hello students in the last few lectures i have discussed about chemical equilibria and today i am going to discuss your ionic equilibrium

so as the name suggests ionic equilibrium is basically ah your equilibrium equi equilibrium between ions

so equilibrium between ions and certainly this this can only be achieved when there is ionic reaction ionic reaction now first thing we will discuss is why when you have a reaction which involves ions ok a reaction which involves ions

so reaction involving iron involving ions are when ions are ions are involved involved in the reaction in the reaction

so first ions need to be formed first ions need to be formed and

so that they can be involved in a reaction

so how ions are formed formation of iron ions are formed when ions are formed when an electrolyte is put into the solution put into the solution aqueous solution i mean aqueous solution for example if we put nacl nacl in water this is your water nacl will break and ions are formed

so n a plus aqueous plus cl minus

so first thing is ions are only formed when a electrolyte is put into the solution and electrolyte is put into what is electrolyte electrolyte is any compound compound which when put into the aqueous solution aqueous solution conducts electricity conducts electricity when a circuit is formed a closed circuit is formed and that's why they derive the name electrolyte because they conduct electricity they conduct electricity and this is because of they conduct electricity because when we are putting your electrolyte into aqueous solution they dissociate into ions they dissociate into ions

so if i take water and put any electrolyte put water and add any electrolyte it will dissociate

so electrolyte dissociate into dissociate into iron to iron and if we put a electrode cathode the torso cathode anode and then we complete the circuit we complete the circuit then you have light there are two types of electrolyte one is your strong electrolyte electrolyte and second is weak electrolyte now let us discuss what we mean by a strong electrolyte and weak electrolyte

so a strong electrolyte is electrolyte which completely dissociates into water almost completely into water for example if you take a g n o three in water it will form a g plus or if you take for example s c l it completely dissociate h plus plus c l minor and this is in aqueous

so it is almost like you know 100 percent dissociation almost hundred percent

so for example if i take four molecules of molecules of zinc sulphate which is a strong electrolyte suppose i take like this zinc and then i make this sulfate ion if i put this into a beaker with water solution what will happen is almost all will dissociate

so this is four molecule of zinc sulphate this is suppose zinc two plus and this is yours sulphate two minus

so you will get something like this

so you have a four molecule of zinc zinc two plus and four molecule of sulfate iron four zinc two plus and four sulfate iron

so this is an example of your strong electrolyte now if suppose i take a weak electrolyte electrolyte for example acetic acid acetic acid is your weak electrolyte and if i suppose take four molecules of acetic acid and let us denote this by and you can take something like this

so this is your acetate ion ch3coo and this is your h plus ok now if suppose i put this in water this is your water only few molecule of acetic acid will dissociate others will remain as your undissociated molecule and associated and associated and

so these are called your weak electrode

so any compound which is not completely dissociated dissociated but not completely dissociated is called weak electrolyte weak electrolyte now why some compounds are strong electrolyte and some compounds are weak electrolytes why some compounds are a strong electrolyte and some compounds are weak electrolyte this will depend on behavior of behavior of iron in water behavior of iron in water ok but do i mean by this that there are some ions some ions they simply get hydrated when comes into contact with water in contact with water with water for example if you take n a plus ion and put in water what you will get is n a plus hydrated whereas if i take c s three c o minus and put in water this is basically what you are going to get is c h three c o o h plus o h minus

so there are two different behavior for two different ions two different behavior for two different ions one type of iron will simply hydrate whether as whereas another ion for example c s three c o minus will react with water to give your acetic acid plus o h minus iron depending on the kind of behavior an ion shows in aqueous solution we have a strong electrolyte or weak electrolyte generally in the case of a strong electrolyte a strong electrolyte in case of a strong electrolyte both the ions for example n a plus

