why c splaton is only active and transplanting is not that is an important area of ah understanding or the knowledge where we see that only the seas variety has some functionality which can attach to some biomolecule to give its corresponding medicinal value and that's why it can be used as a very good drug anti-cancer drug but the trans is reacting differently that's why the trans isomers are also different and a large area of understanding and the research and the work can be there where we can say that how the seeds variety can be synthesized and how the trans variety can be synthesized

so it is very interesting to note first that how these metal complexes are synthesized and then particular variety or the particular stereo isomer or the particular structural isomer how we can synthesize

so for the other part that means the structural isomerism we first see that the linkage isomerism

so linkage isomerism is very simple to understand the compound containing ambidented ligand

so that also like side by side we are just talking about the ligands and we classified the different types of ligands and once we say about this isomerism we see something which we call as the ambidented ligand

so so far we are just considering some groups and some ligands

so one such example we can take first is the n three minus which is the agide ion and we know that is the tri atomic anion

so we have the connectivity of n n n and the charge and the lewis dot structure you can draw and you can have how many bonds you can get there with that particular type of arrangement and the number of lone pairs are there

so the lone pairs will be available from this nitrogen as well as this nitrogen

so they can function

so this nitrogen lone pair can be utilized to coordinate to a bond to a metal say m one similarly this lone pair can be utilized for bonding to m two but when we go for a mononuclear compound a mononuclear compound which could not have any distinction

so the same azide can be bound to the metal center whether that particular bond is forming from the left hand nitrogen or the right hand measurement we get the same compound but if we get the same one where this n is there

so is the thiocyanate is there n c s and we have again the charge and if we just consider that instead of this particular ah two nitrogens we have carbon and sulfur groups attached to this

so the overall the total number of electrons are all same but this charge can move from this sulphur to this nitrogen also depending upon the lone pair of electrons and the corresponding lewis dot structure which is giving us the movement of the charge that means there is residence of the extra electron on sulphur sphere or on the nitrogen sphere

so now the situation is little bit different when either the nitrogen of the anion or the sulfur of the anion can coordinate to the metal center

so if we consider that the same which is also a very good test the analytical test for identification of ferric ion in solution in aqua solution which is fent yellow in color and this can be our reagent and addition of that reagent this reagent addition to this which is forming some reaction which is the change in the color how you monitor the reaction is very easy to monitor within a test tube or any other reaction flux we just look at the corresponding change in the colour and this particular colour change is due to the corresponding coordination compound formation or the coordination complex formation

so this particular iron will have the option

so either this iron in f e three plus is coordinating to ncs or it can coordinate to scn

so either it can bind this through nitrogen or through sulphur

so what we are looking for this particular color change we are looking for whether we are establishing some new iron nitrogen bond or new iron sulphur bond and if we are fortunate enough to make both the two compound in one case we are just going for first coordination because when it is in water medium we know that it has six water molecules surrounding this particular iron center

so this nitrogen is coordinating

so this bond

so that which immediately change the coloration and the color which we get which is identifiable is the blood red in color

so from fenty old to a blood red coloration will indicate that you have the corresponding coordination of the thyroid anion through nitrogen

so this particular case also give rise to this particular linkage isomerism if the metal center is bound to nitrogen or the metal center is bound to sulphur

so obviously when it binds to nitrogen we get one particular color and when sulphur is binds to sulphur we get one particular other type of ah color and also it is interesting to note here that in some cases when we force it to bind this particular one the thyroid we can bind to the metal center that means if we have the copper center

so copper we know that the copper can have two oxidation states the copper two plus and one plus and like the species what we have seen just now that it can be your one minus the q plus having bound to two chloride groups having a coordination number of two already we have seen similarly this particular one that means this c l minus can be changed by s c n minus the thousandth groups

so the binding of these thousand groups can lead us to some groups of these type

so you can have c u s c n whole to minus if the copper is in plus one oxidation state similarly if we go to copper two plus where we can write as ncs and it is three minus or four which is having a charge of four minus

so this is little bit softer in nature

so which is soft and which is hard and that also tells us some idea that among these heteroatoms the groups which are having different groups

