okay good afternoon everybody
so in this
second class of our coordination compounds we will see how we can utilize nicely
the bond which is formed between the different metal ions say with some species which will be termed as the ligands
so this particular interaction between the metal
ions any metal ions any source of metal ions or sometime we will also find that the metal in
the zero oxidation states that means the atoms can interact with some smaller groups those can
be very good anions or some neutral molecules
so this particular interaction if they
are of the nature where we can get some interaction in terms of the coordination bond
we get the resulting coordination compounds
so this will see in this particular second class
of this coordination compounds and we were just discussing taking example from your book that when
cobalt chloride
so basically cobalt chloride is reacting with ammonia and why we are talking to
say all these things is that if we have simple cobalt two chloride we all know that is
a solid compound
so cobalt does chloride
so this cobaltous chloride
when we react with ammonia will find that cobalt ion
can form some interaction coming from the lone pair of electrons on the
ammonia molecule because ammonia we all know this is typically a pyramidal molecule
so where
these cl minus will be there and how these are from the solid state that means this is a solids
compound
so solid state identification of these things where the metal ion is only present and
the bivalent state and the chlorides were there like the regular packing what we all know the
rock salt structure of sodium chloride say
so when we come for the solution
so this is
a very good example to study some interaction for knowing the solution chemistry
so solution chemistry for all these will be very much informative in terms of the
corresponding availability of these chlorides because these chloride ions will also
be available to us as the same ligand and definitely if the concentration depending upon
the concentration if the concentration is not that much the available chlorides will be less and if
we add this because this concentration is higher that concentration of ammonia molecules are higher

than that of our chloride ions already available   here because we are not adding any externally the
chloride ions that means the sodium chloride or   any other thing we are not adding as some external
source of chloride ions
 so basically these ammonia   molecules will try to gather around the
cobalt center and will start interacting   with this particular cobalt center through
the well defined dative bond between   nitrogen of ammonia and the cobalt center which is in the bivalent state
 so how we can identify these compounds
so the coordination compounds   will give rise to different compositions
that we have discussed in our previous class   that how we can analyze these compositions
in terms of the availability of this chloride   where because we have defined also the primary
valence and the secondary valence whether this   chloride is available attached to our cobalt
centre where or they are remaining outside   the quantum sphere because whatever we have inside
this particular square bracket this square bracket   the metal center will be attaching with
 so many
ammonia centers
 so if it is number is 6 we have   a regular octahedral geometry around this
cobalt center and this particular thing that   means the whole entity the coordination entity
we get as the corresponding coordination sphere
 so how this coordination sphere is forming and
what is the nature of these things and also   these chlorides which are staying outside
is required for charge neutralization
 so this is required for charge neutralization
then we will just use something that means   since we are doing everything in solution
so we dissolve some amount of this compound   once it is formed in the solid state and we
know the concentration of that compound in   that particular solution
 so wherever we make
any solution we all know that certain amount   of solute will dissolve in a certain volume of
the solvent giving a particular concentration   and that particular concentration is important
to know something which will be now tagged as the   solution molar electrical conductivity
that means this is the cationic part and these are the anionic part like the salt we
all know the sodium chloride the calcium chloride   or aluminum chloride we basically compare them
in terms of their corresponding lambda m values
 so lambda m values that means the species which
are available the ions which are available to   carry the electrical charge from one electrode to
the other that will give some idea that means the   how many of those pieces the

charge carriers
are available to carry those electric charges and that will immediately distinguish whether
your chloride is outside the quartz and sphere or inside the coordinate sphere
so that we give
get this example from this particular table
so we have the yellow compound the purple compound
the green compound and the violet compound but you see the number of chloride ions which
are outside the quartz and sphere are different in the first case it is three in the second it is
two and two other cases this is one and one only
so if we measure the solution electrical
conductivity in terms of the lambda m values the capital lambda m values we can define
them as their nature that the electrolytic nature of these electrolyte is one is to three one is
two two one is two one or one is to one like that of our aluminum chloride calcium chloride and
sodium chloride
so we must have some good idea about that that the where the chlorides are and
that will also differentiate that means the color of the species and its electrical conductivity
and we can identify this
so it is one of the property which can be readily used to identify
a particular type of compound because this molar conductivity at a particular concentration
is related to the number of moles present
so if we consider that we are going for
a 10 to the power minus 3 molar solution we calculate out that particular specific
conductivity and then by multiplying the molecular weight we get the molar conductivity
and that is also immediately known to us whether a particular complex is electrically neutral
also because sometimes we find out that from some particular type of reaction we
get the compound which is separating out which is not
so soluble in water medium or the
alcohol medium or the water like solvent medium the compound which is precipitating out
is also a coordination compound with a neutral character that means no charge
is there either cationic or anionic and they don't show any electrolytic behavior
that means their lambda m values would be very less sometimes it is very close to 0 only
and that also immediately characterize the electro neutrality of those compounds and
we can write down the formula very easily
so this basically is formed and we can define that
a metal complex or the metal ion complex is formed when this particular hexa amine
cobalt three chloride is forming and some of these that means the chlorides

