# Elementary Electrochemistry
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## Conductometric Titrations of Weak Acid with Strong Base

Welcome back to this experimental demonstration in the course Elementary Electrochemistry. In the previous video, we have demonstrated the conductometric titration of strong acid versus strong base and we have got the readings noted, we will discuss about the readings how to plot the graph, and then how to get the end point from the graph after we complete these experiments.

So, now I am going to show you, demonstrate the experiment of weak acid versus strong base using conductometric titration.

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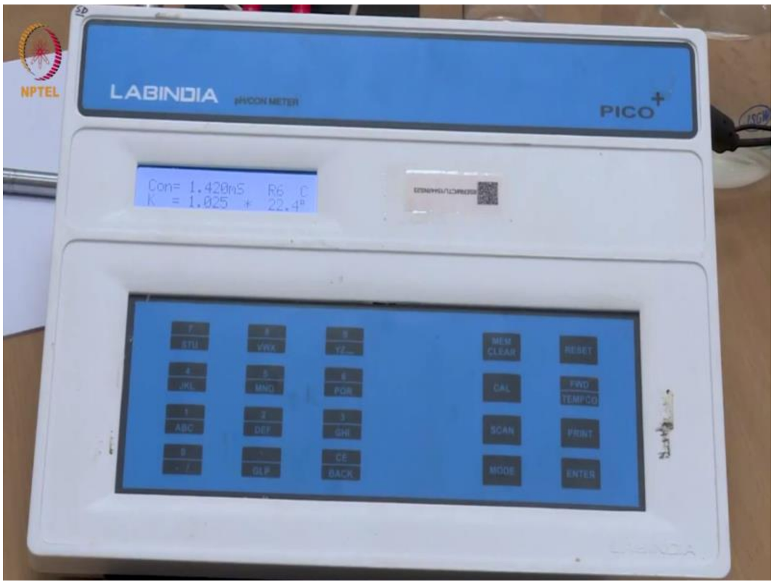

So, here you can see in the inset that I have already calibrated the conductivity meter with a solution of 0.01 molar KCL and the conductance of that 0.01 molar KCL is supposed to be about 1.4 to 1.44 milli-siemens with a cell constant of 1.025. So, with this solution we have calibrated the instrument. Now, I will change the solution I will keep it aside for future checking once again after the experiment is over.

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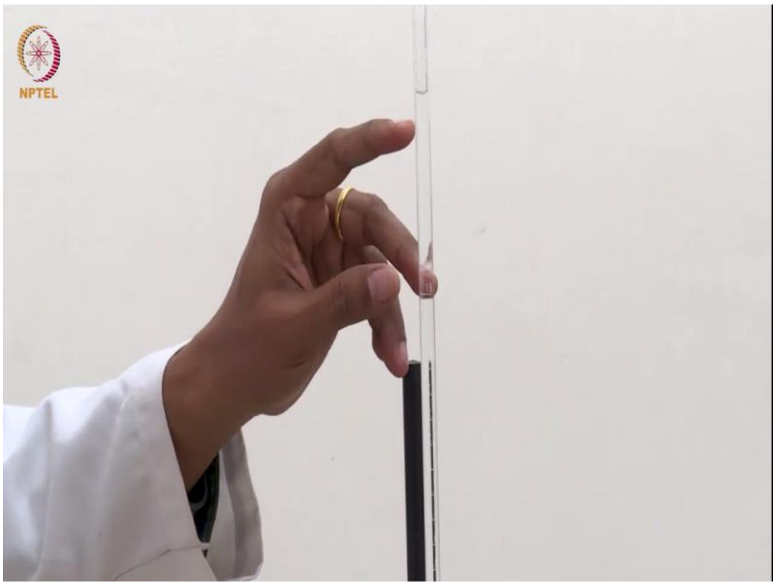

And we will use this N by 10 acidic acid as the unknown analyte, this is prepared approximately N by 100 and we will titrate this with the stronger, 10 times stronger NaOH solution which is N by 10 NaOH which I have taken in this 10 ml burette which you can see here is a 10 ml burette and I have filled it up to the mark.

