Bio-electrochemistry
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Lecture – 08
Standard Potentials – II

So, let us resume our 8th lecture. So, today we will be starting our lecture 8.

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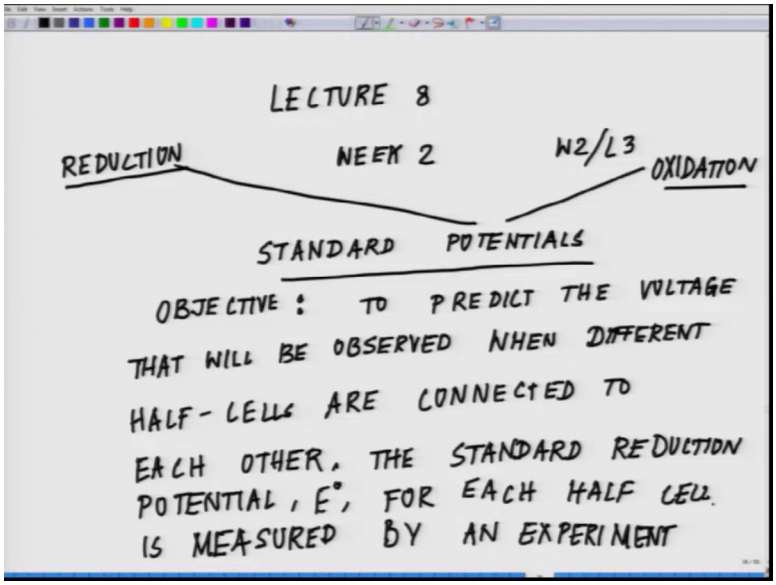

And we will continue with our standard potential story which is lecture 8, which is week 2 essentially W 2 week 2 and lecture 3 of the week 2 and our topic will be continuation of standard potential standard potentials.

Now, talking about standard potentials let us jot down the objective of what we are trying to understand. The objective what we are trying to understand is to predict the voltage to predict the voltage, that will be observed that will be observed when different half cells. So, I have already introduced the concept of half cells different half cells are connected to each other or connected to each other.

The standard reduction potential now I will come to this concept standard. So, when we talk about standard potential it could be standard reduction potential or standard I told you that you have to go by one, either you talk about standard oxidation potential or reduction potential based on that you develop the chart this standard reduction potential,

which is denoted by e naught for each half cell is measured by an experiment we will come to the experiment how you measure it.

Now, let us go back for a second to this reaction what we exactly did.

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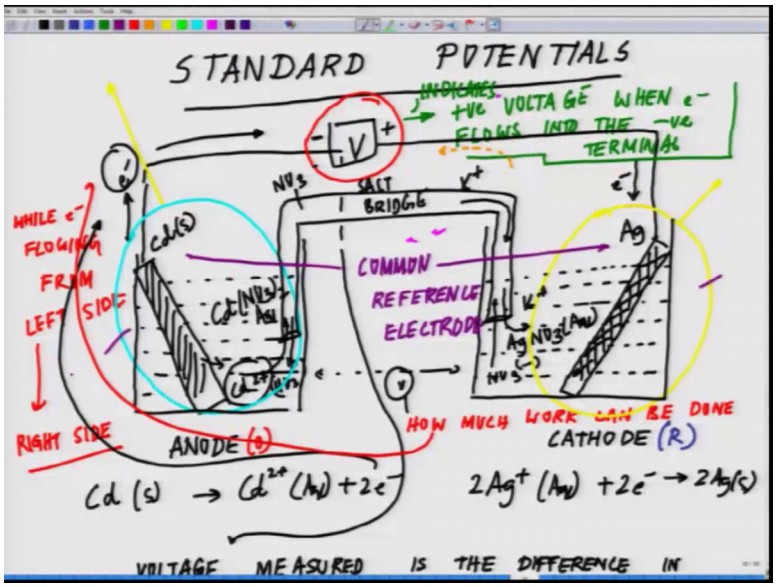

So, you have this cadmium which is getting oxidized you have silver which is getting reduced. So, in other word if I have to give a philosophical analogy to this; that means, power of silver to accept electron is higher as compared to cadmium. And if I had to put a reverse statement power of donating electron of cadmium is higher than silver. Now it is a relative parameter I can introduce another thing to cadmium silver I can introduce zinc whatever.

