Elementary Electrochemistry
Professor Angshuman Roy Choudhury
Department of Chemical Sciences
Indian Institute of Science Education and Research, Mohali
Calculation and Graph Plotting for Conductometric Experiments

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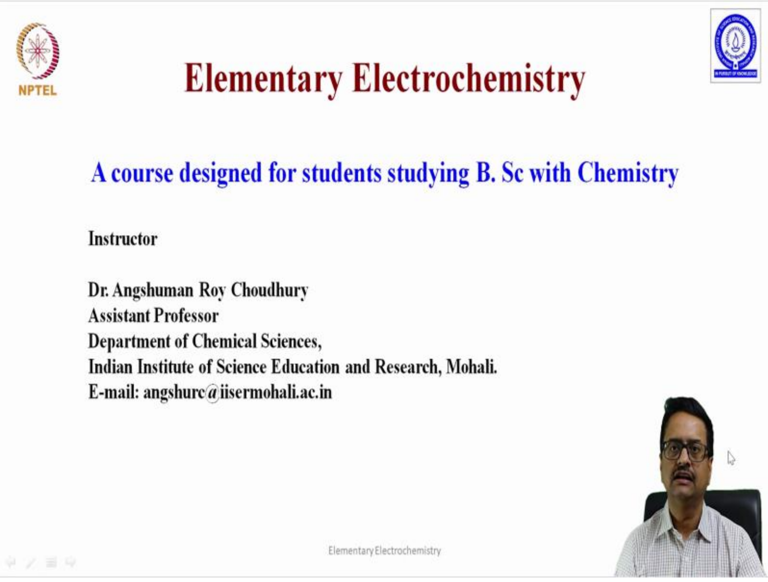

Welcome back to the course entitled Elementary Electrochemistry. We have now reached the last lecture of this course, and I hope you have seen the demonstrations of electrochemistry experiments, the conductometric titrations, and also our dilution law experiments.

And, in today's lecture, I will discuss the calculation part and how to draw a graph plot for those experiments, and then I will show you how you can calculate the endpoint of those experiments. So, before going into the presentation, I want to show you the data.

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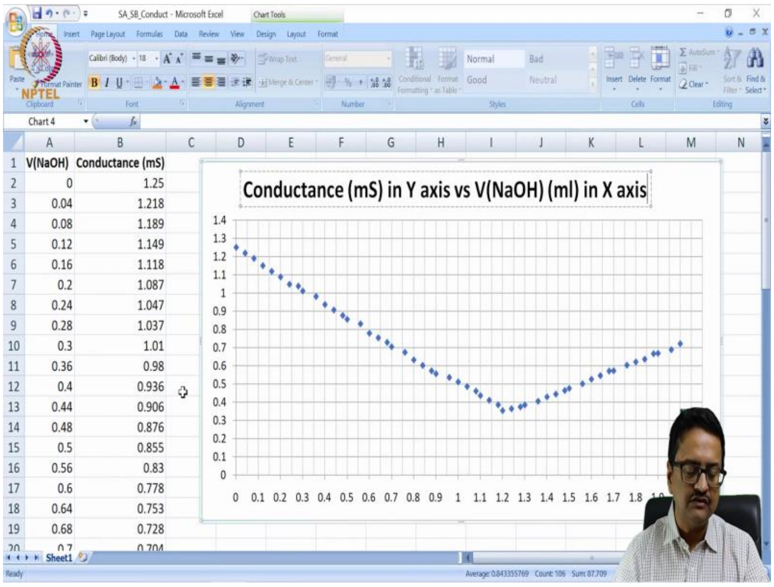