so both the iron cation and anion when they react with water this simply gets hydrated simply gets updated similarly c l minus plus s two will simply get hydrated on the other hand in case of weak electrolyte in case of weak electrolyte for example acetic acid the behavior of one of anion and cation will be different whereas h plus will be simply that's a hydrated c s three c o o minus plus water there will be no hydration there will be a reaction which will give you c h three c o o h plus o h minus and this is the reason why in a weak electrolyte in weak electrolyte dissociation is not complete in a weak electrolyte dissociation is not come now there are different kinds of electrolytes and generally can come across three different kind of electrolytes one is acid second is base and third is your salts is it base salt

so arrhenius definition of acid is any compound which is capable of which is capable of capable of giving h plus r capable of giving h plus n for example s c l acetic acid

so s c l inverter gives you h plus i plus c l minus r since h plus has been given by s c l s c l gives h plus and s c l is capable of giving h plus n s c l is an ac whereas any compound which is capable of giving of giving o h minus is called a base this is arrhenius definition for an acid and obvious

so sodium hydroxide put in water will dissociate into n a plus plus o h minus since naoh is capable of giving o h minus ion

so nh naoh is your base no h is a base i explained you about a strong electrolyte and weak electrolyte similarly this kind of concept can also be applied for acid and base

so any acid which is any acid which is a strong electrolyte a strong electrolyte is a strong ac strong acid for example scl in water completely dissociates into your h plus aqueous plus c n minus its almost complete dissociation almost complete dissociation and

so scl is a strong electrolyte strong electrolyte and

so s c l is a strong ac s c l is a strong acid

so any acid which is a strong electrolyte is a strong acid whereas an acid which is a which is a weak electrolyte weak electrolyte is a weak acid for example if you take acetic acid it dissociates to give c s three c o minus plus h plus this is a weak electrolyte weak electrolyte it does not dissociate completely only a small amount of small amount of acetic acid is dissociated into your acetate iron and h plus iron and that's why acetic acid is a v k c acetic acid is and v k c similarly we have weak a strong base again a strong base is a strong electrolyte electrolyte and

so it dissociates completely yes completely dissociates completely and then you have for example you have naoh and put into water it gives this is complete almost complete dissociation almost complete dissociation this is almost completely associated now whatever salts source can be of two type soluble salts for example nacl agno3 these are quite soluble in water whereas there are some salts which are insoluble it means sparingly soluble salts

so solubility is very low what i mean by insoluble solve that solubility is very low we can use another term you are sparingly soluble a sparingly soluble salt soil

so this salts for example a g c l this solve does not go completely into solution completely into solution

so generally they are weak electrolyte

so sparingly soluble salts are weak electrolyte whereas soluble salts are your strong electrolyte

so salts can be of two types soluble salt insoluble salt soluble salts are strong soluble salts are a strong electrolyte whereas insoluble salts are weak electrolyte a strong electrolyte or soluble salts completely dissociated they are completely resistant in aqueous solution completely dissociated these are your strong electrolyte they are a strong electrolyte on the other hand you have sparingly soluble salts something like agcl silver chloride gives you a g plus c l minus x and here it is a reversible reaction what does this mean is a g c l is not completely dissociated only part of a gcl will be in solution and that part will be dissociated whereas other will go out of the solution other will go out of the solids and that's why these are examples of weak electrolyte since it does not completely gets associated ah dissociated now after the discussion about acid base and salt acid based salt we will discuss how to get how to apply equilibrium concept into this equilibrium concept into this but before that before that i will like to give a concept of what is known as ph scale which provides us an idea about your whether a solution is acid or a base acid or a base ok

so first how do we know whether a particular solution is acid or base

so if i take solution which is basically salt in or any electrolyte in water in water electrolyte in water when it will be a acidic solution when it will be a basic solution ok

so first thing is when concentration of h plus iron is greater than concentration of o h minus ion then we say solution is acd then we say solution is actually second when concentration of h plus ion is less than concentration of o h minus ion then we will say the solution is basic whereas when h plus iron is almost equal to o h minus ion then the solution is called your solution is called neutral

so suppose if we have sodium acetate

so if we put salt into water and we want to know which kind of solution this is whether it is an acidic solution basic solution or neutral solution