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Now, I am going to change the solution, I am going to keep this KCL solution aside and before doing anything I need to wash the electrode thoroughly so that there is no leftover KCL in the electrode, wash it with plenty of distill water, wash the temperature sensor and discard that water then we need to wipe it out once with tissue paper to remove any water droplet.

And also we should clean the inner part of the glass which is protecting the electrode from accidental damage.

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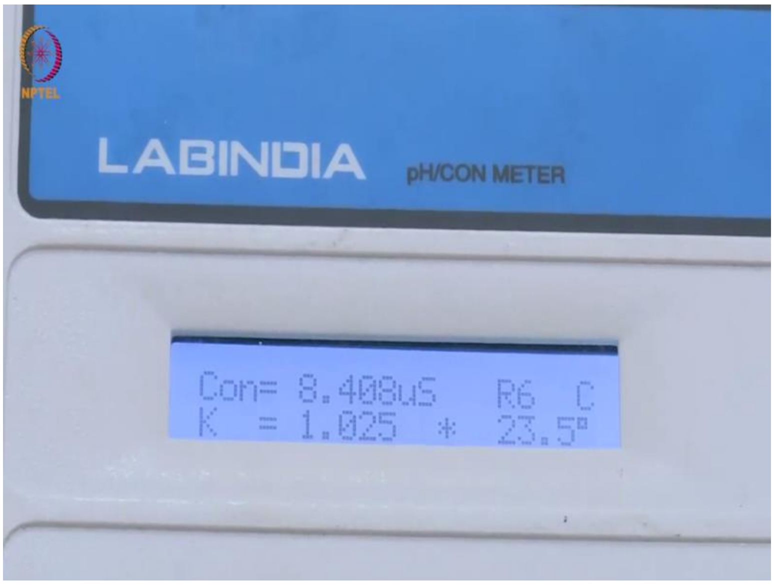

Now, we will take about 20 ml, 25 ml of water such that the electrode is completely dipped in water and it should then show the conductivity of this water which should be close to about 8 to 10 micro-siemens. So, you can see in this conductivity cell, the conductivity meter you can see the reading has come to about 8 micro-siemens which is fine for a good quality distilled water because when we add acidic acid the conductance of this solution will increase.

So, now I am placing this just below the burette so that when add the solution then the drop should not drop outside.

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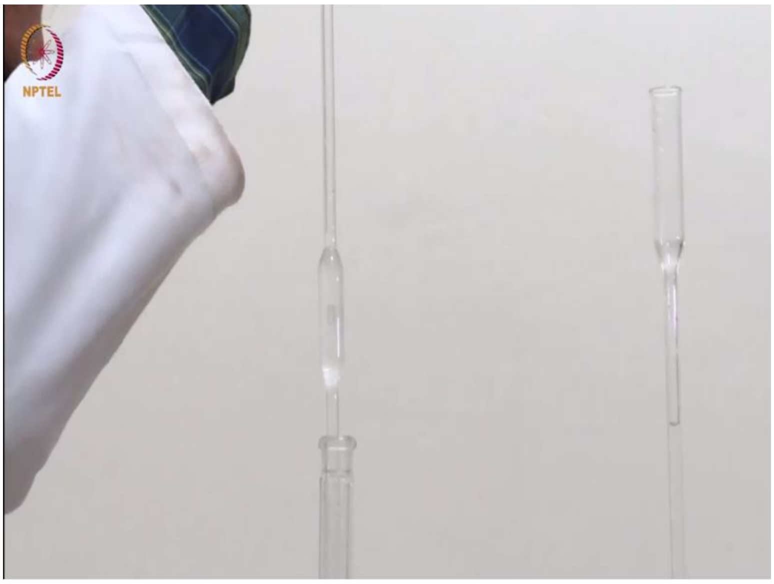

