good morning everybody today we are
going to see what is chemical bond chemical bonds refer to a kind
of attraction between atoms it it is very important principle of chemistry so
understanding about the bonding is very
important to explain any property of a molecule for example take a carbon
dioxide carbon dioxide
is a greenhouse gas one of the greenhouse gases it is present in the
atmosphere it is not
allowing the heat from the surface of the earth to dissipate out as a result
the temperature
on the earth surface is increased but if you consider that it is not the only
carbon dioxide present in the atmosphere there are other gases for example
nitrogen and o2 are
present in large quantities but they are not called as greenhouse gases but
the com if you
look at the amount of carbon dioxide present in the atmosphere is 0.
04 percentage only but
it contributes to the global warming what is the reason it is something to do
with the nature
of the bonding present in the in carbon dioxide this is a carbon dioxide
structure
okay it's a linear molecule and okay and the central atom is the carbon
connected and surrounded by two oxygen atoms
so it is because of its chemical bonding
okay it it contributes to the global warming
so you know that heat energy is related to
the infrared radiations
so carbon dioxide has a bonding pattern in such a way in such a way
that it absorbs light in the infrared region which is related to the heat that
is the reason
carbon dioxide contributes to the global warming
so so you can from this but if you
look at that nature of the bonding in n2 or o2 they are not contributing it
is
because of the nature of the bonding in in them
so it becomes more important to understand what
is the nature of the bonding in each molecules how to understand the bonding
so if you look at the elements elements combine to form a molecules molecules
are lower energy compared to the elements
so after bond formation energy of the
molecule is lower compared to the elements why these are the things we have to
have
in mind to understand the bonding
so to explain the bonding
between atoms and let us consider the model
so called model from the
model called electrostatic potential energy model okay electrostatic potential
energy
model electrostatic potential energy model electrostatic potential energy model
so using um this electrostatic
potential energy concept one can explain the bonding between atoms
so under this
concept electrostatic energy is given by is directly proportional to charge
the problem given by proportion

the product of the charge q1 and q2 and then inversely proportional to the the distance between the charges
so electrostatic energy is once again directly proportional to them product of them charges and inversely proportional to the distance between them
so if you have a charge of negative negative sign and if you have a particles and its charge is positive okay when they approach each other because one particle is positive another particle is negative they are attracted to each other when they approach each other the energy is decreasing okay
so because the charge on one particle is negative and the another job another charge on the another particle is positive the product of um positive negative is negative
so energy becomes negative the energy becomes negative as they approach okay as they approach that energy will become further negative when the distance between the particles decreases
so energy is ultimately decreases when two particles of oppositely charged approach each other l becomes negative as the particles particles approach each other each other
so if we have yeah for example we take m a cation say as a plus is approaching um b plus sorry b minus when they approach each other there is a attraction between them energy is decreased as they as the distance between the these particles decreases
so and then it reaches a minimum energy where they are stable okay where they i where it attains the the maximum minimum energy which can be represented by a diagram like this this is a potential energy potential electrostatic potential energy in kilo joules per mole and this is the distance between the nuclei distance between the particles now if you say this is a energy is zero zero and then the particles are away at one time so there are two particles here is the a particle which is its charge is positive and here is the b particle its charge is negative and they approach each other okay
so the energy of the system decreases okay they when they approach each other energy decreases that can be represented by this diagram as it is like that
so they approach still more closer and closer to each other the energy decreases that's why i am putting the diagram the energy is zero above is and positive below is a negative
so it energy becomes negative as then it reaches a minimum and then it after that it increases okay
so as i explained before okay it's a product of charges the equilibrium energy is directly proportional to the product of charges and inversely proportional to the distance