are going out which were originally present with the cobalt salt as the chloride salt
of cobalt
so chlorides are not taking part in the complex formation and they are only held in ionic forces and the solution molar electrical conductivity measurement gives us
some idea that this is a typically ionic compound ionic compound in the form of then that is
the cationic part is a complex part and the anions are simple chloride ions
so that we can
remove these chlorides as silver chloride also that we have also seen
so not only the
transition metal ions or 3d block elements or sometimes we can also consider that the f
block elements or the lanthanides or actinides but also the main group metal ions and
sometimes the main group metal atoms also can give rise to this sort of interaction
that means the coordination compounds and as we have discussed already
so this we are
basically again ah recapitulating what is the primary balance and the secondary balance the two
types of balances we get and one will be directly related the primary balance corresponds to the
oxidation number and the secondary balance is the coordination number what does it mean that
if we know the primary valence that means the primary valence which was originally there for
the cobalt salt which was therefore the cobalt as the corresponding cobalt chloride
so we
have the formula of the compound as c o c l three dot six n h three and sometime we also
find that this number the number six is varying depending upon the number of molecules that means
the ammonia molecules surrounding the central metal ion center
so if we now see that particular
primary valance
so p v if we say the primary valence corresponds to the typical oxidation number which is also true for the salt itself when we use this particular salt but here the
reaction we do basically from cobalt task chloride and the oxygen from the air is responsible for the
oxidation of the cobalt center because in presence of ammonia the e 0 value the redox potential for
the cobalt 2 cobalt 3 is less which is higher in case of bound water molecule but when the water
molecules are replaced by ammonia the e0 is less and which is achievable by the simple oxidation
of the dioxygen molecule which is present in air
so this is getting oxidized
so if we now consider
that particular formula of that compound that how many chlorides are there outside this coordination

sphere
so outside this coordinate sphere the number of chloride ions will tell you the
corresponding oxidation number
so since we are starting from a salt which is in the lower
oxidation state that means the cobalt does ion and that cobalt ion is getting oxidized
so if
that particular compound the complex compound what is formed over there due to the
reaction with the ligands ammonia if that is forming still with that of the lower
oxidation state that means the oxidation state is still cobalt touch will be getting two chlorides
over here and this particular oxidation state will give rise to the corresponding charge on it
so the
primary balance is also responsible for the charge on the corresponding complex species and which is
neutralized by the corresponding number of anions
so sometimes it
so happens that this particular
part is forming but due to the non availability of right number of chlorides the compound is
basically the complex cation is not separating out as a precipitate from the medium as a solid
precipitate from that personal reaction medium which can be water pure water or which can
be a water alcohol mixture or something else
so this particular thing is that you have to
supply or you have to provide the corresponding anions to know this thing and what about this
coordinate sphere because here we find that in case the inside this thing that we are
having six such nitrogen cobalt bonds
so six such cobalt nitrogen bonds will be forming
over there and which is related to our secondary balance sv
so secondary valence will be equal
to then the corresponding coordination number
so one is the corresponding oxidation number
if cobalt is trivalent the number of chlorides outside the chords and sphere will be three if it
is two it will also be two but difficulty arises due to the nature of the corresponding metal ion
or the metal atom to identify the corresponding coordination number
so that will also related to
our formula how we write the corresponding formula and how we get the ah formula and
the corresponding number of ligands which is surrounding the central middle ion
so what we see here that cocl cocl36nh3 thus according to the
warner the alfred warner defined that thing the cobalt has two valences and one is three and
another is six