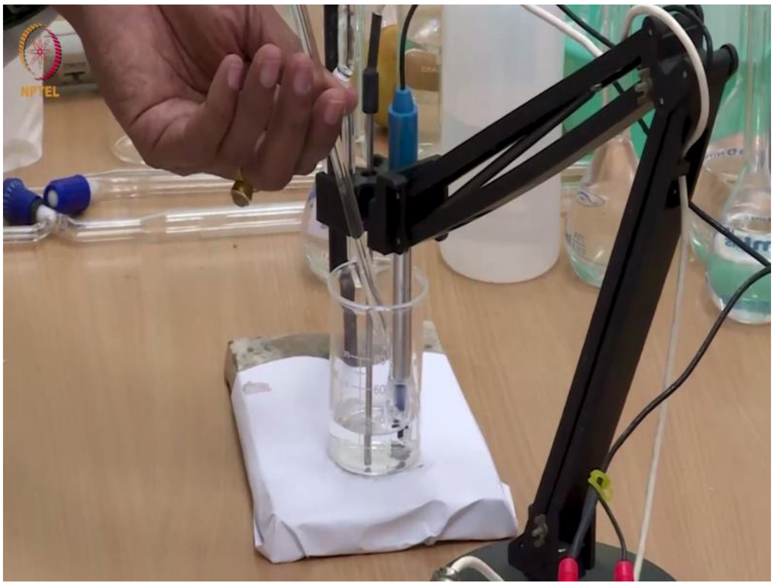

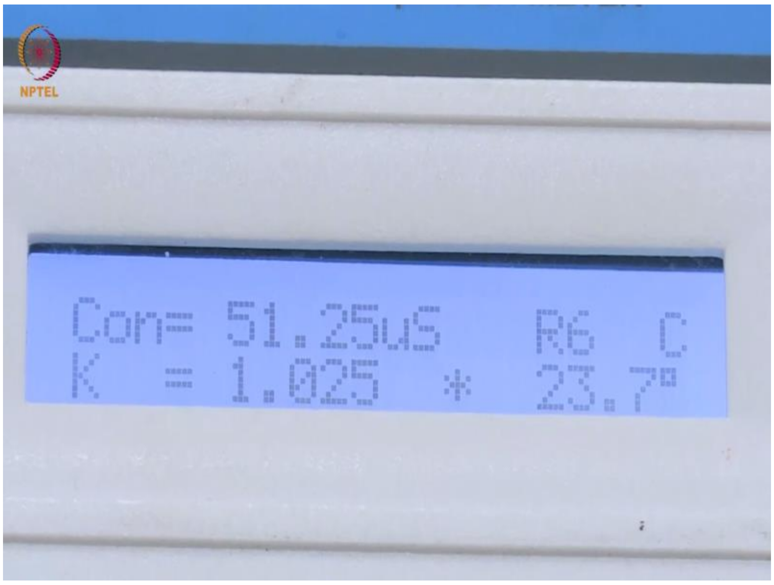

Now, I am going to use this 10 pipette. We will use a 10 ml pipette to pipette out acidic acid and then transfer it to the reaction beaker. There are some water droplets inside so before we take our required amount I will take little amount of this acidic acid to rinse the inner wall which is always required when you try to do some quantitative analysis. You take the analysis analyte solution and rinse the inner wall and discard the first part.

So that when you are taking this acidic acid it is not getting diluted because of the droplets that you have already in the pipette. So, now I am taking 10 ml of acidic acid exactly up to the mark and we will transfer it to this beaker carefully without letting any drop fall outside. So, you may be seeing in the meter that now it has started fluctuating because now it is getting mixed with acid and that will increase the conductivity to some extent.

So, I have transferred 10 ml of acidic acid and it is still not homogenized then that is why it is showing some like 50, 55 micro-siemens, we should homogenize the solution and it should show then the correct conductivity of about N by 100 acidic acid. Here what we see is the conductivity is only about 70 micro-siemens. So, we will wait for a while for this reading to stabilize with a 69.9 and we note that the reading is coming in terms of micro-siemens.

So, with 0 ml of NaOH added the conductance is 69.93. So, just like what we have done with the previous titration strong acid and strong base we added the same quantities of 0.04 ml of NaOH at a time we will continue the same practice here as well.