so as particles approach each other the energy of
the system decreases and reaches a minimum here okay after that energy
increases again what is
the reason that is what you have to include if you take a particles okay or
ions it has electrons
and nucleus
so how much they can approach each other this much this much or this much no
they
cannot approach each other beyond certain distance okay
so what will happen if they approach too
close air there is a repulsion between particles because each particle has
electrons as well as
protons the electrons present on one particle repels the electron present on
the other particle
similarly the proton on one particle is ripples okay the proton of the another
particle so
as a result there is a repulsion between like charges okay that will lead to
an increase
in energy that is the reason
so as
so this is a particular distance okay energy is minimum okay
you know this is a energy at this distance ok and this is the distance at
which this is the
energy ok this is the distance at which this is the energy
so so at this point at this point
the repulsive and attractive forces are balanced okay if you go beyond this or
less than that
distance then the forces are not balanced okay
so it is that point attractive and
the repulsive forces are are in balance okay and the energy is minimum
so that
distance is okay is characteristic of each atom for example
so this this concept this model can
be used to explain the ionic bond as i said before you take a particle of a
pla a plus and b
minus okay because they are oppositely charged particles they approach each
other
because they are attracted to each other and then they have they form a ionic
bond
form they form ok they form ionic bonds ionic bond
so you can explain if the particle ok
um formation of ionic bond by this type of electrostatic potential energy
model okay
what about bonding between two neutral atoms for example for example um
hydrogen atom hydrogen
a for example say hydrogen atom a hydrogen atom b okay and then they form
hydrogen
molecule a hydrogen molecule is formed how do you explain that the bonding
between
two hydrogen atoms which are neutral by this model one can also explain the
bonding
between the two neutral hydrogen atoms by this model how because each atom has
negatively charged
electrons as well as positively charged protons

so it is possible for the atoms to attack each other okay
so then the same way one can explain the bonding between two hydrogen atom for example here the two hydrogen atom a and a are far apart they are well separated and there is no attraction between the two particles as as a result potential energy between energy for that system is zero
so that at this distance okay
so this potential energy is zero
so energy is zero
but as the distance decreases between the two neutral hydrogen atoms the energy decreases like this okay
so this is the distance of the energy the distance this is a distance this way the energy is this way
so energy decreases when these two particles approach each other and then reaches the minimum okay that this optimum distance between them at which the minimum energies this is a minimum energy is obtained okay after that distance any distance after any decrease in distance will lead to a um increase in energy okay that is what happening
so two hydrogen atoms combine to form a molecule can also be explained by this electrostatic model this is very general way of treating chemical bonding although there are several okay there are very good theories exist there we will see that later on but one can look at the bonding by this model as well it gives some general idea about chemical bonding
so as you can see here the energy is decreased at this distance now what is the distance for two hydrogen atom which leads to a which leads to a hydrogen ah a bond between two hydrogen atoms if the distance is the distance in this place it is a h a and h b okay
so this distance corresponds to 74 picometer
so any distance lower than this for example 73 picometer will be in higher energy okay compared to 74.

so that is the distance between the two hydrogen atoms
so that distance refers to
so called bond length okay the distance is 74 picometer
so 74 picometer is called is called bond length and the energy at that distance is energy is electrostatic energy electrostatic potential energy is energy is minus 432 kilo joules per mole
so that energy is that much energy is released when two hydrogen atoms combine to form a one molecule of hydrogen gas okay
so that much

energy is released urban
so you can see from this explanation that the energy of the hydrogen molecule is lower in energy compared to the its elemental form hydrogen atoms so that is the
reason bonded molecules are lower energy compared to the um elements from which the molecule
is formed from which the molecule is formed
so this is the energy
so that means as
you can see here
so this is a this is a distance at which it is energy now suppose
if you want to cleave this two hydrogen atom okay apart then you have to one has to give that
much amount of energy that is 432 kilojoules per mole energy to be given to a hydrogen molecule to
break the two hydrogen atoms apart
so that means that means 432 432 kilojoules per mole of energy is to be given to cleave to cleave the h2
molecule then you will have the elemental hydrogen atoms
so you can tell that 432 kilojoules
per mole is the energy of the the bond between the two hydrogen atom
so it is the 432 kilo iso
kilojoules per mole is the is the bond energy bond energy of of the bond in h in hydrogen molecule that is a bond
energy
so from this it becomes clear what is bond energy okay what is a bond length
so you have one hydrogen atom okay you have another hydrogen
atom ok let us say this is h a let us say this h b ok this is a nucleus this nucleus the distance
between the two centers of the sphere two hydrogen atom is 74 picometer okay
so that distance
refers to a bond called covalent bond this bond is called covalent bond
so as you can see here what is covalent bond
covalent bond is formed between two hydrogen atoms that is a one type of bond one
type of bond in chemistry there are several type of bonds another one
is the ionic bond covalent bond another one is the ionic another one is the metallic bonds there are other bonds hydrogen bonding there are
weak forces these are the three major types of bonds in chemistry using which one can explain or
one can understand the property of the molecules
so what is covalent bond covalent bond
is formed by um okay between two atoms for example in hydrogen molecule now um we have
some um idea about what is covalent bond we will see about covalent bond moreover more later on
now let us see briefly about what is ionic bond ionic bond is formed between two ions which can
also be understood by potential energy diagram and okay and then the when you consider ionic
bond it is basically formed between metal and non-metals metals and non-metals non-metals
on the right side of the periodic table metals primarily electropositive metals