so immediately we will have some good idea about the number of groups which are
surrounding the metal center and the number of outside groups which will be required to
separate that particular compound as the ionic solid
so these are also very good ionic solids so
coordination compounds are the corresponding ionic solids
so the entity which is forming within
the square bracket is your coordination entity and it has the central metal atom or the
ion and bonded to a fixed number of ions and molecules because the ligands can be
ions and ligands can be neutral molecules
so what are those central atoms and ions it is the
atom or ion which has a fixed number of ions and groups bound in a definite geometrical arrangement
so we can have a typical geometrical arrangement and we will see that the corresponding geometry is
also related to the corresponding c n values that means the coordination number values
so what is
that coordination number then we basically bring the idea of the ligand
so the ligand with that
of your donor atoms if it is water molecule it is the oxygen atom which is responsible for donation
is charged through its lone pair of electrons to the central metal ion if it is ammonia it is the
nitrogen of the ammonia molecule which is directly forming bond to the central metal ion but
if it is species like p t c l six two minus where you see that we know that the
simple platinum salt what we get that the platinum chloride
so if the platinum
chloride we get
so is a typical salt like nickel chloride
so is a bivalent one then as
a complex species we can have p t c l four two minus and also another species
what we are writing over here is p t c l six that is also having a
charge of two minus
so what does it mean is a very interesting thing that how you
get it we know is a simple metal ion salt which is also true for other metal ions like
nickel chloride palladium chloride and etcetera and here we get something which is a coordination
compound and this coordination compound we have a platinum center and we should know the
corresponding oxidation number therefore since the charge is two minus we how we are
getting this
so the if the palladium is also bivalent like this palladium chloride this is also
a palladium in a bivalent state and four chlorides are surrounding this palladium platinum center and
giving rise to overall charge of two minus on this particular coordination

sphere but what about this
particular species where you see the corresponding coordination number has also been changed and the
charge is also of the same type the chlorides has changed the number of chlorides present with the
platinum center is more but still the charges are same it is also two minus then which was also
there for this other species as the two minus
so definitely this is a oxidized form of platinum
so platinum in the tetravalent state can give rise to a corresponding coordination
number of six which is not
so common
so there should be some relationship we therefore see that
the relationship between oxidation number and the coordination number as we move for that
means as we are able to oxidize the center it can assemble more and more number of anionic
groups particularly and if it is not available it can also try to gather the more number of
this corresponding dipole the negative dipole of the neutral molecule as the ligand surrounding
the central metal ion
so this is an interesting observation and how we can isolate this particular compound as salt also and this particular compound has salt also we should know
so in this particular
case what we see that the second example where we get the nickel when you dissolve any nickel
salts nickel sulphate or nickel nitrate in water and with that then add ammonia we get this
species this particular species
so initially we get that some species is forming like this and
sometimes it can also change to a ah corresponding coordination number to six also but initially it
can also form echo species like this
so here this corresponding cn value is 4 for nickel
so this has
been defined
so first time this is another alfred alfred stock in around a 1960 not in relation
to the course and chemistry of the metal ions but also for the silicon chemistry first defined
this particular thing which is interacting with the silicon center which is a not a metal
p purely metal center is a metalloid center but which is interacting with some other groups
like nitrogen or oxygen he coined the term ligand from the latin word liga liga is to bind that
something is binding to that particular center
so that's why it is open up
so so many things that
means whatever species starting from your solvent like water molecule the

methanol molecule or the
acetonitrile molecule which is organic solvent we can level them in terms of the coordination
compound that they are also our good ligands
so they can be small ions or molecules which
are able to bound to the central metal ion or the metal species like that what we just now
discussing about the chloride ion and the small molecules like water when we use water as a
solvent for the preparation of any solution or when we add the dilute solution of ammonia
as the base also and we define something that some larger organic molecules or sometimes even
macromolecules can also be ligands
so what does it mean that if we go beyond this ammonia this
ammonia is nh3 but this is the amine function on a organic backbone
so it is basically nh2ch2ch2
and h2 is nothing but your ethylene diamine
so i mean the ammonia is a typical amine or we can
go for methylamine or the ethylamine or sometimes the trithylamine also which is also a base of
different quality or different character
so what happens to this particular base that these
nitrogen is available to interact with the metal center will see that whether this other part
of the same amine which is a small one whether the other part is also available to bind to the same
metal line or a different metallic or it remains dangling or hanging similarly this is also
another different type of tripodal i mean with this nitrogen like ammonia nh3 we know that n is
there instead of three hydrogen attached to that we can have the ethylamine if we add three
ethylamine arms to it
so that particular thynamin arm can give rise to some species which is also
ammonia-like that means ammonia like pyramidal
so that pyramidal environment also available
with that of the lone pair pointing towards the different side above that corresponding site we
can get the corresponding species as the ligand and also the protein part
so we all know that
the proteins are amino acids the building block of proteins are amino acid
so the carboxy
function the acid function as well as the amine function ammonia nh2 function is there
so that's why like ammonia like ethylenediamine and like this tripodal i mean the nitrogen
of this protein part or the nitrogen from some other groups from the protein chain like
that we know in our blood in hemoglobin and myoglobin the histidine residues are there which
is having immediate side chain
so the backbone is forming through the carboxyl and amine end of
the amino acids to give you dipeptide tripeptide or the polypeptide which are

