hello good morning everybody in this class of
d and a block element this is the second class we will be continuing what we are discussing last
time about the different properties
so this d and f block elements but right now we are just
concentrating or focusing our attention on d block elements and in this particular case we are talking something which is enthalpy of
atomization
so that enthalpy of atomization such that we get
atoms from all these metals can tell us two different things that if
they can have very high atomization enthalpy atomization enthalpy
so that
can have different consequences and those consequences what i told last time
is that they can have high melting point and high boiling point and the
melting point part also we have
discussed among the group which is chromium molybdenum and tungsten where we have seen that
the corresponding melting points only if we look at the melting points in
degree centigrade one
is 1903 next is 2620 and for tungsten it is 3 4 1 0
so which is very high but if we consider that
there is some trend
so trend down that particular vertical line and we also know that there
will be some trend in the horizontal line also
so whatever we find in all these cases that
means what we are discussing for the 3d 4d and 5d elements can have the
corresponding horizontal trend for different physical properties and
also we can have some vertical trends and these will definitely correlate
something related to the corresponding electronic
configuration
so going from chromium molybdenum tungsten if we go to the extreme
right on the extreme right side we have zinc cadmium and mercury and by defining
them in terms of the corresponding d electron configuration we already defined that
these are not in the class of d block elements so zinc cadmium mercury will not fall in
this particular trend
so they will have correspondingly very low melting point
so zinc
will have 419 degree centigrade melting point cadmium will have 321 degree centigrade melting
point and mercury definitely we all know that this is liquid
so it is minus 38 degree centigrade
so down this line and on the other
side we can have this the maxima we are obtaining here
so it is the maxima and it is the
minima in this particular point
so related to these things that how the enthalpy of atomization
can change and other physical properties also
so coming back to the different
other physical properties we can see something where we just considered for
these d block elements that this d block elements how they are changing for
their different

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chemical characteristics at the same time

so if we just consider their physical characteristics at one point of time will also be getting some information about their chemical characteristics and as we all know their occupancy of the electrons in different d cells

so as we know for the main group elements the s block and p block elements the electron transfer reactions and the reactivity is also particularly same with oxygen say fluorine and all that can be controlled by the different number of d electrons in all these different cells

so d cells basically and their occupancy will control the definite chemical characteristics of all these elements and particularly these are all metals that means the d block metals they can also have something which we will discuss later that occurrence of variable oxidation states which is not very much available for other type of element that means the main group elements

so in a particular condition only the main group elements like nitrogen like chlorine they can give variable oxidation states but these are all metallic elements or the metallic components which can have the different oxidation states

so what we can do we can have a particular electronic configuration for a metal ion say iron say nickel or copper and during this particular process that means the electron transfer reaction that means the simple oxidation reaction what we have seen earlier the dipping the zinc rod in aqua solution or water can give some electrode potential and due to that the zinc can lose electron and zinc can go to zinc 2 plus in solution

so that particular tendency or inherent tendency is there and those are due to the losing of electrons from the s cell or the d cell when a particular metal ion say nickel in plus two oxidation state we all know that it has a corresponding electronic configuration of three d eight

so that particular electronic configuration if it is stable enough we cannot go beyond that oxidation state that means the plus three oxidation state or we cannot reduce very easily that particular oxidation state from nickel two plus to nickel 1 plus but if some situation can arise in presence of some other groups which are bound to the nickel center we can get some other oxidation state that means electron transfer is possible

so the nickel like other metal ions also the 3d elements they can go for the different oxidation states also if