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So, using this burette I will be adding 0.04 ml portion of NaOH and measure the conductivity and note down the readings. Now I have added 0.04 ml of N by 10 NaOH which is nearly 10 times strongly than the concentration of acidic acid and the conductance has reduced to 60.77.

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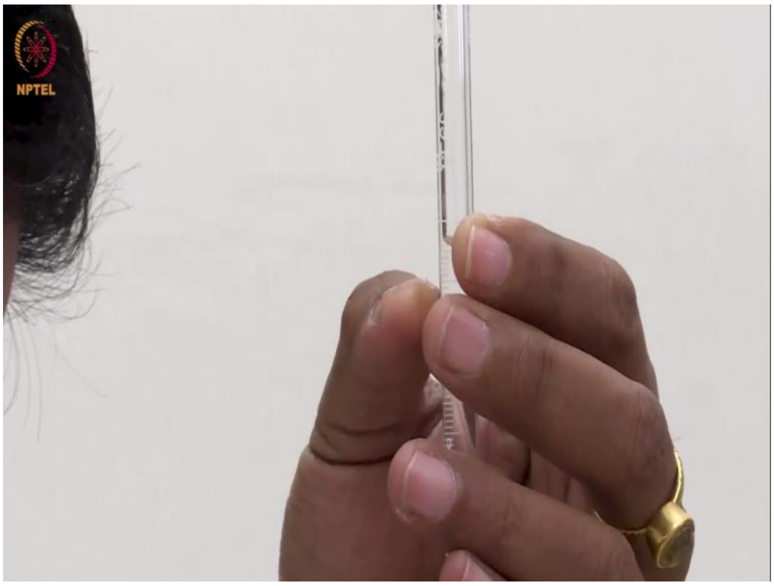
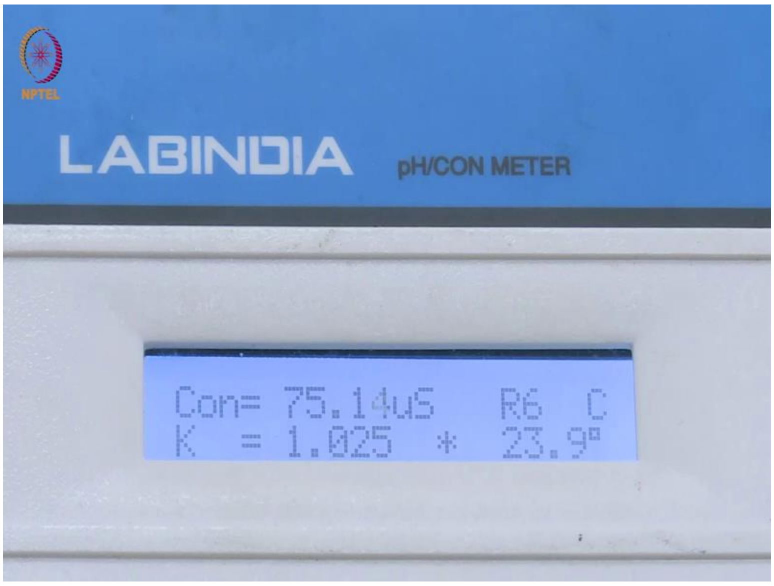

NPTEL


NPTEL
LABINDIA
pH/CON METER
Con= 75.14uS R6 C
K = 1.025 * 23.9°


NPTEL
LABINDIA
pH/CON METER
Con= 81.62uS R6 C
K = 1.025 * 23.9°

So, we will now continue the same addition 0.04 ml each step homogenize the solution always to get the correct conductivity 56.96, 0.12 ml and it is 54.90, let us wait because I think at some point it should start increasing slowly, and then we have cross the equivalence point, then it will start increasing significantly, so 57.89. So, with 0.16 ml we see that the conductivity has started increasing slowly.

And this feature we have explained during the theory class that initially with decrease happens because the concentration of H plus reduced suddenly by addition of NaOH and then when a certain amount of H plus has been removed. Then acidic acid starts to disassociate faster because the equilibrium is now shifted more towards the right that is acidic acid disassociating into acetate and H plus.