the typical backbone
of the protein structure but we can have nitrogen we can have oxygen and some other pendant groups
which can also be available for coordination to the metal ion center
so in case of proteins
the versatility is more depending upon the nature of the protein structure or the amino acid
pendant groups those groups will be available to coordinate to the metallic center
so these are
very simple example what we can have the water already i discussed a lot then ammonia then the
chloride also which is a very good sphere like arrangement having one charge since the size
is very big initially what we can see that the one lone pair of electron can be available
to bind to the metal center but theoretically as we want to predict it whether it can have some
bridging aptitude or whether all four lone pair of electrons around chloride ion
will be available to interact to the metal center in fact it is possible you can
have some in a particular situation you can have entrapped chloride inside some cage like
arrangement where all four lone pairs of electrons can interact to different metal ion
centers like m 1 like m 2 m 3 and m 4 giving rise to a tetra nuclear complex where this chloride
ion can function as a nucleating bridging group in mu 4 form that means in the mu four binding mode
is available for this chloride ion to show its ligating behavior and this is a small gas molecule
like dioxygen molecule what we all know that the dioxygen is also interacting to the iron center
in our blood molecules
so this is the carbon monoxide as we have seen is nickel tetracarbonyl
which is in the zero oxidation state of nickel this is forming some interaction through this
carbon end the lone pair on the carbon side because oxygen is more electronegative
and this particular thing is forming or stabilizing the low oxidation state that
means the nickel in the zero oxidation state forming that particular carbonyl compound
so not
only nickel carbonyl we can have the interaction with the other carbon metal ion center the metal
in the zero oxidation state that will see briefly for those compounds which are the metal carbonyls
so some mononuclear metal carbonyls are known as well as some binocular metal carbonyls are known
for the 3d elements that will see afterwards
so how many donor atoms we can have
so this

ethylenediamine have two donor atoms this is one nh2 and the other nh2 so the ligand can be bidented similarly if we go beyond to we get tridented dented and polydented behavior so this is some good example from those ligands so we should immediately know some good molecules and these molecules whether they are showing some interaction to the metal center like this carbon monoxide this chloride similarly the cyanides the first example what we have taken is the corresponding ferrocyanide and the ferrocyanide ions also and their cyanides are the ligands to the iron center similarly this thyroid it has a very good value in terms of the corresponding analytical chemistry because when we add thousand it very dilute solution of carcinoid to any iron solution in the ferric state so ferric solution when interacting with this thiocyanate giving rise to a very good or blood red coloration which is very much characteristic for this corresponding identification of that iron center and water already we discuss this then the example for the bidentate ligand which is also useful that means one end and the other end if the molecule is like this so it's basically not a strictly linear molecule but is a zigzag type of molecule because this carbon is tetrahedral this carbon is also tetrahedral so in the zigzag way you can have this thing but if you bring this nitrogen around the same metal center with along with the other one we get a cyclic arrangement like the any other organic molecule the cyclic type of arrangement what do you see here so if your center is any cobalt centered that means the cobalt in the plus three state so one of the ethylene diamond this ligand you see this is a typical bending mode of binding so is forming a particular one two three four five five membered ring which we call as a killer ring so chelate is the typical binding claw is the binding so is basically binding through these two nitrogen so these two nitrogen hands are heads are coming close to each other for binding the metal center which are basically this angle is 90 degree that means the seas angle around the octahedral geometry so this seas angle which is occupied by one of the ethylene diamine molecule can also be extended to other two other seas angles basically giving rise to a compound which is octahedral in geometry having three bidentate ligand instead of six one monodented ligand earlier we are seeing that if we have a octahedral complex we require

six monorented ligands like water or ammonia   now since the ligand is bidented
we require three
of them
so we call them as since three of them are   present we call them as the
triskelet complex so
this is the most abbreviated form that means we do   not write the details of
these donor groups but
the binding basically we write in this fashion   and what we see that is a
particular type of
binding
so is basically the three dimensional   view we should visualize always
whenever you are
writing any complex in this form that means the   tree skillet we are writing
so basically you write
in this fashion of a propeller type of arrangement
so this propeller type of arrangement is also
very easy to visualize
so this is one form   and the other form we can also get that mean
instead of connecting this with this point   we can go back that means we can go
to the other
side
so this point can go to this side similarly   this can go to this side that
means the other open
ends can be occupied which can also be a typical   mirror image of this one
so if it is in the left
hand side if we put mirror over here we can get   another image on the right
hand side and these two
will have some interesting property that will see   because is a much more
complex geometry
compared to your carbon center where we   apply the chirality on the carbon
center
the optical activity on the carbon center
so in terms of this metal ion center this
particular cobalt center and all this metal ion   center whether we get these as
the corresponding
thing that means the chirality we can have   and that particular chirality we
get in
terms of the corresponding coordination   which is octahedral in nature and we
have the
three by dented chelating groups attaching to   that particular central metal
ion but if we extend
it further in terms of something what we will   talking in terms of the
corresponding backbone
so this is a basic example of a polydented but   exact definition for that
particular ligand
is hexadented that means it particular this   particular ligand has six donor
groups so
this nitrogen this nitrogen and these are the   charged oxygens
so this charged oxygen and this
charged oxygen and another charge oxygen another   charged oxygen because the
overall charge of this
particular species of the organic molecule is four   minus which is the
corresponding tetra negative
salt of ethylene diamine tetra acetic acid   and sometimes we get this as the