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we
at all get the oxidation states in one plus or two plus or three plus we can say that
nickel is also undergoing something where we can have the variable oxidation states for the different nickel ions and once we get this particular compound in the that for that particular reaction
so they also give compounds as
we have seen that particular dissolution or the reaction of the corresponding oxides or oxide like ores or minerals which can give rise to the corresponding salts when zinc
oxide is dissolved in some mineral acid say hydrochloric acid it gives zinc chloride in
solution and during crystallization of that solid zinc chloride can be separated out from the
medium
so it would be a corresponding compound of zinc 2 plus similarly for iron for cobalt we
can have the corresponding compounds from the metallic state that means the metal zero state
or the corresponding oxides or sulfides type ores such that in these compounds these metal
ions will be present as the corresponding ions suppose if you have a ferric compound
the ferric ion will be present as fe 3 plus and depending upon is corresponding number of
groups attached to that particular central metal ion we can have the different structures
so how we
determine that particular structure or elucidate structure also particularly when we talk about
the corresponding structure of the solid state structures of those compounds such as those oxides
so you know that very two commonly occurring iron oxides which are also available as mineral
which is hematite fe2o3 and magnetite fe3o4 but the solid state structures of those can
be different because we can have these are the typical ionic compound within that oxide lattice
so in the solid state courses or the solid state structure you have studied this that depending
upon the corresponding filling of the solid state area or the solid state space we have the oxide
lattices and inside those oxide lattices we have some vacancies and those vacancies will be
occupied by the ferrous ion and the ferric ion and the particular physical properties which
is originating basically from the different dn electronic configurations d1 to d9 for
these series of metal ions
so this particular physical properties what are those physical
properties one of the most characteristic physical properties will find it out in the solid
state we can have the magnetic properties the magnetic moment we can determine for all these

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compounds and once we dissolve this particular metal or the metal salt in solution we know
that most of them are colored
so this is one more important or the most characteristic
property of these d block elements that they give rise to colored solution so the coloration is another factor which we can use to identify the different types of metal
ions will see from starting from vanadium to copper will find depending upon their oxidation
states and the type of the metal ion we have some definite colors and all those colors can be very
much characteristic for those metal salts
so once you dissolve nickel suppose nickel sulphate in
water we know that that will impart a particular color to the solution and that is mostly
characteristic for that particular metal ion so these are basically originating for the different
number of d orbitals and their occupancy by the different number of d electrons
so what we
get basically about the other physical properties or more type of other physical properties that
if we have like that of your periodic table the left hand side on the right hand side and
the upper part and the lower part
so along this particular group if we just see this is the thing
that enthalpy of atomization just we are talking about the corresponding melting point of the
highest possible melting point for the tungsten
so they have mostly very high enthalpies of
atomization that's why they are having very high melting point and boiling points and if we
just simply plot in this fashion this has been taken from your book then crt book this plot is
there but you have to go through this particular plot at least what type of plot we are getting
if we simply go for the corresponding changes along with the atomic number and depending upon
the different d electron configuration because these atomic numbers will be different depending
upon the different d electron configuration for the first series for the second series and for the
third series that means 3d elements 4d elements and 5d elements
so d1 to d9 or d10 electronic
configuration will give rise to the corresponding change
so the green line what we are getting over
here
so that change in green line along this one and it is in the middle part of the thing that
means it is in the corresponding manganese system
so manganese in the middle of this group in the
3d series
so there is a dip basically and the enthalpy of atomization is falling below
so these

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are basically a characteristic property for this electronic configuration which is also true for the four d elements and also true for the five d elements but we should have some overall idea or overall information about the corresponding double hum nature this is typically a double hump nature for filling off from left to right from d1 to d5 and d5 to d9 or d10 electronic configuration from left to right so where we get that maximum and the middle of the series indicate that one unpaired electron per d orbital lead to strong inter atomic interaction once we start from a d zero system here we have node electron then we get a d1 system this is the d2 system this is the d4 system this is the d5 system at the bottom so once we have because the filling off of all these single electrons why it is single electrons because we are having five d orbitals or the five d levels are there so the first electron will go to the first d orbital then the second then the third and then the fourth like this so when we have more number of unpaired electrons when in a particular situation we have three d five electronic configuration we all know one will be discussing afterwards also that a 3d5 situation which we call as a high spin situation are all the five unpaired electrons are occupying five different d orbitals so you have large number of unpaired electrons and one electron in each d orbital giving rise to strong inter atomic interactions so if you have a very strong inter atomic interactions like that of our chromium so chromium will have also six electrons but all of them are not unpaired but large number of electrons in chromium in molybdenum and tungsten may lead to strong inter atomic interactions so this strong interatomic interaction may lead to a very high enthalpy of atomization so enthalpy of atomization is also increasing in a order by going from left to right and maxima in the middle indicate that one unpaired electron part d orbital is important and once we have the greater number of valence electrons that those valence electrons in the penultimate cell that means the d level when it is chromium molybdenum and tungsten we have six six six electrons in 3d level 4d level and 5d level so they also lead to the strong intermetallic interactions the strong inter atomic interaction and strong intermetallic interactions leaving behind to us a strong metallic type of bonding