So, it is now producing more and more H plus ions. So, as a result the conductivity of the solution increases. So, what we are observing here is that the conductivity is slowly increasing because more and more acidic acid is getting disassociated and giving you the H plus ions in solution. So, we take these reading as 69.02 and then we continue as usual. So, we have added 0.24 ml.

And the conductivity again initially decreased because it removed the H plus ions and again it is increasing because more ion, more acidic acid is getting disassociated I am giving you H plus ions in solution. So, we need to wait for the while for the reading to reach its stable value. So, we take the reading as 75.03 and you see that it is still increasing. So, you can wait for another 5 seconds or so and see where it goes see now it is stabilizing 14, 13, 12 so it is about 75.13.

So, you can see that every time when I am adding 0.04 ml, now we have reached to 0.28 ml, initially the conductance decreased because we added NaOH it consumed the disassociated H plus and now the conductance is increasing because acidic acid is further disassociating. So, this was not observed during the titration with HCL because HCL is always fully disassociated.

So, as soon as we added NaOH, it consume some H plus ions and the conductance were reduced and it stayed at that reduced value, but in this case it gets reduced then you wait for a while the acidic acid disassociates and compensates for the consumption of H plus reaches its equilibrium then you are able to see a stable reading in the conductivity meter. So, here you have to be very patient and do this experiment carefully and smaller amount and making this solution equilibrate and give you a stable conductance value.

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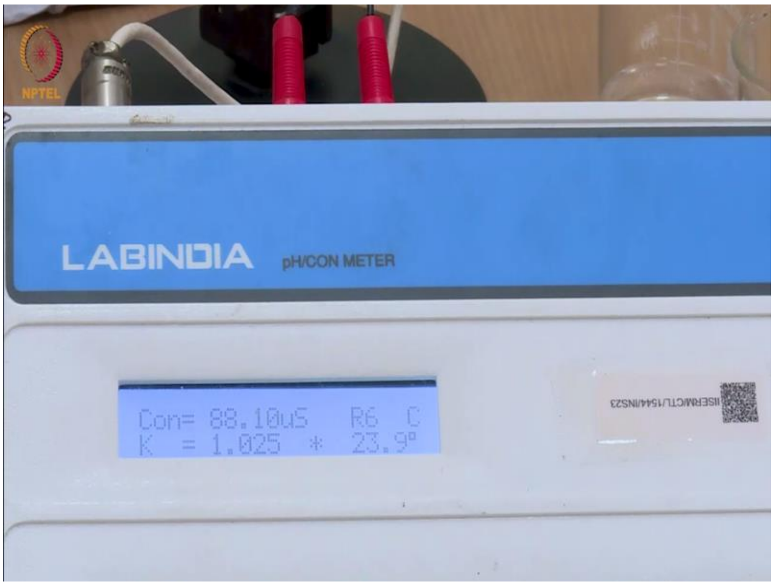