corresponding
disording salt
so disording salt of ethylene diamine tetra acetic acid which is a white crystalline compound can be in our hand so what is the nature of this denticity of this
particular ligand
so two nitrogen if it can donate to the metal center we can have this oxygen we can have this this and this oxygen that means four of these oxygen atoms can also
be available to coordinate to the metal center as a result what we get that the bidentate or the
polydented that means the tridented tetradentate and the hexadented ligand they are all
collecting agents because they hold the metal like a claw
so again like that of your
definition for the ligand for the latin word now the greek word chella is used
for the claw which is using for the chelating one for the coordination to the metal center by a bidentate ligand
so if we consider this lead
so not that we can
have calcium also we can determine the calcium in hard water by doing some analytical chemistry
which is known as complexometric titrations
so this particular complex symmetric titration is
also useful because we know that just now i told you that the disorderium salt of edta is a very
good reagent which is solid reagent you can take some amount of that solid and you dissolve it in
water such that you get a standard solution of this particular ligand and when we use instead of
lead if we have the calcium or magnesium in some water sample that means we are talking something
which is related to the hardness of water
so we can determine the hardness of
water by determining the calcium two plus and magnesium two plus in water we basically do
not want these metal ions to be present in water when we use soap or detergent to get
good leather
so this can be avoided so this particular one
so these metal ions in our
hand not in hand it is in water
so everywhere if the source of water is not
so good we can
have calcium or magnesium and sometime we find that the industrial effluent water
can also contains or contaminated by calcium two plus and magnesium two plus so
the metal ions will be in our hand and if we use edta edta four minus ethylene diameter acetic acid
so this is our hexadented ligand and we have seen
that this particular one having this ethylene diamine backbone
so that

ethylenediamine backbone will then tell us that it has two nitrogen along with four oxygen
so these are the abbreviated form of that ethylene diamine tetra acetic acid
so when it binds
basically
so we get a calcium n 2 o 4 complex and how we immediately draw basically so drawing of this is also very important because we are correlating the binding of this
edta that means the hexadented ligand to the calcium center or the magnesium center
so since
these two nitrogens already we have seen they can very easily form a bond which giving rise to a
90 degree chelation
so this particular around 90 degree collation these are the seas angles
so these two are occupied then we can have four other points available
so we have
to fit this particular molecule over here
so what we get this nitrogen extended with this
oxygen and this another one with this oxygen similarly this nitrogen will come for this oxygen
and this nitrogen will come for this oxygen this particular one will have a total charge
of 4 minus calcium is having 2 plus
so overall we can have some charge there again
so this is
2 minus since we are talking all these things related to something where we consider these
as the corresponding species forming in water because we are determining the hardness of
the water which is contaminated with calcium and magnesium
so water some metal complex or
the coordination complex species is forming due to the availability of this which can also
give rise to the corresponding standard solution you can weigh out this standard solution and
we can quantitatively determine the amount of calcium two plus present in that water sample
so in water the coordination compound which is forming and which is anionic also that is
why that will also be in the soluble state
so that give rise to something
which like redox titrations like your titration with permanganate titration with dichromate we call this as a complex
so metric analysis using um complexometric type
iterations
so like redox titrations we can have the complexometric titrations where if we know the
standard solution that the known strength of this known strength of this solution of m by 10 then
we can find out the unknown concentration of this calcium which is present in the water molecule so
that gives rise to a very good example for these and also this particular information can be