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so a corresponding conduction band due to metallic bonding is achievable and we can have the corresponding conduction band and the valence band and their separation in the typical metallic bonding type of thing and the corresponding properties of these will also be related to their corresponding sizes

so atomic sizes of these elements and all other transition elements are also important if their sizes are comparable what we can also see that this metallic bonding can also be helpful for alloy formation

so if we can have two different metal centers are there and we are looking for some solid state structure where alloying can take place or mix solid state mixture or solid solution or solid state solution if we can get then there also we can have a very strong corresponding metallic interactions or metallic bonding and this particular thing that means the enthalpy of atomization

so enthalpy of atomization will also be important when we talk in terms of the corresponding contribution for electron transfer

so once we get from the bulk metallic state to the atomic state like that of our system when we know that a particular thing can also be vaporized to the gaseous state and we all consider that the electron transfer or electron acceptance can take place from one side to the other in the gaseous state similarly after this atomization process that means metal in the bulk is going for m zero that means the atomic state single single atoms are there and if we just go for their corresponding electron transfer reaction that means we are talking something related to our scandium or titanium whether those metal centers can be oxidized nicely to scandium one plus scandium two plus candium three plus similarly for titanium also for titanium we can go for electron transfer because it has a corresponding atomic state electronic configuration is s two d two

so whether we all be able to remove all the electrons in a stepwise manner that when we move one electron from the s level will remaining with one more s electron and two d electron but if we are able to remove all four electrons if we are able to remove all four electrons then titanium will go to a corresponding oxidation state of titanium four plus

so this will again once we discuss about the oxidation state and the corresponding enthalpy for the atomization also can contribute for the corresponding ah ionization process

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so the ionization process is also important for knowing the corresponding electrode potential of the metal
so metal first goes to the atomic state for the going to that particular atomic state we require to talk about these enthalpies of atomization so
enthalpy of atomization is important contribution for metal to go from the bulk state to the
atomic state and then that atomic state that m zero can go for electron loss to go to m1 plus
then the second step or the third step that means the first step of ionization or the second step
of ionization or the third step of ionization is related to the different e zero values
so e 0
1 e 0 2 and e 0 3 for first electron transfer for second electron transfer and for third electron
transfer to occur
so already we have seen that if you have a very high enthalpy of atomization and
that high enthalpy of atomization do contribute to the melting point
so metals with having high
enthalpy of atomization also we should know that they have also very high boiling point are noble
also noble means that they are not very reactive
so noble metals we all know that gold is a noble
metal platinum is a noble metal
so all these metallic states
so they have basically a different
type or different amount of this atomization
so high enthalpy of atomization
together with the corresponding electron transfer potential that means the standard electron transfer potential make them a energy greedy substance or energy grid species
where in both the two states that means both the two processes that one is the atomization process
and second is the electron transfer process both are very high if both of them are very high we
are not able to get very quickly the corresponding atomic state and also we are not very much ah
easy to get that corresponding one where we get that corresponding electron transfer very quickly
so metals if it is possible then go for the atomic state but they will not undergo any reactivity
for going to its corresponding oxidized form that means the gold in the plus one state or the
plus three state
so along with this that means why we are talking about this gold and ah platinum
because we are just discussing along with the 3d the 4d and 5d containers also
so if we have
these that means we can have the early elements in these groups
so we have a family
of 3d elements then a family of four d elements and a family of five d elements