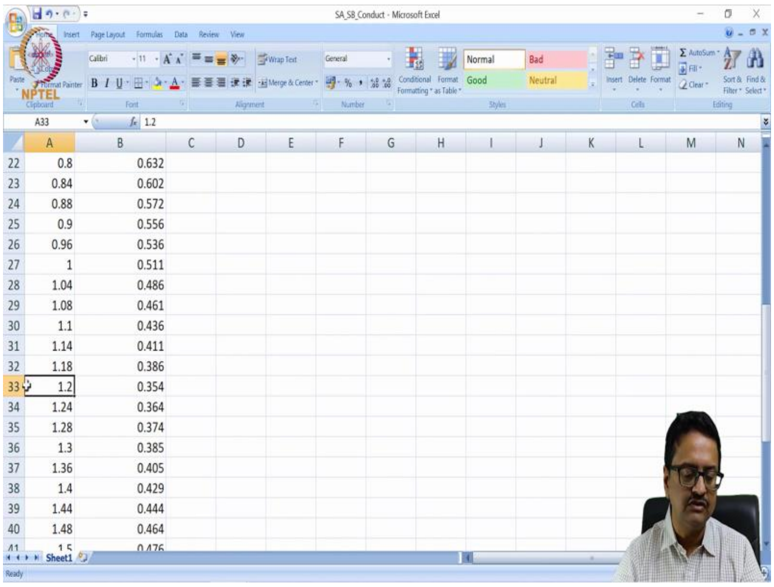

So what you can see here is that I am demonstrating it with the data of strong acid versus strong base titration that is HCl versus NaOH. So in that experiment, we generated the data with different volumes of NaOH and the corresponding conductance in milli-siemens that was recorded.

So if you remember the data, we took it at every interval of 0.04 ml of NaOH being added, and then we equilibrated the solution to reach the stable conductance value and read the conductance values. And we had done this experiment up to 2 ml and hope you remember that the NaOH was our 10 times more concentrated than the unknown HCl.

So when we look at this data, we see that at 1 ml also it is continuously reducing and then 3.386354 and then it starts to increase and then it slowly increases beyond that. So it is somewhere here at around 1 point, between 1.2 and 1.24 ml we should have our endpoint.

So when these values that is volume of NaOH was plotted against the conductance, you can see a V-type plot that I have shown here. So these data points are generated from the experiment.

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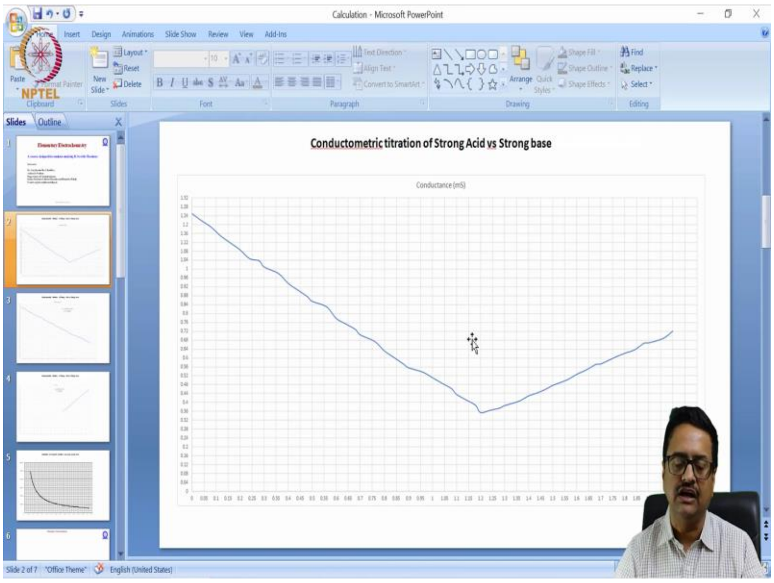