extended if we consider that if we have something   that some metal ion that means the lead which
is not good for us the lead is a poison one also
 so if somebody is affected due to the lead
poisoning in their you know in his or her body
 so if this particular species that means this
can be added as a corresponding medicinal value   that it can go to the body and bind lead nicely
such that this particular species can take out   from your body through your urine such that
the lead poisoning or lead contamination   can be avoided
 so starting from the analytical
chemistry application of this edta we can have   some medicinal value of that particular edta
because it is present everywhere it is also   present every day we use in toothpaste also so
this chelation basically give rise to something if   we write this edta as this the metal edta complex
where the stoichiometry is simply one is to one   just now what we have shown to you and when
we get this
 so when edta is forming this is   not right this is this should be two minus since
this two plus is there and four minus is balancing
 so what we here we are i am trying to tell that
if you have two species in solution on one side so   this is one species because this is also present
as a corresponding equated species or where   six water molecules are bound to the
metal center
 so this is a complex species
 so hexa echo metal ion corresponding hexagon
metal ion species in the bivalent state is one   particular species which is also interacting
with the adta and right hand side what we get   we basically get seven species because six water
molecules will be losing from the coordination   sphere or the coordination environment of the
metal ion on the other side
 so that is why   there will be energy gain for the from the free
energy gain from the thermodynamic point of view   because the magnitude of the delta s is different
so entropy is rising on the right hand side
 so that basically gives us some idea
why this reaction is moving from left   to right that is the driving force for that
particular reaction for edta coordination   and that also gave rise to some idea
why we call it as a chelation therapy
 so this chelation therapy gives us some idea in
terms of the corresponding removal of lead as   lead 2 plus mercury as mercury 2 plus and cadmium
has cadmium 2 plus just now what we have seen the   corresponding complex which is forming with lead

2 plus similarly the mercury will also though it is not favorable for a octahedral complex
which is also not true
so much for cadmium but if we force if the ligand is forcing us
to go a corresponding stoichiometry of one is to one only
so the metal will have no other
option to interact with that particular ligand basically it is getting trapped
inside the ligand which is providing six donor atoms that may be not good bonds
forming around mercury and the cadmium but it will be trapped inside and the
stoichiometry of one is to one is also valid for these two species there
so like lead also
this is wrong this is two minus
so for the lead what i have just now shown to you is also
the corresponding thing
so lead which is a poisonous thing for our body which can kill
our cell the cellular destruction can happen but this is not
so poisonous
so body can excrete
from the body without any problem
so that is why the edta is helpful if it is present
in our toothpaste it is also helpful if some amount of lead or any other metal ion
like mercury or cadmium is there in our body which can be removed nicely
so the species
what is forming due to the removal of these and which is known for distillation therapy
saturation we are utilizing for some amount of therapy
so the therapeutic application
so next
item what we can talk about is the coordination number already we defined that the number of
ligands surrounding that particular metal center
so the donor atoms which is provided by
those ligand to the metal or the metal ion is directly bonded
so that gives rise to the
corresponding coordination numbers which is a typical coordination number
so we start from a
typical coordination number of two
so we will have some thing that why we are not asking us that
whether we can have a coordination number of one which is two will be has a reality
so is basically
if we can get something that whether we can get something coordination number of one that means
if we have a metal ion which is n plus we can show one interaction with that particular metal ligand
so basically this particular one from starting from here to there that means you have something
that means your middle iron is basically trapped and it has no other donor groups available
to coordination to the metal center
so it is basically some thing where the metal

ion is only trapped but is not showing any other coordination or some bulky grooves
so bulky hydrophobic environment which is not showing any bond to the metal center is
surrounding that metal iron then only one point of attachment is available then some small
groups can come and interact with the metal and center
so that can be the typical example for a
coordination number of one but which is not of much reality
so we will start our thing that means
the reality is from coordination number of two which is there that means the ligands are there
metal ions are there and it has a good reality
so this coordination number of 2 is the typical
one where the thing is that we can write a g n h 3 whole 2 in square bracket having a charge
of 1 that means silver is present in monovalent state what we all know this particular species
is forming for the analytical identification of chloride ion in solution because chloride we
all know that which can be precipitated by adding silver nitrate with a white precipitate of
silver chloride which is soluble in excess ammonia
so what does it form that silver chloride
which is forming over there is solubilizing in ammonia that means the species what is forming
the way we are doing all our discussion on cobalt chloride with ammonia similarly silver chloride
is interacting with our ammonia giving rise to the corresponding ammonia complex
so the driving
force is that formation of a g n bond instead of the simple ionic solid as the silver chloride
which is precipitating out from the medium
so that gives rise to something which is also
similar to any silver thing why we are talking all these things here is that the example of silver
the identification of that particular silver is very important and that silver will tell
us that whether we can get something for some other reagent
so silver based reagents also
we do some organic chemistry reactions or the organic analytical chemistry there we find
the preparation of tolerance reagent
so that tolerance reagent is also that we can have
the silver
so silver as the silver nitrate and preparation of that tolerance reagent can
also be helpful because we most of the time we use the tolerance reagent and the laboratory
you are supposed to know that particular reaction for the tolerance reagent
so is we by name it
is called as the ammonia called silver nitrate solution
so what does it mean the ammoniacal