on the left side of the periodic table
so when they combine
so they form a ionic
bond covalent bond is formed primarily by non metals as well as metallites
ionic bonds are formed between metal and non-metals another bond is called
metallic
bond metallic bonds are formed by metal itself
so if you consider um what is metallic bond if
you consider metals just for example sodium metal
so i am i am drawing the sodium metal as a circle
like that and then there is another sodium metal and then another sodium metal
another sodium metal
another sodium metal and then another sodium metal it has a nucleus they are
there everywhere
each atom circle each atom has a nucleus now um there is m these metal atoms
exist together because there is some bonding between them otherwise they
cannot exist
together what is the nature of the bonding in them that nature of the bonding
is called metallic
bond metallic bonds also involves sharing of what we saw just now is the
covalent bond in which
electrons between two hydrogen atom is shared which is very important concept
electrons
are shared to form a bond that is what called covalent bond similarly the
same
thing happens in metallic in metallic bond formation as well unlike covalent
bonds in covalent bonds you see we have seen a pair of electron is shared
between a pair of
atoms but in metallic bonds electrons are shared not only between two atoms
electrons are
shared among several atoms in in metals
so metals which are what i drawn here is only a
two dimensional figure metals are arranged in a three-dimensional way
so here again there is a
sharing of electrons among the atom it is not sharing between any two metal
atoms sharing of
electrons among several atoms okay such a shared electrons are not located at
between two atoms and
okay they are actually moving around all over the metals okay
so that creates a sea of electrons in
which the nuclei present because of movement of these shared electrons among
several atoms metals
have a characteristic characteristic properties such as conductivity we say it
is a very good
conductor of heat and electricity
so that is the difference major difference between the covalent
bond or ionic bond is that in case is that in terms of sharing of electron
between
two atoms or several atoms in covalent bond the shared electron is located
between two
atoms but in metallic bonds the shared electrons are moving around all the all
over the atoms
as a result there is a sea of electrons ok
so electrons are free to move they are d

localized
so called d localizer ok electrons are delocalized
so so
so electrons are delocalized in metals
they are free to move that means freely moving
so as a result they are very good
conductor of electricity and um heat but in colon bond basically is a sharing of pair of electron between two atoms in metallic bonds shared electrons are delocalized
so that is the reason they are very
good conductor of heat and electricity now let us move to a different concept so called leaves dot structures is he a chemist a great american chemist proposal rule called octet rule he is the only one he is the first person showed that bonds are formed by sharing of electrons ok he wonder what he proposed is
that to form a bond two electrons are needed so by sharing two electrons between two atoms a bond
is formed that concept is the icm revolutionary concept first proposed by levis before quantum
mechanics orbital concept arrived
so that was a um great idea proposed by gb gian levis
and he proposed what he did is that he looked at several molecules several stable
molecules of the second two elements of the in the periodic table for example you looked at several
molecules stable molecule for example water water and then ammonia these molecules are very stable and
then you can take um whoa what two these are the molecules formed by them second row
elements main group elements and these molecules are very stable and then you notice these
molecules the number of electrons around each atom is eight ok second two elements means the energy
level is two n equal to second row for second row n equal to two and they have s and and p orbitals when these two orbitals yes electron s
orbital can accommodate two electrons p orbital can accommodate six electron in total there are eight electrons
so then once these two cells are filled
up it okay then you will end up with ah close to shell configuration which is well known for noble gas closer shell noble gas for noble gases or they are called inert gases
so they are unit because they are not chemically reactive although there are several compounds
nowadays but its uniqueness initially attributed to the closed cell configuration its close to cell
configurations similarly when he looked at the number of electrons around each atom in this
type of molecules and he found that there are eight electrons are shared among the
between the atoms if you take for example o in water molecule number of electron or number
of electron around this oxygen atom is eight how there is a bond a single bond this is
called a single bond a single bond means two electrons double bond means four