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so this is 3d this is 4d and this is 5d
so in terms of the corresponding atomization
process we also see the high ah atomization enthalpy will also consider that is changing
that the property is changing along this line
so within the 3d elements we can compare their
corresponding melting point and the boiling point and there we will see that the reactivity pattern
so from the left hand side that means in this particular state that means where we have the
scandium we have titanium we have vanadium from the 3d series
so these are basically we can
call them as the corresponding early elements
so these are all these early elements are
highly reactive
so thermodynamically they are reactives to what
so if we say or if we write
that they are thermodynamically reactive
so reactive
so what reaction reaction is in
the atomic state also that means candium zero titanium zero and vanadium zero will be very much reactive towards other electronegative elements like that of our
oxygen and fluoride
so what we get if they are reactive even if you do not
have the corresponding ionic state from the elemental state that means why they are
not getting in terms of the other elements what we are defining just now as the noble elements
or the noble metals
so where we have the noble metals and why these we are calling as noble metals so
if the early transition elements for 3d for 5d for 4d all cases they are highly reactive so
this is a thermodynamically driven process where we go for the bulk metal
to the corresponding atomic state and this can undergo corresponding oxidized form 1 plus scandium 2 plus or scandium 3 plus
so what
we are saying over here that they are reactive and they are reactive with say other electronegative
elements such as o2 minus such as f minus chloride etcetera
so nature will do that particular
reaction that means the reactivity with that of o two minus f minus and c l minus we get as a
result from this reaction with o two minus that oxide minerals
so these oxide minerals are hard oxides and fluorides also
so we can have also the fluoride also why we are getting these as the corresponding
thing which can show the real reactivity because they are harder anions
so their charge is highly
concentrated their size is small
so we require hard anions for this
particular reactivity and we all know that this this reaction is basically coming from

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electron transfer to your oxygen from the gas or the environment or from the air
so this can
also be available from f two
so electron transfer from this particular species that means the f two after gaining electron can give fluoride o two can also give rise to the o two minus but the ultimate
reaction is that the metallic state can react with o two the metallic strain can react with f two to
give these fluoride minerals but what about these
so if we just simply consider these conditions
or these properties to the early elements
so those properties which is directly attached
to the early elements are really violated when you go or when you move towards the other end so
noble metals will be what then the noble metals we simply define since we are talking about the
corresponding reactive they are extremely reactive or highly reactive which is also a thermodynamic property
so the thermodynamic quantity which is the
reactivity towards oxygen or towards fluorine
so that will also tell us that
these noble metals are less reactive
so if they are less reactive
they basically remain as in the metallic state whether it is in the bulk metal
steel or in the atomic state
so they basically provide something where we consider these metals
as noble metals or coinage that means the material or the metal which is used for making coin
so they are the corresponding coinage metals
so these coinage metals are there for the
noble metals because they will not react and if at all they react they will have some
tendency to softer grooves that means the softer anions such as sulfides
so sulfide
is the softer anion
so basically softer anion if at all they react will provide
some material like that of your oxide minerals and fluoride minerals
will end up here as sulfide minerals and that particular sulphide mineral
if at all we get is true for copper is true for silver is true for gold
so copper is the member of the 3d silver is the member of 4d and gold is the member for 5d
so their reactivity is very less
so what about if we just see on the
right hand side and if we compare from that of the left hand side and now if we just move for the other elements in the 5d and 4d elements
so this particular group
have also suppose we have here the iron we have cobalt we have nickel
so we know
the other containers the iron we have ruthenium we have osmium and for cobalt also we
know that this is rhodium then we have iridium and for nickel we the next element in