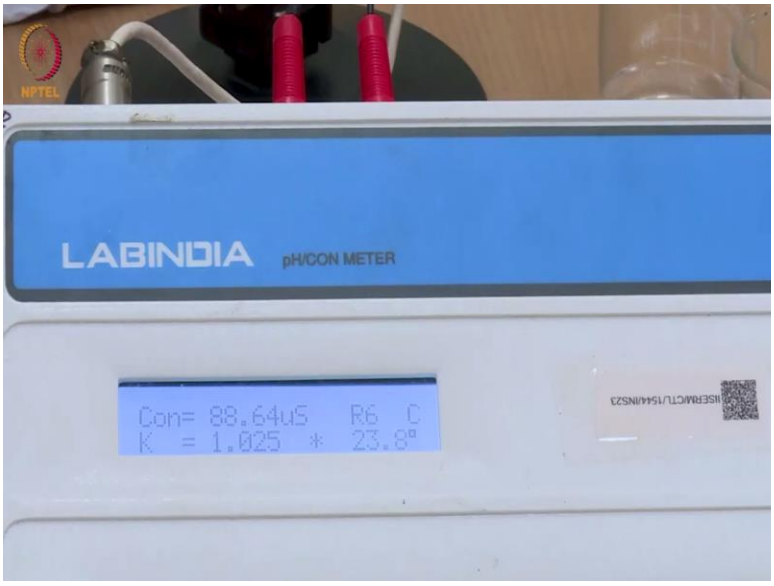

You see basically initially the conductance falls much below every time we are seeing the same phenomena and this is nothing, but due to the consumption of H plus by NaOH that we have added, and then slowly acidic acid disassociates, and compensates for the consumption of H plus, so the equilibrium is reached. And we are reaching a conductance which is now the equilibrium conductance of disassociated acidic acid along with some Na plus ions. Now, we have reached a stable value of 88.64.

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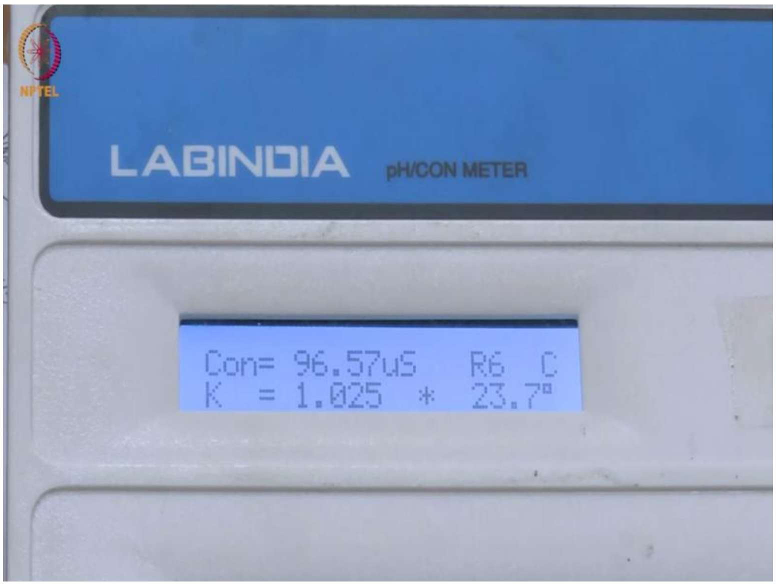

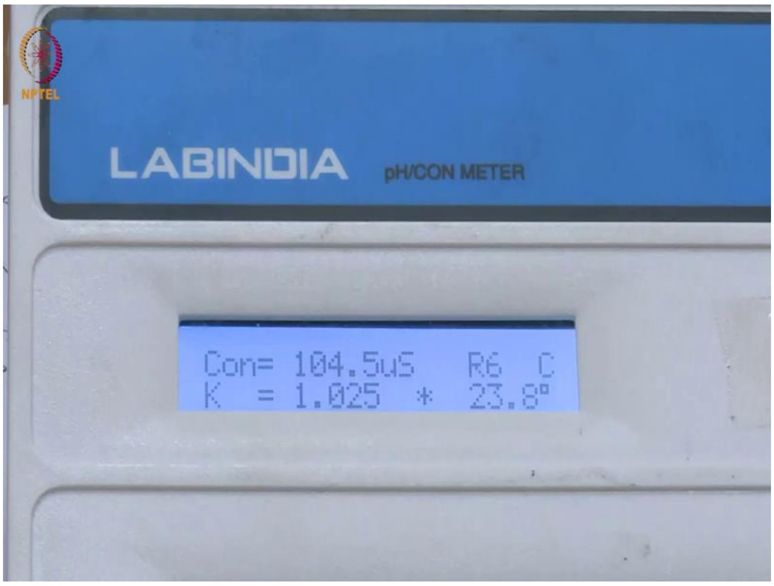

Now, I have added 0.36 ml and the conductance is again increasing we need to wait for a while to see it is stabilizing. Now, we see that the reading is nearly stabilized that 96.54 which is still slowly increasing, but we can take it as 96.57. So, we will add one more portion of 0.04 ml. So, now we have added 0.4 ml and it has now stabilized to 104.5 micro-siemens. So, I will continue taking greetings like that and I will again show you when we start seeing a significant jump.