silver nitrate solution what we can prepare is that if we have a solution of silver nitrate
so silver nitrate is treated with a very dilute solution of sodium hydroxide giving rise
to the precipitation of silver hydroxide
so the medium is typically alkaline due to the
presence or appearance of silver hydroxide in the medium and like silver chloride we just
dissolve it in ammonia
so ammonia solution is next added giving rise to a g nh 3 hole
2 which is the corresponding complex pieces if outside the hydroxides are there the hydroxide
will be balanced
so what we do basically we are getting this particular one
so this is your
ammonia called silver nitrate solution is the tolerance reagent which can be reduced for
some other reactivity pattern which is derived from your silver nitrate
so this particular
species as immediately tells us that it has the corresponding coordination number of two because
the silver ion center is there which is forming only two bonds with the ammonia molecules and
which is the linear one having one eighty degree nitrogen silver nitrogen bond angle
similarly we can have other example for cu cl2 minus the if the copper
is present in the queue prostate like silver we all know that the copper silver
mercury and all the typical triad
so copper also not in the bivalent state because the by valence
state once we know that the oxidation state if we change the oxidation state its corresponding
coordination number and the corresponding ah other groups which will be attached to
that particular center will also be different
so this particular cuprus chloride is also like
that of our silver that means you have a linear arrangement of two chloride groups attaching
to your ah copper center which is not true for our silver silver is silver chloride but is
not
so easy to get agcl to minus over there similarly the other very good ligand to these
metal ions is the cyanide ions because the cyanides is a good processing reagent for
the recovery of metal ions from its ores for silver for copper etcetera
so this species the
corresponding species if instead of chloride if we can have the cyanides it will be cu c n whole
two minus
so that is basically coordination number two and the coordination number three is also
not very common and we will not discuss here about this coordination number but typically if

we consider a particular type of metal center   and again if only three points are available
that means a t shaped arrangement or a regular   trigonal arrangement then only we can have
a corresponding coordination number of three   then the coordination number four immediately
what comes into our mind that if we have   a coordination number of four and if we
place four groups around this metal center   we get a corresponding tetrahedral arrangement
which is more common and the other one is the   corresponding square planar one for the d8
electronic configuration that means we will see   for the triad of ni two plus the bivalent nickel
the bivalent palladium and bivalent platinum   these are all in the series of the d8 electronic
configuration they can have this particular   arrangement and the other alternative arrangement
is the corresponding tetrahedron formation of   the tetrahedron and we all know that there are a
large number of tetrahedral cobalt two complexes
so far we are discussing cobalt three once we
get it as a cobalt tree we stabilized in the   octahedral geometry
so the coordination number is
high when the oxidation number is also high which   is trivalent in nature but if the oxidation number
is less which is plus two we can restrict the   corresponding compound to a tetrahedral compound
and this is the well known example already we know   this about the tetra carbonyl species of nickel
zero
so it has a tetrahedral geometry not a square   planar geometry
so it is basically preferring a
geometry where the corresponding hybridization   scheme will see about the corresponding valence
bond structures and all this when we study that   that this particular arrangement is favored
compared to your square planar arrangement   then if we write something that one particular
compound that we instead of write this thing   as the tetra case
so b stress and tetra keys we
all know that the nomenclature what we are using   that means when we have the two ligands we call
as the breeze already if we the name contains some   ethylene diamine type of things ethereum diamond
is the abbreviated zen of the ethylenediamine
so ethylene diamine
so diet the term dye is
already there within the name of that ligand
so when number of such ethylene diamine
present around the metal center is more   that means we have two ethylene diamine moieties
we can call it as a base ethylene diamond   complex of that particular metal ion
so we'll

bring that base then similarly if we have three such species like that we just now
we have seen that if we can have the cobalt tris ethylene diamine cobalt three
so which is a trees complex
so this this means we have two ligand three
trees means we have three ligand then tetra case will immediately tell us if we know the number
that it has four groups of those ligands surrounding this particular center
so tetra
keys triphenyl phosphine palladium and just if we miss the oxidation state we should also
be very much careful about the oxidation state if this is missing that means the palladium
oxidation state is not given to you how you can identify that what type of oxidation state you can
have over there is that you have this particular one
so what is the nature of this ligand
so you
should be able to know what is triphenylphosphine
so triphenyl phosphine is nothing but pph3 it
is like ammonia where ammonia is there nitrogen attached to three hydrogen atom similarly if the
phosphorus is there like phosphine is analog of phosphine where you have the ph the ph because instead of this ph bond we
have now ph bond that means p carbon bond
so that p carbon bond has some extra stability thats why
it is a very good ligand and very useful ligand useful monodentate ligand and if we surround these as the
four number
so if we have the tetrahedes triphenyl phosphine
so like ammonia we are not able to
get any charge out of this triphenylphosphine
so therefore if the overall complex is
neutral then palladium must be in zero oxidation state and that is the corresponding
affinity like that of our carbonyl affinity to the nickel zero center
so the palladium also
has some affinity palladium zero also has some affinity to try phenyl phosphine to give you
the tetrachase triphenyl phosphine compound
so this is the very beautiful compound in a
petri dish we call this this as the petri dish
so but it is the sample we usually take
out it in and is a very beautiful color
so coloration what gives us that is also something
that you have a triphenylphosphine compound of palladium where four such triphenylphosphines are
attached to this and it has some good role to play in organic chemistry in industrial chemistry
because it will have some catalytic role and the same tetrahedral arrangement here also you
have the same tetrahedral arrangement we get having some this triphenylphosphine which