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the periodic table will be palladium   and platinum
 so if we take this particular
group also and if we like to compare that   particular elements with this as in terms of
the atomization energy
 so in terms of those   atomization energies for these
 so in terms of of the atomization energies for these six elements
 so experimentally
determine quantity what we can get   they can have which are four d and five d elements
 so these 4d and 5d elements   luthenium osmium rhodium iridium palladium platinum they also have high atomization energies
 so this can therefore can control can dictate the
property of these elements
 so the whole group therefore
 so this ruthenium rhodium palladium then osmium iridium and platinum
 so these six metals if we form a class they have high atomization
energies when we compare their atomization   energies and they belong to four d and five d
elements and therefore the last member of these   that means the platinum we all then call
that as the platinum group metals platinum group metals because their reactivity would be less
they little bit they will be comparable to our   copper silver and gold and due to that high
atomization energies they are not like this   nobility in terms of the gold copper and silver
but they are also of different properties so   they are have some correlated reactivity
pattern in this platinum group of metals
 so when we see that the nature that means when we
find these in the mineral this is the nature will   give us those minerals that means oxide minerals
and the fluoride minerals we get from the nature
 so they basically occur in nature also
together
 so these all these elements they occur in nature together and since they can have also comparable sizes
size is also an important factor for all   these properties
 so the atomizer energies are
similar their sizes are also similar sometimes   they also form very good metallic alloys
 so they
are also useful for giving metallic alloys for the   metals in the platinum group
 so just we have
seen in that way that the metallic bonding so   this we already told you that the metallic bonding
in tungsten
 so when the tungsten is only there so   that is the highest possible melting point for
a metallic species and which can be exceeded   only by the other species which is carbon and
with increase in principal quantum numbers the   special extent of the d

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orbitals increases
that means the size of these d orbitals or the d cell in space is increasing
and
since this is increasing
so if we find that one 3d orbital is approaching to the other 3d
orbital to form some bond for a type which is known as the metallic bonding
such as we
find in tungsten but in case of tungsten that would be a interaction which is
chromium
molybdenum and tungsten down
so tungsten belongs to the category of d elements
so we will
have interaction of five d five d interaction which is higher than that of our
forty forty
interaction which may be present in molybdenum and which is still further less
ah for the chromium
chromium interaction
so as the size of the d orbitals are increasing their size in the space
that means the spatial occupancy is increasing
so as it increasing they can consider for the
higher degree of overlap between these orbitals
so the trend in the overlap for metallic
bonding would be 5d 5d will be greater than 44d which will be greater than
also for 3d 3d
so heavier metals therefore thus exhibit many more compounds containing metal
metal bonds
so which is also true because we will not have that much time to discuss about
the
compounds having metal metal bonds but if we just simply what we are talking
about the metal metal bonds or the metal metal interactions in the metallic
bonding in
the metal itself
so there will be some discrete compounds the inorganic compounds we can have
where we can have metal metal bonds and sometimes we can have metal metal
multiple bonds that
means the double bond between two metal centers a triple bond or a quadruple
bond even
between these two metal centers so if we consider that these metal metal
bondings are
there
so other positions we also consider those as the ligands attached to this
first metal which
is m one and which is on the right hand side m two
so other ligands will also be there and those
ligands can also give rise to some the bridging unit
so those clusters which is very common
for the different types of carbonyl clusters or some simple salt like ranium
chloride salt
so tetrachlororenate if we consider
so that is a different type of compound or different type of
proposition but when we talk that in terms of a simple metal salt
so if simple metal salt we get
by dissolution of the ore or the mineral in acid
so zinc oxide dissolution in hydrochloric