So, now I have to give a value to that potential of cadmium and potential of silver. Now in order to do that what I probably have to do is I have to develop a way I have to develop a common reference electrode. Common reference electrode and that common reference electrode with respect to this and with respect to this will give me that value by virtue of which, I can say that cadmium can lose electron much with much higher ability as compared to silver or reverse statement silver can accept electron at a much more higher ability it has much more power to grab the electron as compared to cadmium fine.

So, in order to develop whether I say about oxidation potential reduction potential I needed that common reference electrode with respect to the common everything will be

calculated and if I could have a chart something like this . So, now, with this background now read the lines to predict the voltage that will be observed when different half cells. So, your half cells are these are your half cells right this is silver half-cell this is cadmium half-cell fine different half cells.

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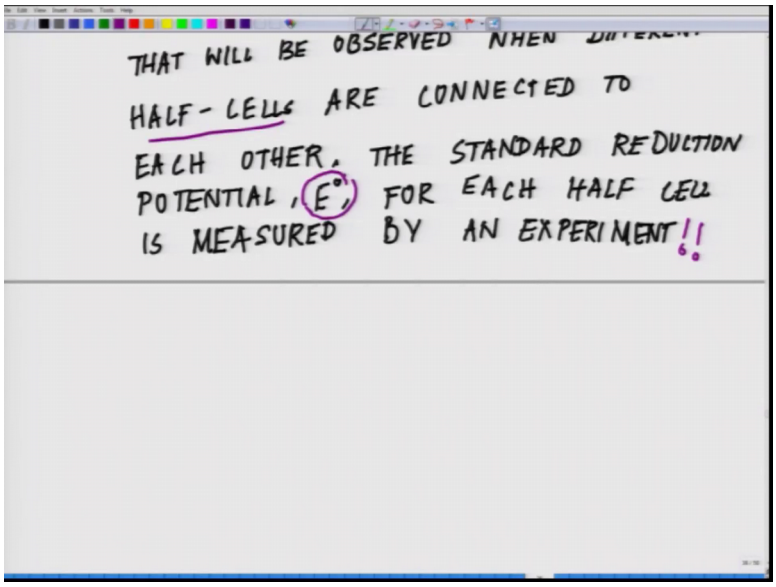

Are connected to each other the standard reduction potential E 0 or E naught standard reduction potential E naught for each of the half-cell is measured by an experiment. And we will talk about what is that experiment which helps us to measure that individual E naught of silver and cadmium and if I know these 2 values.

So, what we want is something like this say for example, this is hypothetical what I am going to drop before I go to go to the experiment say for example, I have these elements.

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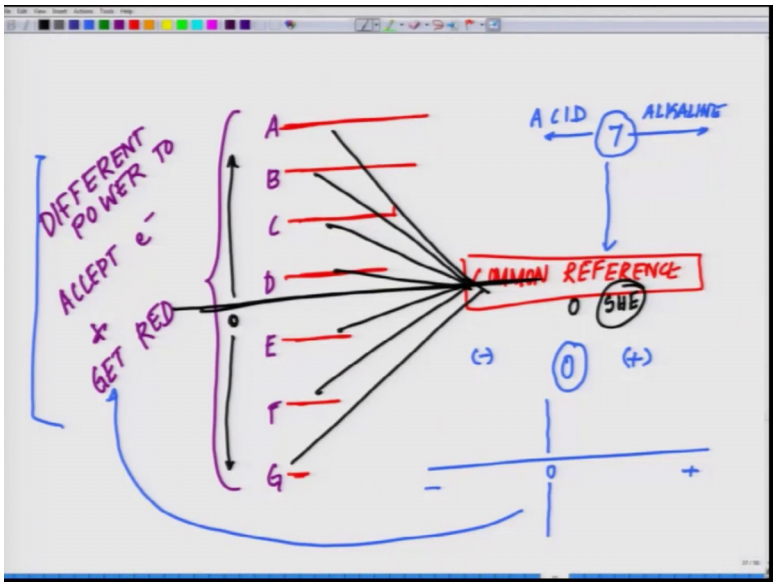

A B C D E F G and all of them have different powers say for example, they all have different power to accept electron or different power to get reduced different power to accept electron and get reduced.

