Bio-electrochemistry
Prof. Mainak Das
Department of Biological Sciences & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture - 02
Basic Concepts-II

Welcome back to the second lecture on Bio-electrochemistry. In the first lecture we kind of we started the course and today we will be outlining all the points what we will be dealing in next 4 classes which includes this class also. And apart from it we will talk about some of the very very basic concepts. So, let us start today's lecture. So, this is for lecture 2, out of 20.

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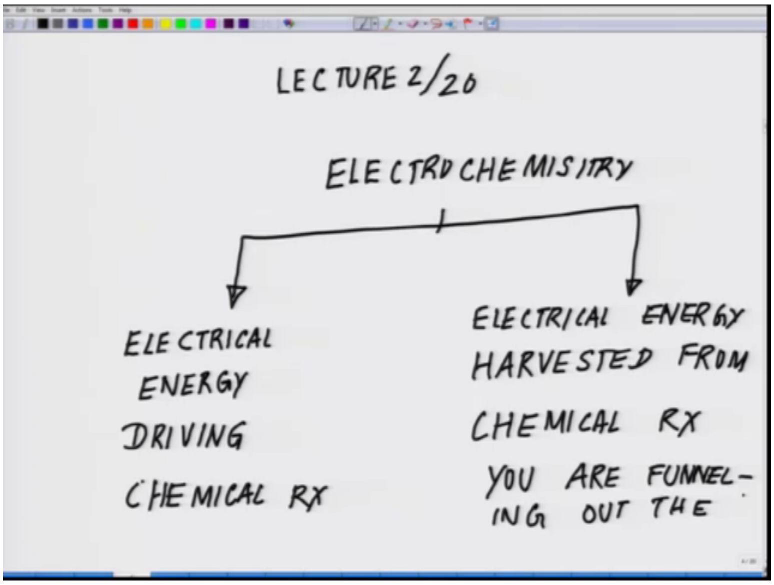

One aspect which I wish to highlight is when we talk about electrochemistry there are two ways you can look at it a chemical reaction leading to generation of electricity or electricity driving a chemical reaction. In other word when you apply electricity to break down a compound which is electro catalysis. So, you are using electrical energy to break a compound. Similarly when there is a chemical reaction taking place where there are electron transfer taking place, so you are harvesting electricity from it. And both these are fairly common if you look around.

Say for example, when we go to metal purification plants where from different kind of ores metals are being purified, there are lot of electrical electro catalysis is being used.

Similarly when we talk about a battery or some other fuel cell or some energy harvesting system that is where we see we harvest the energy which is generated or the electrons which are being generate during chemical reaction. So, in other word when you talk about electrochemistry these two aspects needed to be kept in mind and these two are dealt kind of in a separate way. So, one is where electrical energy driving chemical reaction. Similarly, electrical energy harvested from chemical reaction, harvested from chemical reaction. In other word you are funnelling out the electron transferred between chemical species due to potential difference between them.

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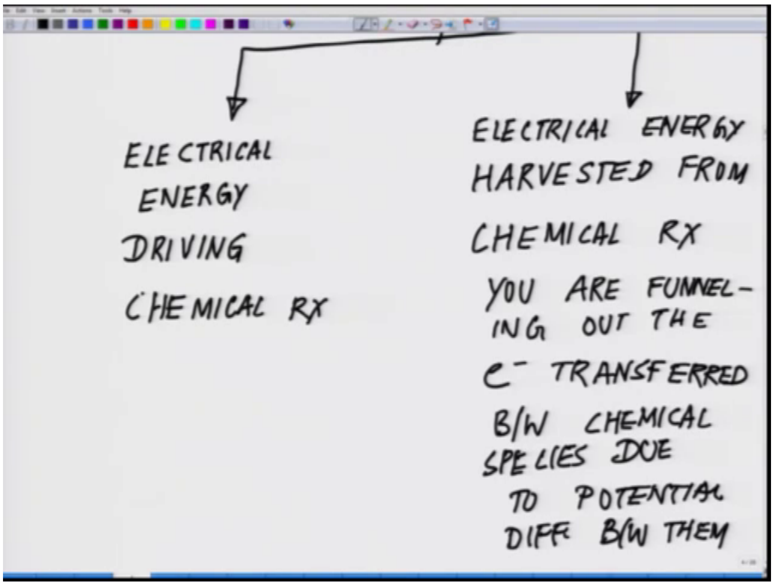

If you remember in the last class we talked about why electron should flow from a species A to species B or point A to point B. The flow takes place because of the potential difference or in other word the energy function of that particular material. So, we can always have a scale which can tell you whether the electron from point A will flow to point B or not and how much energy we need it for a reverse reaction to take place to raise an electron from a lower potential to higher potential which is an energy intensive process. So, keep these two aspects very clearly in mind because both have their applications in the industry and this is one industry, electrochemistry is one industry which is part and parcel of our day to day life at every quarter we have used these electrochemical techniques time and again time and again and time and again.