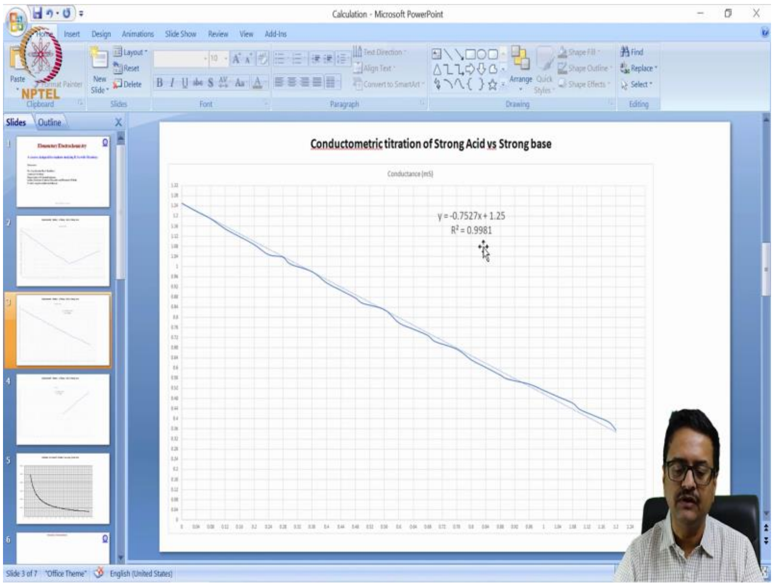

So now what we have done is that we have plotted this and joined with straight lines. So it looks joined with line, that is it looks like a V. And then what I have done which one can do using graph paper in a different way, I will tell you about that, what I have done is I have splitted this graph into two parts.

One part is this downward line that is the negative slope line and the positive slope line and then I have used Excel to calculate the equation to fit those points that is the equation for a straight line where y equal to mx plus c is here, where the c is the conductance value at 0 volume of NaOH, that fixed c and the fit is reasonably well 0.99 is the R squared value. So that indicates the fit is very good. So with that, this is my equation y equals mx plus c for the points before the equivalence point.

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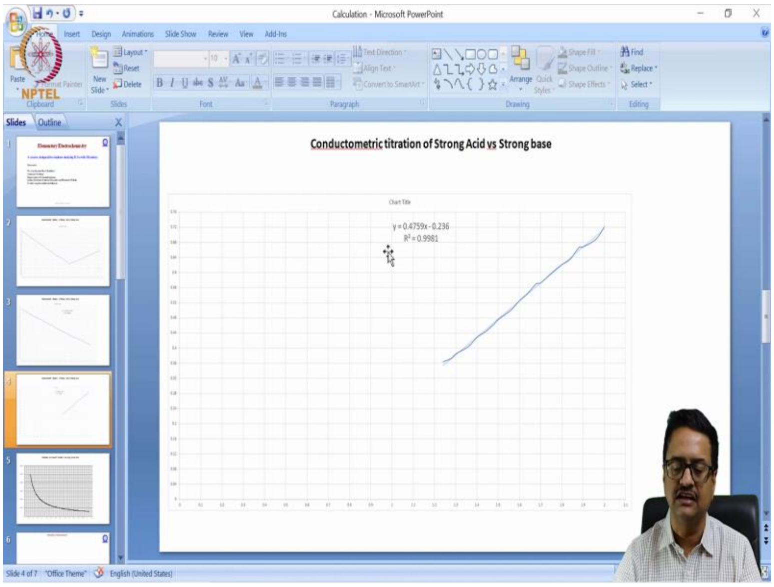

I have taken the line on after the equivalence point which is showing a steady increase in the conductance and in the same way I have drawn a best fit straight line using this data points and again it is 0.998 which is again a good fit. So one can easily calculate the endpoint by using these two equations.

The previous one here and this one there and try to find at which point these two straight lines meet using simple mathematical method. So that point where these two lines would meet, one can I assume that is the endpoint. So that is the value of x and y for the endpoint.

And here the x will then give you the value for volume of NaOH. So using that one can easily calculate the concentration of unknown HCl solution. Remember that we had already standardized the NaOH solution using oxalic acid as primary standard. So we already know the strength of that NaOH solution.

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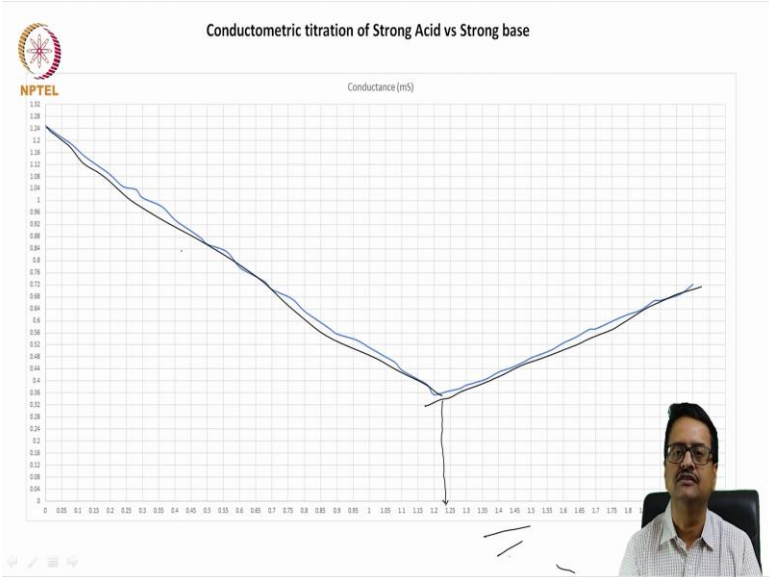