so if suppose i take nacl take one example simple example nacl into water

so what we will get it is if i put sodium chloride into water what i will get is n a plus plus c l minus this is almost complete dissociation this is almost complete dissociation n a plus will convert into n a plus

so this is hydrated sodium plus this is hydrated chloride ion they will form an equal amount this will be hundred percent dissociated

so you can see that in this reaction neither h plus is formed not o h minus alpha whatever h plus will come will come from s two s two and the concentration of h plus and o h minus will be equal equal to this and

so equals solution of nacl is neutral across solution of nacl is network now take solution of scl

so when we put scl into aqueous solution it breaks to give h plus and cl minus r there is also dissociation of s two and that will give you h plus plus o h minus n but we know that s two is a weak electrolyte weak electrolyte and
so amount of h plus and o h minus obtained is very small is very small in comparison to h plus which we have got from scl
so h plus from scl is generally quite greater than o h minus ion concentration since h plus ion concentration is greater than o h minus ion concentration the solution is solution of scl solution of scl in water is acidic is acidic now think about a salt such as sodium acetate what will happen in this case sodium acid
so we took sodium acetate and just put into the water solution now question is whether this is a basic solution acidic solution or neutral solution
so let us think about this this is a soluble electro soluble salt what does that mean is this will completely dissociate any soluble salt completely dissociates into almost completely dissociates into water ah into their ions
so first thing this happened now what will happen to these ions when they contact ah come into contact with water molecule
so n a plus plus water you know n a plus gets hydrated
so what about acetate iron acetate iron plus water will give you c o o h plus o h minus r that's what we know ok and
so now you can see that in the solution o h minus is generated
so the solution will be solution will be your basis
so generally a salt of weak acid which is acetic acid and salt of a strong base is always basic that's what we know salt of weak acid weak acid and salt of strong base this is a strong base which is your sodium hydroxide is always basic it goes by the which one is strong and this is simply because acetate iron in contact with water will go acity i will give acetic acid plus hydroxyl now we can think about a salt of your a strong acid which is which is your scl and your weak base which is ammonia solution which is ammonia solution in this case again salt in water will completely dissociated completely dissolved we know c l minus plus water will give you c l minus hydrate ok whereas n h four plus reacting with water will give you ns3 aqueous plus s three o plus now you see this is basically h plus ion and
so in the solution h plus iron is in excess and
so the solution is solution is an acidic solution solution is an acidic solution now once we understand whether solution is acidic basic or neutral now we are going to define a scale by which we can know that a solution is acidic how much acidic it is whether it is a strong acid or v case or a strong base weak base how do we get the quantitative measurement of acidity and basicity the scale which we use is called ph scale the scale which we use to quantify the acidity and and basicity is called your pha scale and ph is defined as minus log activity of h plus r activity is your actual concentration of h plus r real concentration s plus activity is defined as multiple or two different quantities one is called activity coefficient into concentration in molarity
so concentration of h plus ion in molarity
so this is your gamma h plus which is activity coefficient coefficient
so p h scale is used for quantitative estimation dative estimation of acdt and basicity and this is given by minus law activity of a h plus activity of h plus where activity of h plus is gamma h plus into concentration of h plus r activity of h plus iron is one almost one for dilute solution and
so your activity of h plus iron in dilute solution is almost equal to s plus h plus i and
so in dilute solution in dilute solution we have p h is equal to minus log h plus r and similarly we can define p o h and that is simply minus log activity

of o h minus i n and again in dilute solution this is equal to o h minus in dilute surface
so for example if i take 10 to the power minus 4 molar scl solution 10 to the power minus 4 molar scl solution we have since s c l is completely dissociated into water
so what you will get is 10 to the power minus 4 molar of s plus ion and 10 to the power minus 4 molar of cl minus 10 to the power minus 4 molar of h plus iron and this and
so p h will be simply equal to minus log since this is a dilute solution and
so we can simply write ph is equal to 4 for 10 to the power minus 4 molar acetic solution
so if suppose we have another solution with in this case your ph will be simply minus log minus 3 and
so this is ph3
so now you can see that if i take 10 power minus 4 molar scl and 10 to the power minus 3 molar scl p h will be four and p h will be three now let us think of if p h is high whatever that mean ph if ph is high then concentration of h plus iron will be low ok
so here ph is low concentration of h plus iron 10 to the power minus 3 which is greater than 10 to the power minus 4.