Now, in order to do that I needed a common reference with respect to what common ref with respect to common reference, see if this is the common reference with respect to it I measured it. So, I see this one has a value this one has a value this one has a value these are the like kind of you can give a number to them with respect to it.

So, that that may like somewhere that common reference may be something. So, maybe something is just like the PH. So, whenever we talk about the PH. So, we say 7 above 7 and below 7. So, this is what we called as alkaline and this is what we call as acid.

Now, exactly like 7, I needed a common reference electrode which I have to set something like says 0 I set it at 0. Now with respect to 0 with respect to 0 I could have positive I could have negative which side of the number line you are going positive I could have negative.

Based on that I will be able to give different number to the power of accepting electron or donating electron vice versa at this point we will only talk about the accepting electron because we are talking about the reduction potential.

So, now, the critical question is what is that what is that standard electrode? Now we will good will we are going to talk about that standard electrode. So, what is that experiment.

Now, let me draw the experimental standard experimental situation and then I will explain it. So, the standard experimental situation is slightly more complicated than what you saw previously.

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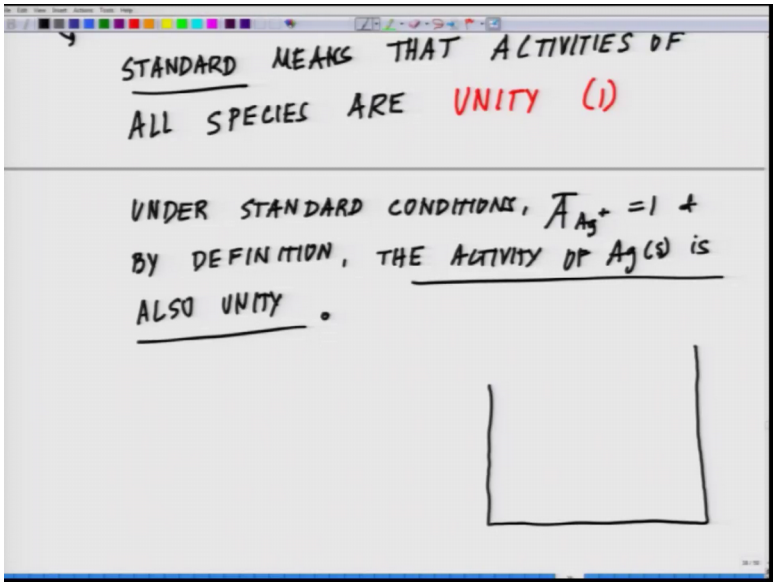

So, by the way we are first dealing with the silver half-cell. So, that is what we are going to deal with. So, the half reaction of interest at this point is silver plus electron solid.

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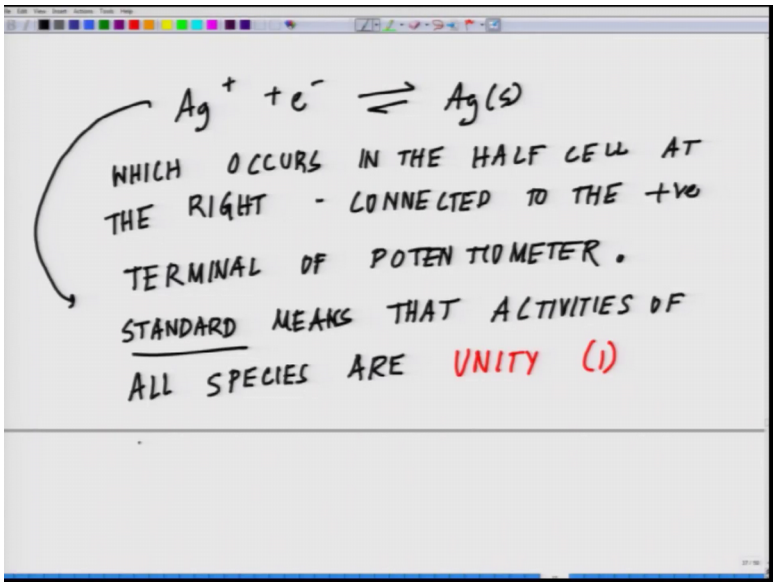