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acid or iron metal rod in hydrochloric acid will give rise to the corresponding chloride salts
so those chloride salts are always there and those chloride salts are not the whole thing that means
it is in the solid state entity
so if we have metal chloride which is divalent
so metal
center is in plus two oxidation state or mcl three metal center is in trivalent state
so any metal salt say it can be our nickel
chloride will discuss in detail again
so any metal salt like nickel chloride like palladium chloride
or platinum chloride
so they are basically solids
so it is a solid material
so that solid material
can have some different type of structure but when that particular solid metal salt is
dissolved in aqueous medium or water what we get we get something that means we have the
nickel the nickel is present as nickel 2 plus and side by side the remove
chloride ions will be there but we do not know whether we have
some existing nickel chloride bond
so in this particular case the nickel
chloride bond whether it is present or not but if we see that we are handling
some nickel chloride nicl two only so per nickel that means nickel in in
two plus oxidation state we can have at best two chlorides attached to it but if
we like to have something that means if we add more chloride because chlorides will be discussing
at some point the chlorides are very good ligand which can bind to the metal centers that means
the metal ion center
so this metal ion center if it is allowed to bind more chloride a species
can be formed which is nicl4 two minus
so which is tetrachloronicelate two ion
so that
tetrachloro nickelate ion which belongs to the 3d series
so if we go for other groups that means
we know that the series in manganese technician and uranium
so in manganese technician
uranium again all of them can give rise to chloride salts and this particular rhenium since
it is a bigger one and it belongs to 5d element and if we are trying to have some species
like this that means tetrachlorine nickel at salt of that metal ion
so tetrachloro
or further
so tetrachloro or further metal salt will be a difficult proposition for
uranium where if we can consider that in the discrete metal compound we can have the
metal metal bond that means in the discrete compound we can have rhenium uranium bond we do
not know how many but you can have the interaction and we see that we can have

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the chlorides
are bound like this
so apart from this   that in which geometry because
that will discuss also later on   that if you have the geometry
so depending upon
the geometry if some space is allowed and these   two uranium groups can be
pushed together like the
metallic bonding in metal
so in free metal in the   free metal if you have the metallic bonding
so free metal will give the metallic bonding and if that sort of interaction is
still present in ionic compound these   are ionic inorganic compounds
so we can
still have some metal metal interaction   which is only present when you have
bigger
5d orbitals
so the 5d orbitals will be bigger   then only you can have the 5d5 interaction
which
is not present in case of 3d orbitals and which   is also not present in case of
4d orbitals
so that
is why we are just considering this particular one   as the heavier metals like
uranium
in the group of manganese can have m   m bonds
so that is a typical proposition and that
has been established experimentally by determining   the corresponding
structures and structure
will also tell that you can have a very close   rhenium rhenium separation that
means
we can have the rhenium rhenium bond
so this particular thing that means what we
are just now telling that when we get the ions   that means the nickel two plus
we are getting
from nickel chloride
so the ions of the same   charge in a given syringe that means all
of them are bivalent from left to right   from scandium 2 plus to copper 2 plus
if we just
have in a given series when we get that the same   charge
so the progressive decrease in radius
with increasing atomic number
so the charge is   all cases will be 2 plus
so that particular
charge we are considering that means the   positive charge we are not changing
much if the
size is also not changing much what is happening   the nuclear charge is
changing the atomic
number is changing from scandium to copper
so that atomic number change that means from
scandium to titanium what we are getting
so increasing atomic number will keep the positive
nuclear charge
so the positive nuclear charge   will attract the electron density or the
electrons
in the different orbitals
so the corresponding   ionic size will basically go for in the decreasing

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trend
so there will be more attraction due to the   presence of higher effective nuclear charge
so the higher and effective nuclear charge   will decrease the size of all these ions so
that will have a particular advantage also   and we will find afterwards when we talk about the
coordination compounds that the size also plays   some important role if we want to have some
interaction for the metal ion and the ligand   that means the coordinate bond is forming between
metal ion and the ligand
so that particular metal   ion size will also contribute to define the
corresponding distance between the metal and the   ligand if it is a simple coordinated coordinate
bond between metal and the water molecule
so metal and the oxygen bond is also important and
that metal oxygen bond length is also important
so the size that means whether it is a scandium
bivalent scandium two plus and whether it is   a copper 2 plus
so the scandium oxygen bond
and copper oxygen bond we can compare keeping   in the mind that what is the corresponding ionic
radius of bears candium 2 plus and copper two plus   and because of this when we move for
one after another electron occupancy   the electrons are entering the d orbitals the
different d orbitals we know the five different   d orbitals will be available to us and each time
you see that the nuclear charge is increasing by   one unit as we move from scandium to titanium
titanium to vanadium till we reach to copper so   the selding effect of the d electron is also not
that effective and due to that ineffectiveness of   the shielding property of the d electron the size
is basically decreasing why this particular radius   is decreasing because the selding effect is less
for the electron and all the incoming electron   starting from your scandium to copper is only
entering d level
so the nature of the electron   is same but your nuclear charge is changing much
so nuclear charge is changing from 21 to 29 so   that basically squeezing the size of all these
ions
so this same trend is also observable for   other series also
so atomic radii for a particular
given series as we see and the variation within   this series is also therefore quite small so
unlike your s block and p block element in the d   block the ionic sizes are not changing mass
and we expect the properties of all these   things will be mainly controlled by the number of
electrons present in the d level