electrons
are shared between atom a single bond means single bond means two electrons
shared between between two neighboring
between two atoms two atoms double bond means four electrons
so when he looked at the number of electrons
around each atom and he found that it is eight
so it is there is a single bond between oxygen
atom and hydrogen atom
so that means there is a two electrons there are two electrons in
there and in addition this is these two lone pairs these two are called lone
pairs okay
unshared pair of electron and atom is called lone pair okay there are two lone
pairs on this
oxygen atom what is called what is the lone pair unshared pair of electrons is
called lone pairs which is present on this oxygen atom and so
and there is another single bond between this oxygen atom and hydrogen atom
so in total
there are eight electron two electron here two electron here four plus two
electron
here six plus two eight
so total it has eight electrons similarly if you look at the number
of electron around this nitrogen atom is eight because there is a two electron
here there is a
two electron here there is a two electron
so in there is a lone pair
so in total eight similarly
you can count the number of electron around each oxygen atom here as well
so that is the reason
he proposed a rule called octet rule octet means means eight
so if you have a molecule and
it is stable and then the atom okay each atom in it should have eight
electrons
so then that molecule is stable then he come
up with a rule called octet rule according to this octet rule each atom in a
molecule should
share eight electrons with its neighboring atoms
so that is a rule proposed by the octet rule and
in addition he said also that a pair of electron is needed to form a bond
sharing of electron
concept is the original concept of g n levies from which other theories
developed for example
valence bond theory is developed from the eye original idea of sharing of
electrons pair of
electron sharing of electron between two atoms now um there is a symbol called
lewis symbol what is that it represents now how many
valence electrons present on on a particular atom for example if you take a
boron okay
its leave symbol is like this like this like this this is a levy symbol of
boron
so boron
belongs to a group group three
so its number of valence electron is three boron has three
valence electrons which can be shown like this
so this is called leave symbol

so that means
for example carbon has four valence electron
so which can be represented by this way so
this this is these are called levi's symbols which represents how many unpaired electrons
present on them how many unpaired electrons present on that
so using leave symbol um
we can draw
so called levi's structures to draw a leave structures it is important
to know how to draw lewis structures because to whenever you are writing organic reaction
mechanism for example you need to know how to draw a lewis dot structure
so for that purpose it is important to know how
to dry a lavish dirt structure there are five six steps one has to follow to dry
a leaves dot structure drawing leave structures to draw a leave structure you must first
count the number of valence electrons of each atom in a molecule
first step step one determine the number of valence electrons that means you have to count the balance
electron for each element for example water h2o okay the valence electron for hydrogen is
one
so for this one it's a two into hydrogen plus whoa the valence electron for hydrogen is one
two into one plus where the valence electron of oxygen is it's six
so in total there are eight
electrons
so like that one has to first find out the total number of determine the number of
valence electron total number of valence electron available for for bonding we are
concerned about balance bond okay um
so called valence electron because bonds
are formed using only valence electrons core electrons are not involved in bonding
so here for writing levy structures we are concerned about number of valence electrons
that you can find out from the group itself third group elements means balance electron is
three fourth group elements means the valence electron is four fifth group elements means
nitrogen balance electron is five similarly sixth group element is the oxygen its electron
at six for fluoride it is seven for neon it is eight
so like that you can find out the valence
electron the first step is to determine the how many number of valence electron present to
draw a structure the second step is the step two find the central atom find the central atom what is a
central atom if you take a molecule there will be a atom surrounded by other atom so
the mid the middle atom is called a central atom that one has to determine how to determine the