so nitrogen is harder compared to sulphur

so the sulfur end will come to stabilize the copper in the plus one oxidation state and nitrogen will come to bind this corresponding compound in the cupric state

so in this example of this ah ambidented behavior of this ligand thiosynic to bind to the metal center through sulphur and through nitrogen and when we try to detect the iron in the trivalent state that the iron in the ferric state which is faint yellow in color

so this will be the corresponding coordination that means since ferric is hard one which is smaller one also

so the hard metal ion center will try to attract only the nitrogen end of the thyroid ligand

so is a linear scn molecule

so that linear scn molecule will try to attract this particular nitrogen center to your fe3 plus center

so it is not forming such bond like if the s bond is not forming instead it can give only the f e n bond through the thousand then depending upon the name what we are talking about the coordination the coordination behavior or the coordination or the binding can give rise to one another kind of isomerism it arises where the interchange of the ligands between the cationic and the ionic entities of different metal ions present in a complex

so this is one particular compound in which the ammonia groups are bound to the cobalt and cyanide groups are bound to the chromium center

so you can have certain type of stabilization for this particular thing that means the chromium can have some good preference for the cyanide ligands instead of the cobalt which is preferring the ammonia ah molecules for coordination now if there is an interchange that means the cobalt will come over here and chromium will come over there

so that is also a reality when the cobalt is basically going for binding to cyanide groups and the chromium is going there for binding to the corresponding ammonia molecules or ammonia ligand

so this basically tells us the metal on nature the nature and the character of the metal ion whether the metal ion is present in the cationic part of the complex or the anionic part of the complex and sometimes it is very easy to understand that if one part of this group because when we consider that this is there

so it is a reality you can isolate it out from the solution you can make it this from the solution and again you can break it also because this hexamine covalent three chloride we know and the potassium ah hexa cyano chromate also we know we can make it and we can then put together to get this compound by metathesis reaction or double precipitation reaction

so in this particular case we and also consider that if we can have that particular one the environment and when you consider that this particular thing is also studied nicely for electron transfer reactions that means this is getting stabilized for both the centers in the plus two plus three oxidation state but if something is that there go one particular center is there and we can look for some electron transfer ah for the one particular center to the other

so once we make this particular center to a heart to a soft they it is corresponding affinity for the corresponding ligand will also be changing and we can get something some intermediate species where one particular ligand like the cyanide like your agite cyanide is nothing but your azide it can bind through carbon and it can bind through nitrogen it can be a very good bridging ligand in that particular case then which is related to ionization ionization is always very important and we should not forget that how this ionization can take place when we also consider the corresponding solution electrical conductivity the lambda m values we can measure and the corresponding ionization of the metal complexes is important the way we have seen that in case of corresponding hexa amine covalent three compound hexamine cobalt three chloride we have seen that in solution this is present as the trivalent cation and three cl minus is present in the solution as the corresponding ionic form

so ionization isomerism will be available to us if the counter iron in a complex salt is itself a potential ligand what we have discussed from our very beginning from a very first class that the chlorides can be inside the coordination sphere the chloride as a ligand it can be inside the quads and sphere or the coordination environment or it can go outside to balance the charge or the charge can be neutralized

so this can be there

so if the ligand is a potential ah potentially you can coordinate to the metal center or you can displace it outside you can provide something where we get this particular situation where you have the corresponding sulfate group is inside the quads and sphere in another case we have the sulfur group outside the coordinating sphere

so these two groups obviously we should know the nature of coordination of the sulphate function and whenever we have some anionic group or the cationic group always you try to write it down nicely that this has the sulphate function and sulphate like your perchlorate and having a charge of two minus

so this sulfur is very much saturated is a tetrahedral one

so the lone pairs available on these sulfurs will not be available to coordinate to your ah corresponding metal center

so that is why we show also the another sulf ah the sulphur bearing solvent which is dimethyl sulfoxide

so is a sulfur is there and the oxygen is also there but it can coordinate to the metal center only through oxygen because oxygen is the terminal point similarly this sulfate groups can bind to the metal center through this oxygen and all four oxygen can be engaged for binding but initially since this is a bulky group it can function as a monorented ligand or it can function as a bidented ligand