So, that is why it is one of the industrially very relevant subject and is being used from energy sector to electroplating to electronalitical as a tool, as a detection tool, as a sensor, as bio sensor, as diagnostics and that is why a basic understanding a very fundamental understanding of the subject is exceptionally critical. And that is why I will be going slowly. These small capsule my desire will be that once you finish this course you should be able to kind of see the power or how empowered you are to think of a problem depending on which aspect you are dealing with and how you can use these powerful tools to resolve them. And specially, it is even more important to realize much of these electro chemical techniques are not very costly they are doable they are not a very high end costly instrumentation. So, these could be set up in small labs across the country, but a basic understanding of the process is extremely essential.

So, now after giving this part of the introduction I will move on to the topics what we will be covering in over the next 3 4 classes, if that is essentially our first week.

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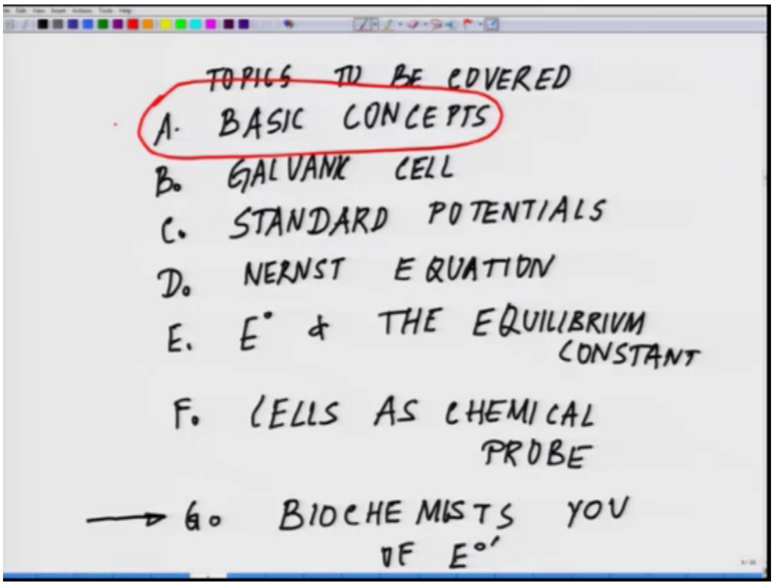

So, topics to be covered first one is A, will be basic concept with partly we have a started, but will continue further, basic concepts. The next thing what we will be dealing will be galvanic cells. Third one we will be dealing with standard potentials. Fourth this week we will be dealing with Nernst equation one of the most celebrated equation. Next we will be dealing with E 0 and the equilibrium constant, we will come later about this E

0 concept. Next we will be dealing with cells as chemical probes. And we closing the week with biochemist use of E 0 prime, there are biochemists use of E 0 prime.

So, a Nernst equation has been translated specially for biological application and that is exactly where in this section what do you see as the g where we will be talking about E 0 prime we will talk about it what are the relevance of this and hydrogen electrode, and pH meter and all these things.

Now, just take a little recap of where we so we are starting now with the basic concepts. So, part of the basic concepts we have actually started, but now we will kind of in a rehash where we left last week or in the last class rather.