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By adding many 0.04 ml fractions, now we have reached 0.6 ml and what we are observing is that here also the same thing is happening. Initially the conductance had reduced and slowly it is again increasing and touching 150 micro-siemens. So, I am guessing that the equivalence point has not been reached. Once the equivalence point is reached then on addition of a certain amount of NaOH will not reduce the conductance. But will increase the conductance of the solution. So, I am going to take these reading as 150.3.

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Now with this addition we have reached a stage of 0.7 ml and in this point we notice that the conductance did not reduce at all rather it increased from the beginning itself and it is reaching a value like 171.2, 171.5 maybe. So, I am guessing that you have come very close to the equivalence point. Once again the same phenomena has happened we have now added 0.06 ml before I could close it reached 0.06 ml so it is 195.2.

It is still increasing 195.5 maybe little more we will wait. So, we take this as 196 because now the increase it has become very slow and we will reach up to 0.8 ml. You see that when it is stabilizing and it gives you a reading it has suddenly increased to 300 then it is coming down to 212 and so on. This indicates that the endpoint has been crossed and we are now adding more NaOH one can check whether it is beyond equivalence or not by addition of one drop of phenolphthalein indicator which we can also do just to make sure that we have crossed the equivalence point or not.

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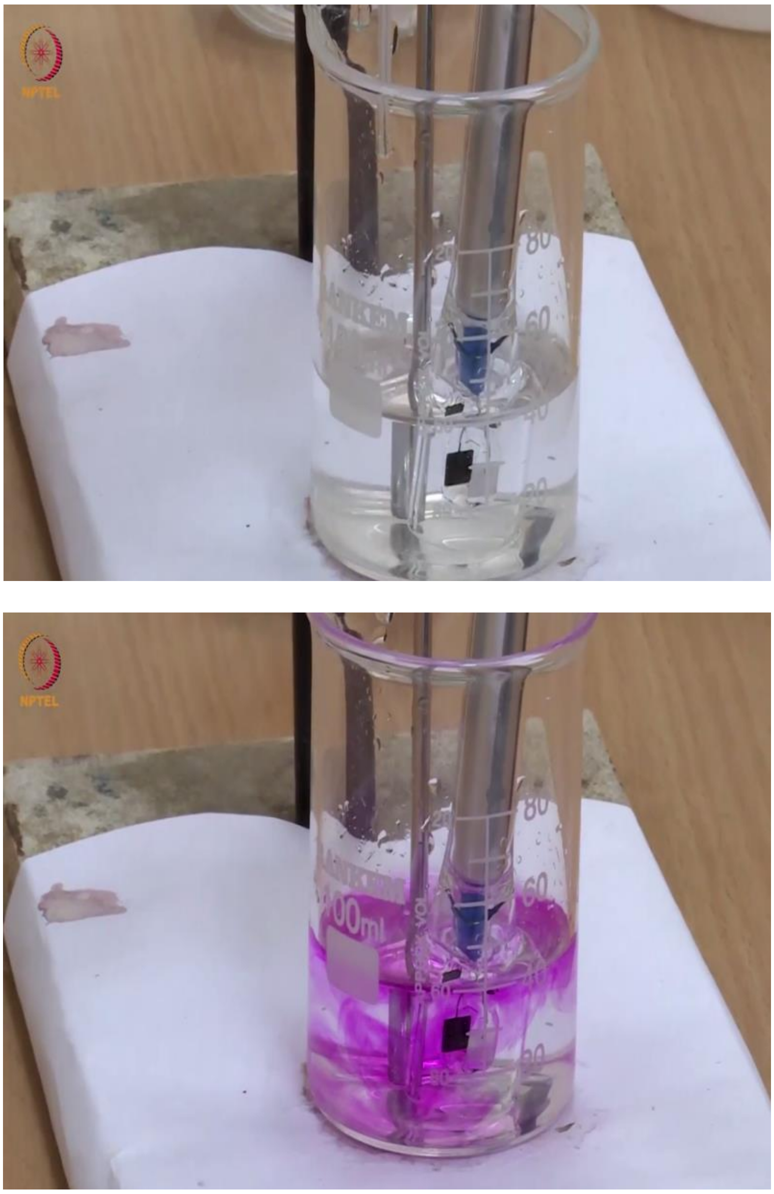