The other method using graph paper is for you to draw a straight line, draw a straight line from this to that using a scale and then also draw another straight line using those. Wherever those two straight lines meet that will be your equivalence point.

So like this one can get the equivalence point using a graph paper and drawing an approximate, the correct straight line on the graph paper. Both the methods are acceptable. So using this method, you can easily get the endpoint. So this method can be used for both for all the conductometric tritration that you have seen and I would encourage you to use the data which I will be sharing in the group with all of you with the lecture slides.

So there you will get the entire data and then you can try to plot and see yourself how the weak acid versus strong base titration changes and how the precipitation titration, triple mixed-up titration plots come out and easily you will be able to understand this experiment yourself and just demonstrating with one of those experiments. Other three data sets, I will share it with you in the forum.

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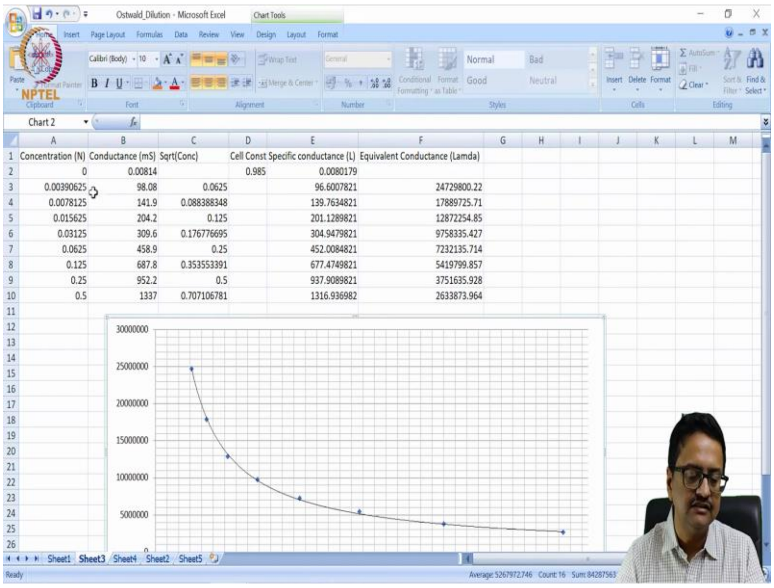