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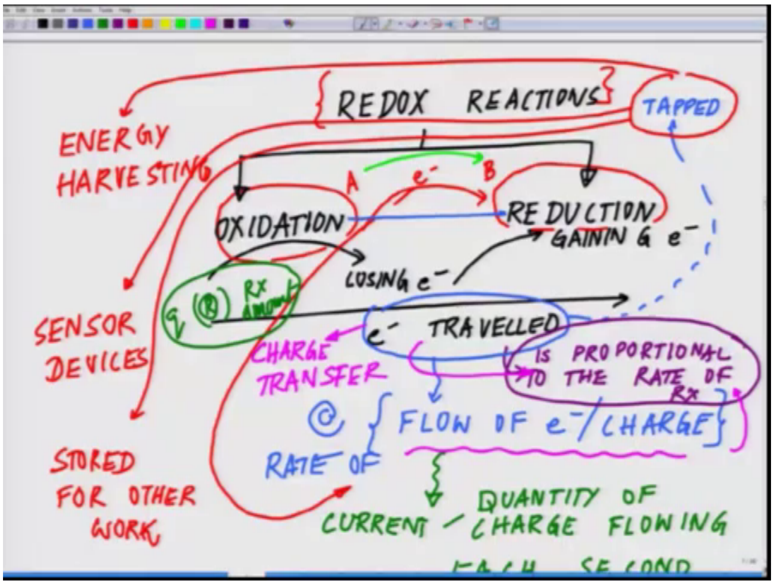

So, we talk about redox reactions that is where we started. So, redox reactions could be classified into two groups, one is oxidation the other one is reduction fine. Now, when we talk about oxidation we are essentially talking about somebody losing electron whereas, when we talk about reduction it is somebody gaining electron

So, in that process what happened? The electron travelled. And the travelling of electron could be tapped or travelling of electron can also be considered as flow of electron flow of electron and if we introduce another term flow of electron or flow of charge whatever you call that, if we introduce a term to this is flow of electron rate of flow of electron that is what we talked about is your current. In other word there is a quantity of charge flowing from each second through a circuit, once again talk about current we are talking about quantity of charge flowing each second through a circuit.

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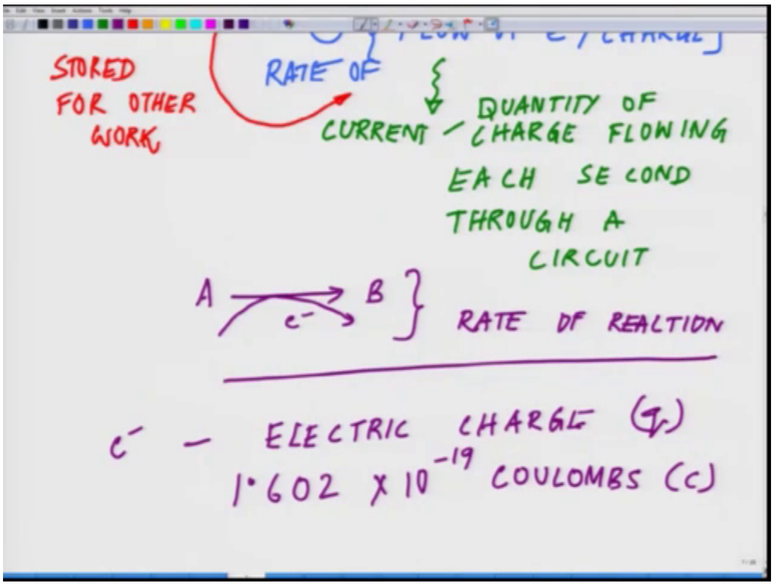

So, you see between two species if I call this as if example. So, if I say that you know this is one species of compound or something which could lose an electron here is another compound which you could gain an electron. So, if I call this as A and if I call this as B and there is an electron transfer taking place which is essentially a redox reaction. So, this electron transferred could be evaluated as flow of current across the species and could be tapped as I mentioned for energy harvesting. Similarly this electron transfer could be tapped for sensor devices. This electron could be stored for other work, but whether the electron will flow from here to here from A to B is what we talked about is the function, work function of the two species.

Now, having said this whenever we talk about there is an travel of electron or movement of electron, this moment of electron indirectly tells something else that tell this is proportional to the rate of reaction. This whole thing is proportional to the rate of reaction. So, what is the amount of reaction which is taking place? In other word the take home message out here will be if a reaction is taking place between this and there is a flow of electron that indirectly signifies the rate of reaction happening. So, this part is extremely essential because we will be dealing with this in terms of the numericals as we move forward.

Now, when we talk about electric charge; when we talk about this, in the electron moving it should have certain amount of charge, so electric charge in this situation which is represented by q. So, it is electric charge of an electron is 1.602 into 10 to the power minus 19 coulombs which is represented by c. Now, this is what we talk about is charge on a single electron. So, a single electron has, which has a charge of 1.602 into 10 to the power minus 19 coulomb.