We will just add one drop of phenolphthalein in this solution to make sure that whether we have crossed the equivalence point or not. So, now I am adding just one drop of phenolphthalein to see whether we have crossed the equivalence point or not. So, now you see that the solution it has turned pink. So, this reading of 0.80 which is 211.6 is a point where we have crossed the equivalence point, maybe in the previous itself we have crossed that we will know when we plot the graph.

So, now after the equivalence point I will need 3 or 4 points which are slightly away from the equivalence point. So, what I will do is I will add 0.1 ml portions of NaOH each time, shape well and take the reading and we will do it for 5 or 6 readings that is 0.5 up to 0.5 ml.

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So, now I had added 1.1 ml reached 90.90 and the conductance has increased and stabilized quickly to 67.2. You see when it is just NaOH and there is no hydrolysis, there is no disassociation of acidic acid the conductance is reaching its equilibrium value very soon. So, this certainly is of course an indicator we did not have to add the indictor to know whether we have crossed or not.

In this case I have added just to show you that the reading that we are getting and what interpretation we are trying to draw is correct. Now you can see by addition of 0.1 ml each time the conductance is increasing step wise and maybe we will take two more or maybe three more readings so that after the equivalence we have sufficient number of points to draw a best fit straight line.

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So, we have reached 1.1 ml and the conductance is 384.6 we will go to 1.2 ml. You see that after adding the conductance has not changed because it has only changed the conductance of the locality where the drop has fallen and then when I shake, when I try to equilibrate, when I try to make it uniform, homogeneous solution then the effect of additional NaOH is easily seen in the conductance of the solution.

So, it is very important that for conductometric and potentiometric titration that after addition of NaOH you homogenize the solution before taking the reading from the conductivity meter or pH meter. So, we take this as 436.5, we will take two more readings up to 1.4. So, with 1.3 ml it is 495.2 and we will take our last reading with 1.4 ml.

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So, let us just wait for 10 seconds to let this conductivity meter stabilize and show me the final conductance of this solution and we will note down the value as 553.8. So, with this we come to the end of this titration of weak acid versus strong base using potentiometry. So, here what we have shown, we have seen from the reading. When we plot it will a evident, we start with a particular conductance.

And then initially there was a small decrease in conductance, that is simply because that acidic acid disassociates to acetate and H plus iron and when we added NaOH at the beginning it consumed all H plus ions and reduce the conductivity of the solution. So, we observed that phenomena for fast two readings and from the third reading onwards we started seeing that the conductance again started to increase.

That is because acidic acid starts to disassociates then when there is lack of H plus ion in solution and it dissociates more and more and generates more H plus ion as a result the conductance was increasing, but that increase was very small, small in the sense every time it was increasing by about 10 to 15 micro-siemens and it continued increasing up to about 104 micro-siemens to 130 micro-siemens, slowly gradually over a range up to 0.5 ml.

Beyond that when we started adding NaOH at some point we saw the conductance is increasing significantly compared to before which then indicated that the equivalence point may have crossed to confirm that we added one drop of phenolphthalein indicator and it changed the colour saying that yes the equivalence point has been crossed. So, then we added larger fraction of NaOH to go away from the equivalence point.

And get 4 to 5 readings much beyond the equivalence point, so that we will be able to draw a straight line. So, in the next class when we discuss theory part of it, I will show you the plots of these experiments, how to do the graph plotting, and how to get the final concentration of HCL using the plots. So, I conclude this for this experiment and we will have one more experiment using conductivity meter that is the experiment of triple mixture which I will demonstrate in the next video. Thank you.