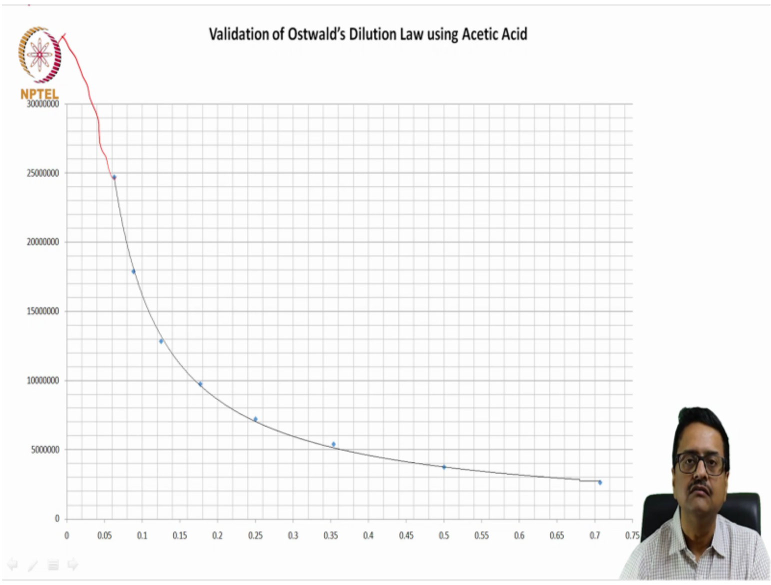

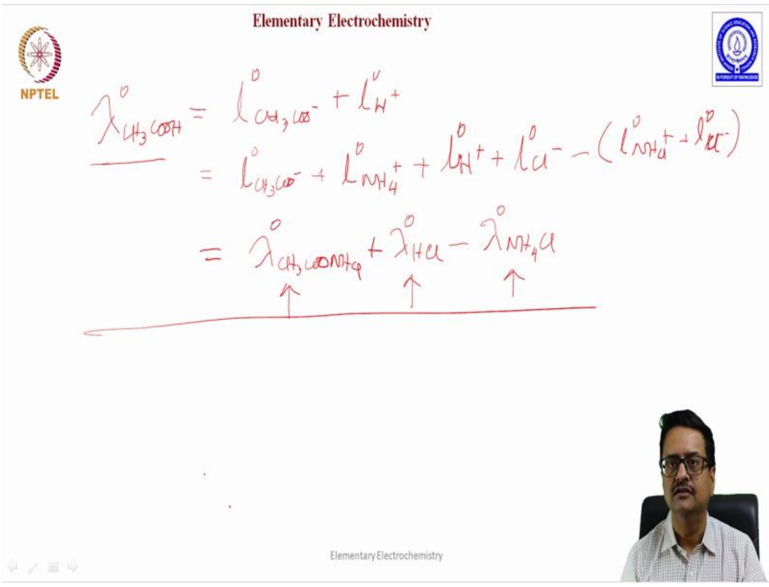

The other experiment that I had drawn, I had done is the experiment of Ostwald dilution law, verification of Ostwald dilution law using various concentrated solutions of acetic acid. So what I have done here is, this is the concentration in normality and these are the conductance values that we measured during the experiment. So this is our experimental data.

And we, if you remember, we determined the cell constant to be about 0.985 if I am not very much wrong. So this cell constant is used to calculate the specific conductance from the value of conductance using the formula conductance into cell constant is specific conductance, x.

So immediately, you know that this value is my specific conductance value and then you pull it, you will get the corresponding specific conductance value. I should not have done that. I had already done a calculation.

Now we need to calculate the equivalent conductance, lambda which you know that equivalent conductance is 1000 into specific conductance by concentration. So using that method, one can easily calculate the value of equivalent conductance for all of those solutions.

And then what I have done is I have plotted the square root of concentration. You see, I have written square root of concentration versus the equivalent conductance. So when I am plotting square root of conductance versus equivalent conductance, I am getting a plot like this.

So what we see here is like a plot which keeps on increasing towards the lower value of concentration, and you see what happens in this concentration range is that the conductance of solution decreases very, very rapidly. As a result, the resistance increases and the instrument does not record those values very accurately. So we cannot determine the value of equivalent conductance at infinite dilution for this solution.

So one should extrapolate this to, one should extrapolate this to the 0 to get it, get the value of equivalent conductance at infinite dilution or one should use the method of Kohlrausch's law that is we have already discussed in that class that if you want to determine the lambda 0 for acetic acid, then you have to use the method where you have l0 of acetate plus, l0, l0 for H plus.

So now, one can write this as l0 for CH3COO minus plus l0 for NH4 plus plus l0 for H plus l0 for Cl minus minus l0 for NH4 plus plus l0 Cl minus which essentially means you need lambda 0 for ammonium acetate plus lambda 0 for HCL minus the lambda 0 for NH4Cl.

So if one can determine the equivalent conductance at infinite dilution for these three strong electrolytes, then one can determine the lambda 0 for this weak electrolyte. So for any weak electrolyte one has to determine its lambda 0 value in this way.

So with this, I will conclude this course by saying that hope you understood some basic aspects of electrochemistry, conductance, and its applications and we will have our final exam ready soon.

And in that exam, we will have a descriptive type of questions, descriptive type means you will have to probably solve some mathematical problems yourself, you may have to derive some equations that we have discussed during the course, and there may be some questions where you will have to draw some graphs or plots and explain the nature of the plots, why it comes like that and such and such. So I hope you all do well in your final exam. With this, I conclude this course. Thank you.