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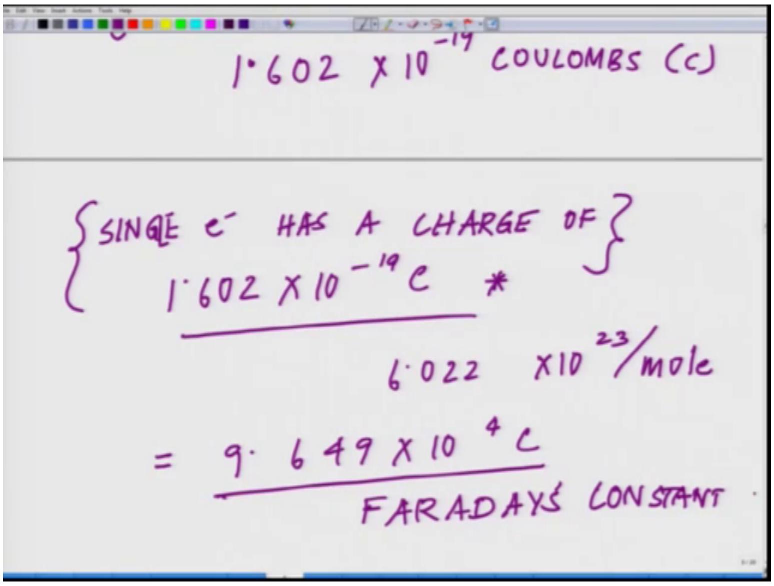

Now, if we talk about a mole of electron how much it will be charged because you really cannot major this charge so easily. Now what you do is if this is the single charge then if you multiply it with Avogadro's number which is 6.022 multiplied by 10 to the power 23 per mole. So, that is the value what you get is 9.649 into 10 to the power of 4 coulomb and this is what we call as Faraday's constant.

So, in other word conceptually if you talk about; that means, a single electron has a charge of 1.602 in 10 to the power minus 19 coulombs now you really cannot measure such a small charge on a single electron. So, the way we do it is that, you considered how much is they charged in 1 mole. So, when you talk about one mole we are talking about something in 1 mole should have Avogadro's number of particles. So, if we assume that total number of electrons in 1 mole is the Avogadro's number which is 6.022 into 10 is got 23 per mole. So, if we multiply that with the charge on a single electron then the value what we get is termed as Faraday’s constant. So, these are the beginning of some of the basic concepts.

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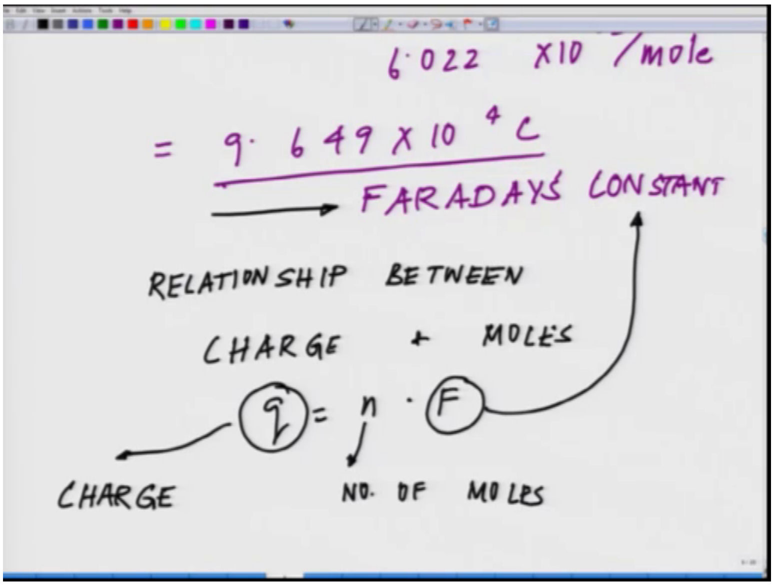

So, in other word the relationship between charge and mole, if you look at it relationship between charge and moles we are landing with q is equal to n dot F, where F is the Faraday’s constant, n is the number of moles, q is the charge. So, please do remember this relation this will come very handy while we talk about the numerical.

Now from here we will talk about the two concepts, we have to relate two different concepts here, this one concept which is emerging is your relating coulombs or charge to the quantity of reaction. This is one emerging concept.