so higher the ph higher the ph lower the acidity acid you can say strength as we go towards higher ph h plus ion concentration decreases and
so you have lower basis similarly we can calculate p o h and p o h is equal to minus log o h minus ion where o h minus and this is only valid when we have a dilute solution
so suppose we take around 10 to the power minus 4 molar sodium hydroxide solution again sodium hydroxide will be completely will completely dissociate into sodium plus plus o h minus
so o h minus concentration is going to be 10 to the power minus 4 molar ten to the power minus four molar and
so e o h of the solution will be minus log ten to the power minus four and that is equal to four
so ph of a strong electrolyte can be ph or poh of a strong electrolyte or a strong acid or strong base can be easily calculated can be easily calculated but what about v cases weak acid for example acetic acid weak acid we do not have complete dissociation we do not have completely association it is only partially dissociated
so if i take 10 power minus 4 molar acetic acid solution i cannot say that h plus iron concentration is 10 to the power minus 4 molar now since acetic acid is a weak electrolyte now how to calculate ph of this
so since this weak electrolyte does not completely dissociate they are a kind of reversible reaction which means some are in associated state and some are in dissociated state we can apply the concept of equilibrium and since this is the equilibrium when ions are involved where ions are involved that is also known as ionic equilibrium this is also known as ionic equilibrium
so if i take the case of this weak electrolyte which is your weak acid also we can simply apply the equilibrium concept k and k is basically your product concentration of product and this constant is called ionization cost
so if we know the ionization concept ionization constant of a particular acid then we can calculate the value of h plus i value of h plus ion and that h plus ion can be used to calculate ph
so it is simple that acid in case of weak acid the concentration of concentration of the acid weak acid is not equal to concentration of h plus r

so weak acid weak base or weak base concentration of acid or base is not equal to concentration of h plus ion r o h minus n which minus ion in case of base is plus ion in case of s we can calculate h plus ion or o h minus ion in such case using the concept of ionic equilibrium concept of ionic equilibrium

so the way we calculate h plus iron is

so for ah acid like h a which is weak acid we can simply write h plus ion into a minus divided by or we can simply also write since we know that h a will be dissociate like this in h plus plus a minus the concentration of h plus is equal to concentration of a minus

so we can simply write h plus this and for a minus h plus since this is equal to they are equal and

so you just write h

so h a plus s square is equal to your k a into j and

so h plus is equal to your square root of square root of k a into a square root of k a into h h plus is equal to square root of k a into h

so this is for your v k c we can again if we want to calculate p h we can simply put minus log h plus and this will be again minus log in place of h plus you can just put this k a into h a we can write p h is equal to minus half for this log k a into h a is equal to minus half log k a minus half log and this is simply equal to half p k a minus half logic

so this is the way we can calculate ph of a v k c p h of f similarly we can also calculate p o h of a weak base weak base for example your ammonia solution ammonia solids

so poh of weak base

so poh of weak base is given by k b is equal to n h four plus into o h minus by ammonia and now you can see that in this case also n h four plus ion and o h minus ion will be equal

so you can simply write o h minus square by ammonia and

so h minus ion concentration will be given as kb into ns3 concentration under kb into n s three and come under

so what we have seen in this lecture is that we discussed about ionic reactions ionic reactions this happens in case of electrolytes electrolytes then we discussed about nature of ions how they react with how they react with with water then we discussed about a strong or weak electrolyte a strong or weak electrolyte a strong or weak electrolyte and then finally we discussed about weak acid weak base weak sparingly soluble salts springly soluble salts and how the concept of equilibrium can be applied in this thank you you