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so size will not a matter of fact for identifying the corresponding behavior of all these elements or the metal ions
so definitely what we have seen earlier that there will be variation in the different
atomic sizes of the transition metals
so as we move from left to right this is once
again another figure which is there in your ncrd book and you should again recall back while you
study the book that you follow the corresponding variation that this particular plot what is this
plot you should always be remembered in that fashion that is the change in the atomic sizes
not ionic remember it that it is the change in the corresponding ionic atomic sizes where these metal
ions from scandium to mercury say all are present in the zero state or the metallic state or the
elemental state
so scandium zero to marker is zero and your radius in in the nanometer scale here
in this size it is in the nanometer scale so why we are talking this because we are simply
comparing obviously the size is less for your 3d series compared to your other
series
so 3d is in green colored then this is blue and red
so the size of the
3d element that means the scandium to copper
so scandium in the atomic state that means
candium zero to copper zero or even zinc zero if we consider that there is a continuous
and a progressive variation till we reach to say cobalt or nickel which is 3d 8 and 3 d7 so
then as we move from nickel to copper there is a slight increase and then up to zinc we just have
a little bit higher increase to this particular value which is below 13 nanometer to above 13.
5
nanometer
so obviously there will be an increase from the first to the second
so as we move as we
side by side compare
so this is chromium this is molybdenum and this is tungsten similarly this is nickel this is palladium and this is platinum
so the difference in this particular scale on
the right hand side is very easy to remember also that if you simply compare the size in
nanometer as you are here which is copper and from copper you directly move to silver and
then to gold you see this silver and gold they these two are overlapping like that of our cadmium
and mercury
so this silver and gold their atomic sizes are same almost
so this separation between
4d and 5d atomic state for those transition metals are very close compared to

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the 3d
so as we move
from 3d to 4d the radii for this 5d series are virtually the same to that of
our 4d series and
the corresponding members of the second series so this particular thing that
means this gap is very
high
so you see that this from nickel to palladium from nickel to palladium this
separation is much
which is the maximum separation between nickel and palladium but between
palladium and platinum these
are close by and these are very close to each other
so the property wise what we also expect
that this particular properties which related to the atomic size of the metals
will be completely
different for nickel but in terms of the size difference and teams of the
properties related
to the size the atomic size of these elements the palladium and platinum are
very close by
so the
properties related to those thing will also be of similar type
so these all these things will be
there that is associated with the intervention of 4a orbitals
so as we move here starting from this
lanthanum
so the second element from the lanthanum here we just put what is the we are
putting the
corresponding four f orbitals are the four f elements
so the lanthanum and the other series of
fourteen elements is the corresponding lanthanoids
so lanthanoids are putting over here
so why these
two are
so close we see the jump from here to here but we don't see any jump from
here to here
this is because of putting the four f orbitals or the lanthanoids in between
and these lanthanoids
when we give the corresponding electrons
so this associated intervention of these four f orbitals
will be there
so what we are seeing here is that that the corresponding separation for the
different atomic sizes as we move from nickel to palladium is very high
so this much gap in
terms of the corresponding nanometer in this scale that
so size is increasing from nickel to
palladium but is not changing much for platinum
so these two sizes are very close by and this
particular one we see why as we move from palladium to why this change is not
there this
is due to the corresponding incorporation of the corresponding lanthanum or
the lanthanides
or the lanthanoids
so after this lanthanum we have a whole 14 elements by filling up of all the
seven 4a orbitals two electrons in each orbital will giving 14 elements in