are basically some amount of umbrella
so this is basically entrapped within the
arrangement of four triphenyl phosphate unit and that means these are if we consider that
is that is a three-fold symmetry that is one umbrella on this side the second umbrella on
this side the third umbrella on this side and the fourth one on the other side
so you will have
basically a four umbrella and which basically trapped inside because each triphenylphosphine
of three phenyl rings
so three into four twelve phenyl rings are surrounding this particular
nickel center which is basically entrapped within a very orga very good organic moiety
which is connected through phosphorus at atom
so the other alternative for
this coordination number of four is is the square planar arrangement and is very much important that if we just consider that corresponding compound which
is n i b r two p p is three hole two which is very good a catalyst and which is used
by this scientist walter repay for the synthesis of acrylic esters from alkyne carbon monoxide and
alcohol which is very good application for this but is again like that of our palladium center
is a basically typically a compound where your two bromide centers are there and two of them
first pens and they are will all be in the planar arrangement
so if we just consider these two
are phosphorous groups and these two are bromide groups is basically a typically a corresponding
planar arrangement but in case of this chloride groups that means if we bring this from bromide
to chloride we get this which is a tetrahedral one and ah complex of nickel which is spin triplet
that means pin triplet is nothing but you have two unpaired electrons and the multiplicity we all
know that the corresponding capital s value is one and the corresponding multiplicity of
that spin state will be twice s plus 1 which will be equal to 3 that means is the
paramagnetic compound and paramagnetism of 2 electron which give rise to the identification
that it is a tetrahedral molecule but if we consider that it is not that for palladium
it will be square square planar enhancement
so we get that as the contrasting thing for these two compounds
one is the corresponding chloride compound around nickel and another is the chloride compound
around palladium and in the palladium size is basically dictating and the corresponding bond for
the palladium phosphorus is also dictating that you will end up with a square planar arrangement
you will have some theoretical justification also when we talk about the

bonding in terms of balance bond theory and the crystal field theory but now you can think of it as a experimental reality if you do the reaction will end up with this product which is tetrahedral in nature in shape in geometrical shape and this will be square planar in shape then the next one will be your penta coordinated one which is a very nice compound of acetyl acetone again useful by dented ligand only thing that the stability on v o the v double bond o the b o double bond part we are taking out and this particular part is very useful to understand that you have a square base coming from that double oxygen bond of the acetyl acetone group so this is the double oxygen from the acetyl acetone group and this is the other end of the acetyl acetone group which is the bidentate o ligand the other one is also a bidentate o ligand fulfilling the square plane but the square plane is not perfectly square plane because the vanadium will be little bit above of this particular square plane with a corresponding vanadium oxygen double bond so towards this vanadium oxygen double bond this banana is little bit above to this particular square base which is formed between the four oxygen of the two acetyl acetone moiety and the reaction is also very simple from the experimental point of view that we can react it with directly with the vanadium pentoxide and the vanadium pentoxide is basically getting reduced to a vanadial compound of acetyl acetone and with the oxidized form of the ligand with the elimination of so many water molecule and it has also some application so the application wise this particular compound not only in terms of knowing this as the corresponding metal complex but is also very useful in understanding its ability as a catalyst because v 2 o 5 we all know which is required for your contact process of making sulphuric acid so vanadium is a very good catalytic site in terms of the metal ion and we can exploit that particular ah reactivity of this vanadium center by binding to a ligand which is the bidented ligand not like your ethylene diamine but is acetyl acetone ligand and you go down to another oxidation state which is a tetravalent oxidation state and that tetravalent oxidation state would be useful for a typical epoxidation reaction of allylic alcohol in combination with some tertiary butyl hydro peroxide because this hydro peroxide is responsible for some double bond c c double bond some allyl group is there so allylic

alcohols are there
so allylic alcohols are there like allylic amine
so this double bond can be
going for the corresponding epoxidation using the tertiary butyl hydro
peroxide which is the source
of organic peroxide supplying that oxygen for the epoxide formation okay
so this is the example of a
coordination number of five for a particular metal ion and as a catalyst its
application because
the center is vanadium okay thank you very much you