So, essentially we are talking about this side we are dealing with this half reaction at this point first.

So, this is what you are be. So, the half reaction of interest is in which occurs in half cells at the right. So, let us define which is where it is happening which occurs in the half cell at the right and remember it connected to the positive terminal of potentiometer positive terminal of potentiometer.

So, here one more thing, what I wish to highlight so with respect to this reaction. So, standard means when we talk about standard potential. So, we have to say what the standard mean potential you have already define, standard means that activities of all species are unity that activities of all species are unity or 1.

So, for the reaction what has been mentioned above what will happen?

Under standard condition under standard conditions the activity as denoted plus is equal to one and by definition, the activity of a g solid is also unity will come later into that what does that mean solid is also considered as a unity.

Now, let us draw the half cell and it is reference cell.

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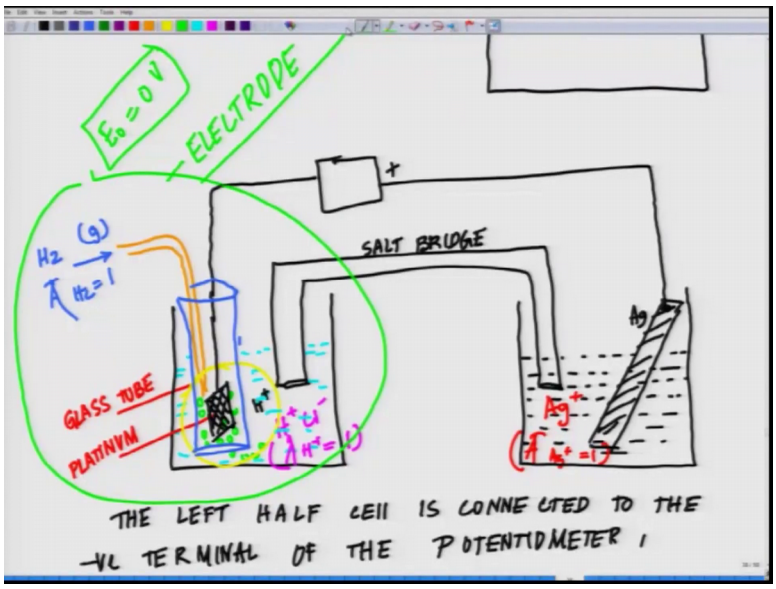

So, here you have the A g electrode silver electrode sitting. So, you have the salt bridge connected out here I am not getting into in depth of the salt bridge anymore because we

have already dealt with it in the previous class. So, previous 2 classes we have dealt with it rather salt bridge and. So, here your activity of A g as essentially A g plus is A g plus is equal to 1 and on the other side what we have is the voltmeter sitting here, which is the positive terminal of the voltmeter and on this side what you have is, now this is the part the first electrode in this course what we are going to deal with is now we are introducing that and that is coming down and there you have platinum sitting here. This is a pure and I will give you the details of what it is in a second let me draw it out and here we are bubbling hydrogen gas H 2 gas of course, that also has an activity of H 2 is equal to 1 which is the activity is unity ok.

So, there you have a glass tube essentially you have a glass tube you have platinum you have bubbling of hydrogen happening out here. So, I am just showing the hydrogen with green bubbles out here and the solution on this side is essentially HCL with an activity of again unity this is your HCL and where activity of H plus is equal to 1.

Now, the left half-cell is connected to the negative terminal of the potentiometer what you have done here is. So, this is your left half-cell.