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between
so those 4a
forbiddens will be filled first because these are   lower in energy before the 5d series is filled so
we start from here until we reach the end of the   series then the 5d series filling off will take
place from hapniam to tantalum to tungsten to gold
so this will basically will not contribute much
and there we see we will discuss again when we   talk about the lanthanoids or the lanthanoids so
this will discuss that the lanthanoid contraction   we call something
so instead of increasing
the size the atomic size instead of increasing   due to that lanthanoid contraction there will
be some decrease basically contraction can   take place as we fill all the 4a orbitals
so after filling of all these 4a orbitals   we go to 5d series and this particular 5d
series filling up will take place again like   that of the filling off of the electrons in the
scandium and in the case of zirconium or atrium
so that will therefore not contribute
much as we move after four f
so that   is why these two series that means the 4d
and 5d series their atomic sizes are very   close by and just now what i told you that we
can define basically also by stating this line   that the filling of of four f orbital before
five d orbitals
so five g orbitals we are not   able to touch the filling of of all
these electrons from hapnium to gold   we are getting something that the lanthanoids
will be filled first and this pacific results   in a regular decrease in atomic radii
so atomic
radii since we are talking about atomic sizes so   atomic radii will be decreasing in that particular
fashion and we call it as a lanthanoid contraction
so if we see that then we can have because
since we are considering this
so along the group   will be seeing afterwards also when we talk about lanthanoids
so during that particular series also   we have a different type of plot definitely
but after lanthanum because we are just simply   jumping the lanthanoids and after jumping we see
that same shape is also almost same particularly   these two are very much correlated 4f
and 5 4d and 5d are very much similar   only 3d is little bit different that their exact
trend is very much similar whether you have   a bottom line of f orbital that means in the 5d
case we have the 4x level but in this case we   do not have anything related to that 4x type of

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thing
so this is therefore very much important and the size is also contributing something in
terms of the corresponding lanthanide contraction
so what we get that the consequence is there the
consequence of the lanthanoid contraction is that the second and the third d series elements which
are basically overlapping to each other one is the member is the zirconium and another is the member
of the hopnium but if we critically compare these two values one is 160 picometer or 1.
6 angstrom
and another is 159 picometer or 1.
59 angstrom
so these two sizes basically is very similar in
there chemical and physical properties and they are expected on the basis of their usual family
relationship because they are in this particular group but the problem will come because the
separation of these that means the we talk about in terms of the corresponding four d and
five d element but if some mineral is there if both of them are occurring together
so size their
chemistry and their physical property similarity will not help us much for their corresponding
separation of this zirconium and hopnium species
so this density is also related to that why we are
talking all
so much about this size
so density is also a relating factor for these elements so
again this values are taken from your book
so density in gram per centimeter cube
so drum
per centimeter cube is changing you see there is a large variation in this density and this density
will also some play some important property related to its physical behavior
so a decrease
in the metallic radius coupled with an increase in atomic mass results in a decay generally
increase in the density of these elements so as we see that the plot is seeing that the radius
the metallic radius is increasing and increase in the atomic mass is also increasing but that is not
overcoming the corresponding change in the radius
so for titanium to copper there will definitely be
a significant increase in the density
so scandium this is titanium
so titanium this is titanium and
this copper is in the range of nine basically nine gram per centimeter cube
so from three to four
to nine gram of this density chain is definitely a significant change
so one of the property
which is directly related to the metallic radius and we all know as we move

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from left to right
the atomic number is increasing the atomic mass is also changing
so definitely density is
also will be changing and we can consider that the metallic copper will be more dense
than metallic titanium ok thank you very much you

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