so what happens in the first case in the first case what we see that the sulphate is within the coordinate sphere and already five ammonia groups are there

so for a octahedral geometry around this cobalt center this sulfate oxygen should function as a monodentate ligand to your cobalt center

so the cobalt environment is n5 only similarly for the second case your bromine we all know that bromine is the monorented one and since the cobalt is a trivalent one so the charge neutralization is taking place from the bromide ion coordinating to the metal ion center as the sulphate

so on the outside

so initially these two can be characterized very nicely because the electrolyte nature is different this is corresponding thing is the one is to one type of uh thing and is your one is to two type of electrolyte

so the nature of the electrolyte that means the lambda m values are different

so capital lambda m values will immediately tell us that you have ionization isomerisms because the pattern of ionization for the coordination compound is different producing bromide in the solution and the sulfate in the solution that can also analytically be identified if we add silver nitrate for the first case to precipitate silver bromide from the medium and in the second case barium chloride can be added to separate out as barium sulfate from the medium and identification of either silver bromide or silver barium sulfate from the medium can also tell us ok this bromide is outside the quadrant sphere and sulphate is also outside the coordinate sphere and these two examples having same molecular formula lead to us for a ionization isomerism then solve it that solvent isomerism is also interesting where we find that the solvation that means how many solvent water molecules are present there and we also call it as a hydrate isomerism the way we know that the formula of copper sulphate is known as the copper sulphate pentahydrate that means five water molecules are present along with that copper sulphate

so hydrate isomerism will tell us that whether the water is involved as a solvent that means as a solvent also if the similar to ionization isomerism that the water is coming to coordinate or water is going outside when water is going outside like this that means something is there we get and then some anions say a two a three etcetera then some water molecules

so now since water is not required for charge neutralization or anything here we can see that these water molecules should be present as the solvent of crystallization which we are calling it as the solvent the water solvent but in another case these salt water molecules can come and coordinate to the metal center where the metal is present in some oxidation state

so the number of water molecule as solvent would be less and this water molecule will come to go inside this water coordination sphere and it is basically a ligand when it is outside the quadzone sphere it is not the ligand

so it can have two character in one case it can be a ligand in another case it cannot

so what you see here is that that this particular one the solvent isomers will be therefore fine if a solvent molecule is directly bonded to the metal ion

so if it is directly bonded to the metal ion we get one composition for the isomer and if it is outside the quadratic sphere and remain as the solvent of ah solvent for that particular complex or solvent of crystallization within the crystal lattice because when we separate it out from the reaction medium we get some single crystal sometimes the crystals what we get they have some lattice and the lattice is trapping some solvent molecules

so these solvent molecules are getting trapped even if we do the reaction in some organic solvent like methanol like ethanol or acetonitrile those solvent molecules have also chances to be trapped inside the crystal lattice but sometimes those molecules can also go inside the quadrosphere to coordinate to the metal ion responsible for this corresponding complex next comes the geometrical isomerism that means the geometrical isomers that how the geometry can control the corresponding isomerism for us and this geometrical isomerism tells us something where we find that a particular arrangement what we have seen and what we have earlier known for the platinum that two of the ammonia molecules we put on the left and that is at the 90 degree apart and two of them are in the transposition

so we get as a cis platin or the transplant in molecules to us and why they are

so important because medicinally we have seen that one can be drug and another cannot be drug and since it is a platinum bearing metal ion it can be poisonous to us also because the elemental platinum as well as the ionic platinum in plus two oxidizing state even not in the plus four or any other oxidation state is sometimes very much lethal for our survival for our cell which can kill cell unnecessarily ah without damaging the cell when we take this as a corresponding drug for treating the cancerous cell

so two isomers why they are

so important because already we have seen that there is a different in the corresponding color

so this color this part is very important when you talk about the corresponding transition metal lines whether it is a 3d 4d or 5d metal ion this color can be very useful to know or know understand is all these cases that color should be different already we have seen in other cobalt compound that is the colors are different similarly if they are solid their melting points will be different if they are not solid if they are liquid their boiling points will also be different and their solubility in water that is very important that once you get a solid compound in hand suppose we are preparing both the compound the cis platin as well as the transplanting and we are unable to detect that there is some applicable color change for them that there is not basically a very color difference