The left half-cell is connected to the negative terminal of the potentiometer and this is called and is called standard hydrogen electrode standard electrode or SH E

Now, let us talk a little bit about SH E first what is this whole platinum thing. So, what you see out here. So, there are 3 points what I wanted you people to remember 0.1.

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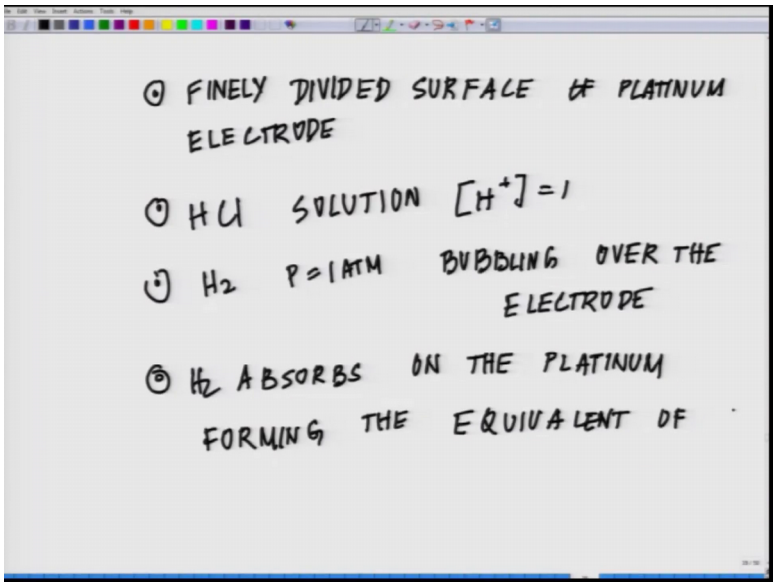

Finely divided surface of platinum electrode then the next important point here is HCL solution with the activity of H plus ions as 1. So, that gives you a catch in case HCL solution H plus activity is not 1, then we will see a different kind of drift into this electrode. So, keep that in mind this is very important at this point what I am mentioning is exceptionally important.

The third point is after this what is important is that hydrogen at pressure of one atmospheric pressure is bubbling over the electrode and the next important point is hydrogen absorbs on the platinum forming the equivalent, of forming the equivalent of ‘solid hydrogen’ electrode and this next point is very important solid hydrogen electrode in equilibrium with H plus.

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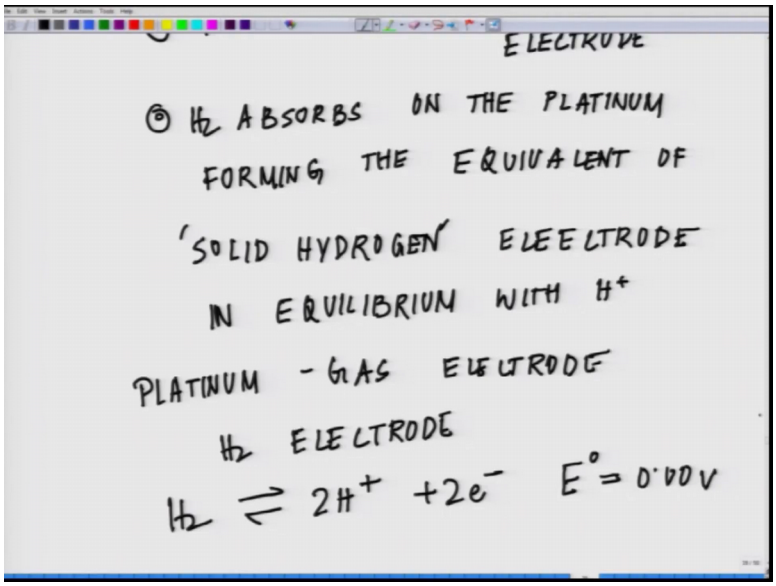

So, in other word the plasma at platinum gas electrode which is the hydrogen electrode? So, essentially the reaction what is happening is something like this 2 H plus plus 2 electron and this is given an e naught value of 0.0 0 volt.