central atom that is a question that usually the central atom is usually less electro negative
element or the element has the highest greatest bonding capacity central elements central atom is the is the one has the greatest bonding capacity what is bonding capacity bonding capacity
refers to the number of unpaired number of okay unpaired electron number of unpaired electron
present on an atom for example if you take a boron okay boron has three unpaired electrons
one two three carbon there are four unpaired pad and pad pad means dot okay unpad means they are not pad
so there are four unpaired electrons for
carbon
so carbon has the highest
so as the so bonding capacity refers to the number of unpaired electrons present on the atom higher the number of unpaired electron higher the bonding capacity like
that
so compared to boron carbon has the highest um bonding capacity
so or you can also choose the
central atom based on electronegativity the less electronegativity negative element is usually
the central atom that we also you can choose
so now we know that the
number of valence electrons and we know what is a central atom then the third step is them okay draw a approximate structure
so after determining the what is the central
atom one has to draw a structure approximate structure for example um water molecule
itself h2o you have a central atom oxygen okay oxygen oxygen has the highest bonding capacity and then you have to draw a
bond between auxin and hydrogen
so uh for example another example is some um
chloroform ch cl3 the central atom is the carbon okay now after determining the what is the central
atom you have to arrange the remaining atom okay around this central atom for chloroform chcl three carbon is the central atom you
put the hydrogen here and then okay sorry um three chlorine atoms around that and
then you dry a single bond between atoms like that because there must be a single bond there must be
a at least one bond must be present between each pair of atoms
so there must be a pair of a
single bond between the um a pair of atom a single bond refer to two electrons then that
means the third step is you subtract ok subtract for forming single bonds from the total valence electrons okay and then you have to step four in step four you have to
distribute the remaining electrons after subtracting the electrons which are consumed for forming a single bond ok should be distributed ok at the terminal atoms distribute remaining valence electrons as pairs around each terminal atoms
so that each atom attains octet octet of electrons except hydrogen you cannot put a pair of

electron okay more than two electrons around hydrogen atom hydrogen has only one orbital
called oneness orbital and you cannot it can accommodate only two electrons
so is
so far
hydrogen that's the first row elements it obeys it requires only a duet of electrons hydrogen requires do it or duplicate of electrons two
electrons are enough around hydrogen atom
so ah
so the fourth step we have to
distribute the remaining electrons around each terminal atom
so that each atom
attains eight electrons now step five it will become clear when i discuss about examples but you if you do all these in a stepwise
fashion and there will be no error after distributing the valence electrons around each atom you have to do match match the number of electrons match them match the number
of electrons distributed to the number of valence electron counted in step one it should match with that because number of you
calculated first number of valence electron and that those electrons were distributed now
after distribution the number of electrons should be the same as what is counted okay
you have distributed the number of electrons in such a way that each atom has eight electrons
suppose if there are more electrons present that's more electron okay the leftover electrons should
be added or should be given to the central atom and then in step 6 complete the octet the sixth step you have to make
sure that the central atom is having eight electrons if it has eight electrons then the structure is done let us see okay and a few examples from which it
became very clear
so let me show you one more time how to draw a lewis dot structure first step is
that find out the number of valence electrons okay for a given molecule you know that what
are the atoms present
so from the ok from the group number you can find out the
number of valence electrons
so add them together then you will have your total number of valence electron that is the first step determining the total number of valence electron and
then you have to choose the what is the central atom after choosing the central atom you
arrange the remaining atom around the central atom okay and then draw a single bond between them
because all atoms are held together by at least one single bond
so you draw a minimum bond that
is one single bond between each atom
so for for forming one bond two electrons are consumed
so you count the number of single bonds drawn that number of electrons should be subtracted
from the total number of valence electron then whatever electrons remaining