so we go for the corresponding checking the solubility we take certain amount of compounds several milligram of those compound and put one milliliter or half milliliter or some drops of water molecules to it and we check the weather both of them have the same solubility

so the solubility differences will be there and the dipole moment obviously we all know that for organic molecules the c's and trans compound the sum some corresponding di chloride compounds ah the dibromide compounds we know that this platinum chlorine bond and this platinum chloride bond we have a charge separation then the bond dipoles are there for cis compound the bond dipoles will be added in nature

so they are additive in nature but in trans case it will be cancelling it out

so the trans isomers in square planar geometry for this platinum palladium even in the nickel compound they their dipole moment will be close to zero or sometimes it is exactly zero what we theoretically predict but in case of c s isomer we have a dipole moment

so the dipole moment measurement or any other physical characterization technique which can give us some idea about the corresponding dipole values will be useful to identify whether we are having some compound which is in cis geometry or the other compound in trans geometry and another type of geometrical isomerism which is also very much useful and famous also in terms of the corresponding orientation of the ligands in the corresponding environment where we are talking about a particular octahedral geometry

so m is there and if we consider that this m is forming octahedral compound similarly this m can also have some ability to form another octahedral compound where the ligands are one is a type and another is b type that means if we have m and b type and if they are of equal number because we have seen because very quickly you can write it down nicely that in one situation you can have a 4 b 2 type and when it is a 4 b 2 type we can have cis isomer and we can have trans isomer similarly if the other compound if it is m a three b three type now the question of trans and c's will not come into picture so we can have two orientations

so if we just see that if we just simply have this and we just try to write it only that how we can write it

so we have to write these three

so these three

so we can write it as a a a and b b and b

so this is one particular orientation

so how we know and how we differentiate this orientation this is the only thing that you can do

so this is one ligand this is the second ligand and this third ligand of one type now we put the same like a here the same a here and the third a which we put over here will not put over here will put over here only

so obviously the b which is occupying this particular position will come over here

so b is there b is there and b is there

so these are basically another arrangement

so what we are getting basically here is nothing but a particular situation where you see all a's a m a a m and ama all are 90 degree

so basically we are getting something which is there

so it is there in your book also nicely written in this form

so it is one trigonal face of the octahedron similarly for the other one the other phase the b phase is also is a b phase

so we have a f s all of a and also a b phase making of all b atoms

so the isomer like that of our cs and trans isomer

so it is very much similar because all of them are 90 degree

so when all a's are there the a m a angles are all close to 90 degree then b m b angles are all close to 90 degree and what will be getting over there is our typical facial isomer

so we just get the corresponding facial isomer that means one phase is occupied by these particular a groups and another phase is also occupied by the b groups similarly we can get this when we move this thing that means that a's are different

so this is particularly the positioning of these a's and the other positioning of b's and if we consider this a is within a corresponding sphere

so within a corresponding sphere

so this is one meridian of the sphere and this is another meridian of the sphere

so that's why when these are there

so obviously this a m a angle then a m a angle two of them are ninety degree but one of the ama angle

so one of them one a m a angle and again 1 b m b angle these are close to 180 degree and these are close to 180 degree we get another situation

so that situation is opposite to this like that of our c's variety to visual variety then the trans variety to meridional variety married duo null ok meridional and we write here abbreviated like cis variety as the facial isomer and these isomer as the male isomer

so this type of thing which is very important for the geometrical isomerism and next day we will start from here continuing something how we can know this thing because this understanding is very important because these we are considering as that all a a and b b b are monoodented ligands now what will you do we do something that where we can have a ligand or by dented type where one end is a and another end is b and do not forget that this particular situation can you can have also for other situation that means the bidented ligand can be a type and the bidented ligand can be b b type so how you assemble all these things what are the isomers possible for that and what are the nomenclature for these things are also important because this sort of things are also there when we go for the multidented ligands for such as by dented the tridented as well as the tethered ended ligand okay

so these we all see in our next class

so for now is thank you very much you