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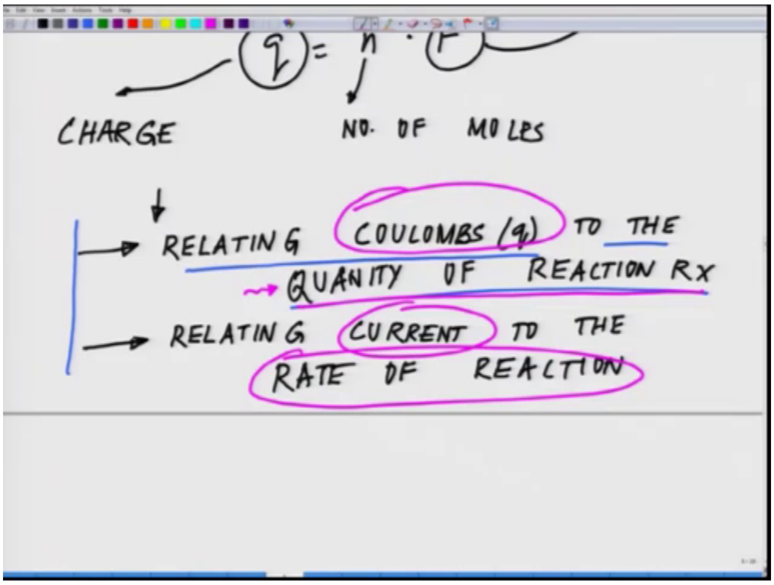

The second is relating current, relating current to the rate of reaction. So, these two concepts are exceptionally important for us to understand because based on these two concepts we will be developing a series of numericals across it.

So, let us look at it what I said relating coulombs, in other word charges to the quantity of reaction. Why this is important because if we go back to the basic concepts where I talked about. So, when we talk about there is a reaction taking place like this. So, in other word there are electrons which are travelling. If the electrons are travelling across it, in that is essentially means there is some form of a charge transfer which is taking place and this charge transfer is proportional to the rate of the reaction. So, there is a charge transfer.

Now, in the light of this, this charge transfer is directly proportional to the rate of the reaction. Now, if you look at this essentially what you are doing you are relating this is where the concept come your relating charge and its relation some way or other I just put it some form for you know relation with the amount of reaction, reaction amount how much reaction has taken place because depending on how much proportionally charge has travelled.

Secondly, when there is a charge travelling as I mentioned it is essentially we are talking about the flow of electron flow of charges. So, the flow of charges is also a indirect measure or a direct measure rather of the rate of the reaction. So, in other word quantity of reaction and rate of reactions that is what I mention. Here is what you have is a quantity of reaction could be correlated with the charge and rate of reaction could be quantified with the current because current is the flow of charges per unit time across a point, it could be per second time parameter you can resolve what time parameter you wanted to carry. So, in other word when you are correlating something with respect to current, you are talking about the rate right because that is how we define current rate of flow of electrons across a point per second. That is how define the unit of current.

So, when you talk about this many current this much current is flowing in other word you are saying the rate of the reaction is proportional to this much current I am observing. Similarly when you talk about the amount of reaction which is taking place you can quantified in terms of the charges. And just to you know clues in a statement because we will be doing bunch of problems in the next class to start off with. Whenever we talk about chemical reactions, so all the chemical reaction is governed by transfer of electron from one species to another, I have already talked to you about it. So, in other word it is the potential difference across two points which we will dictate whether the charge will travel or not.

So, with this I will close in this second class with this very basic concept. So, I am going very slowly just to ensure that you know these basic concepts gets into your mind map and once they get into your mind map you know exactly how to develop the story.

So, let us summarize what we talked about today. We talked about whenever there is a reaction taking place there is a transfer of electron, rate of transfer of electron between species A to species B is in terms of rate of, rate could be defined in terms of the current and amount of reaction which has taken place could be governed or the quantity of reaction could be governed by the amount of charge which has been transferred. So, the amount governing the quantity of reaction and the rate governing the rate of reaction and this reaction will only take place. So, when the work function of these two things are at different point and in order from higher point to lower point that will be a spontaneous process, but from the lower to higher point you have to use external energy.

So, I will close in here. Keep this in mind and in the next class we will pick up exactly from here.

Thank you.