should be added to
the terminal atoms the thermal atoms means the atom located outside the central atom you have to
add electron as pairs such way in such a way that each atom each terminal atom terminal atom attains
eight electrons and then you have to look at the number of electrons added the number of electrons
added should match with the number of electron originally counted which should be the same
if you it should not be less or more than that after was after you made make sure that
each terminal atoms attains eight electrons you if you have excess of electron that
excess of electron can be added to the central atom and then you have to make sure that
the central atom has octet octet of electrons it doesn't have then there is a mechanism of doing
that you have to bring uh a pair of electron or lone paraphrase to the central atom and convert it
into a a double bond and then you count the number of electron it will be eight electrons these
things will become clear as we see more examples let's see an example how to draw a
levy structures for chloroform ch cl3 the first step is the valence electron how to
do that there are carbon there is a hydrogen okay plus there are three chlorine atom
balanced electron for carbon is four plus valence electron for hydrogen is one plus three
into valence electron per chlorine is seven
so that is equal to okay that is equal to twenty
22 26 26 valence electrons are there in chloroform now you have to draw them you
have to find out the central atom that central atom is the carbon
because carbon has four and and lone parabola four and unshared okay on unpaired electrons
so its bonding capacity is higher compared to other atoms here
so you have to
arrange the remaining atom okay that is hydrogen and chlorine around the central atom you draw a
hydrogen atom here and chlorine atom here chlorine atom here chlorine atom here and then draw a
single bond here single bond here single bond here single bond here now there are four single bonds
are drawn that is four into two four single bonds equal to okay four into two that is equal to
eight electrons now eight electrons are consumed then you subtract eight electron from the total
number electron twenty six minus eight equal to eighteen electrons there are now 18 electrons
remaining which can be distributed around this terminal atoms which can be distributed as pass
now you cannot there is a hydrogen atom there you it cannot be added pair of electron cannot be

added for hydrogen it is only a duet electrons do it apply electrons are required
so you
cannot add pair of electron to the hydrogen atom electrons should be added as pass to the
remaining atoms
so let us add here here here here
so now i added three lone pairs around this
chlorine atom
so three lone pairs means six electrons there is a single bond there is a single
bond here that is that means two electrons
so now number of electron around this chlorine
atom is eight similarly you distribute here per as as lone pairs again the number of
electrons around the chlorine atom is eight here is eight here is eight here is the eight now
we come distributed 18 electron has passed to that we have six plus six plus six there are
three lone pairs three lone pairs three lone pairs
so the each three long three lone
pairs means three into two six three into two um three into two six six plus six plus
six eighteen
so now the count the number of valence electrons it should be 26.
here is a two
electrons here is a two electrons here is the two electron here is the two electrons
so eight
electrons eight ok
so there are four single bonds and then there are one two three four
five six seven eight nine nine lone pairs okay
so 4 into that means 4 into 2 equal
to 8
so 9 into 2 equal to 8
so um 18.

so in total there are 26 electrons
so the number
is matching with the number of electron counted at the beginning now you have to see whether the
central atom this is the carbon is synthetic whether it attains the octet rule of electrons
or not now it attains eight number of electron it has eight number of electrons because there
is a two electron there is a two electron there is a two electron there is a two electron so
two plus two plus two plus two eight electrons if you look at this chlorine atom the number
of electrons is eight because there is a two electron there is a two electron there is a
two electron there is a two electron eight similarly for other two atoms for hydrogen it
is only two electrons

so now um now we made sure that the octet around the car central atom is is right
so that means the structure is done
so the drawing leaves that structure is done
let us see in another example ch2 oh now number of valence electron valence electron is
the first step determining the valence electron is first
so carbon plus two hydrogen atom plus oh
carbon has four valence electron plus two into one hydrogen has one valence electron one
plus oxy oxygen atom has valence electron six
so that is equal to four six plus twelve there
are twelve valence electrons available for ch2o the central atom is the carbon and
arrange the remaining atoms like this now three single bonds are formed three single
bonds means three into two six
so twelve minus six equal to six electrons that six electrons
should be distributed around the atom such way that each atom contains eight electrons that is
six here if you put here and if you put here now six electrons are added to the oxygen atom and it
attains this oxygen atom attains eight electron but if you look at the number of electrons around
this carbon atom it is is not eight it is only six two electron two electron two electron its six
only then what to do you have to take away the lone pair of electron from the oxygen atom
towards ah carbon atom then it gives carbon like this
so basically we converted a lone
pair of electron to a bonding okay bonding electron now if you count the number of electron
around the carbon atom is eight two electron two electron two electron two electrons
so eight so
eight electron around oxygen atom two electron two electron two electron two electron eight so
the octet is obeyed the octet rule is obeyed the molecule is very stable this is how one has
to draw the leaves dart structure thank you you