Now, what is exactly happening on the surface of the electrode? So, this is where hydrogen is getting bubbled and here the solution is lot of H plus ions and this hydrogen gas is in equilibrium with H plus ions present there and for this the axiom this is an assumption purely arbitrary assumption that this has a potential of 0 this is your standard now if I go back what I was trying to tell you. So, this common one is sitting at 0 which is standard hydrogen electrode SH E with respect to it with respect to it with respect to it with respect to it we have different values.

So, if some something standing at 0 say for example, this is Z of 0. So, something will be above it lower it and we will come to that real practical value for that what does that mean and how does that fit into our whole equation of stuff.

So, now coming back where I was so you are realizing that this is how that first electrode, when you when we will be talking about electrode and potentiometric you will realize how this will come. So, handy say this is the first electrode we studied a standard electrode if you understand this electron this electrode is all about an arbitrary value being set.

So, what is happening on the surface? So, the important question is what is really happening here now what we have understood is what I am going to draw now what is happening on the platinum subs surface. So, it is something like this. So, I am using the green color to show the atoms of the platinum on the platinum electrode.

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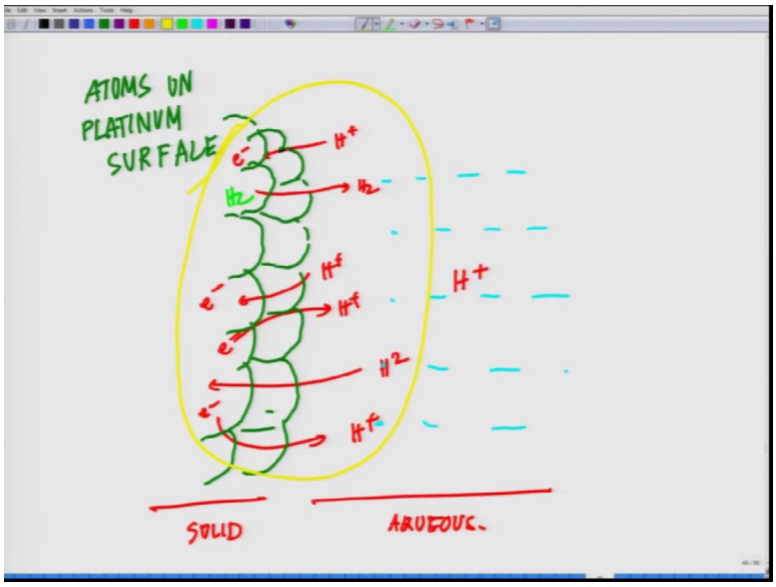

So, this is the platinum surface all in the green. So, this is your atoms on platinum surface.

Now, on this surface what is happening is. So, there are and it is surrounded by a milieu of lot of H plus ions H plus ions and on the other hand platinum itself is getting a lot of let me pick up another color H 2 gas which is coming.

Now, there at a very peculiar equilibration which is happening it is happening essentially is these H plus ions are coming onto this surface tracting with electrons and becoming H and eventually become H 2 now this H 2 is now travelling back into this solution in the aqueous phase. So, this is this is the solid and this is aqueous or the liquid phase.

Similarly, some of these H plus ions are coming here you are giving away the electron and vice versa the electrons are going there and hydrogen from here which is getting evolved is coming back, onto the surface of platinum similarly there is an electrons which are going and kind of you know making it hydrogen.

So, the platinum surface is a very dynamic surface and there are lot of such possible reactions which are happening on this surface. And what is being assumed as I told you that this is a surface phenomena what is being assumed is this what is happening on the platinum surface is something like this.

So, in a normal condition this electrode this electrode by itself standalone we will have a e naught is equal to 0 volt and you please understand this electrode concept, because I will close in here today and in the next class I will tell you what will happen, when there will be a deviation from the 0 and what does that mean and that will kind of give you an idea. So, this is our first electrode what we studied.

So, I will close in here in the next class we will talk about how the value will change out here on the voltmeter once, we connect it to another metal of a different reduction potential.

Thank you.