Elementary Electrochemistry
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Potentiometric Titration of Weak Acid with Strong Base

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Welcome back to this course, entitled elementary electrochemistry. In the previous couple of videos, we have shown you a demonstration experiment of Potentiometric titration of HCl versus NaOH. So, there we use the about N by 100, HCl and titrated it against N by 10 HCl. And we have noted these change in pH with continuous gradual addition of NaOH from a 10 ml burette.

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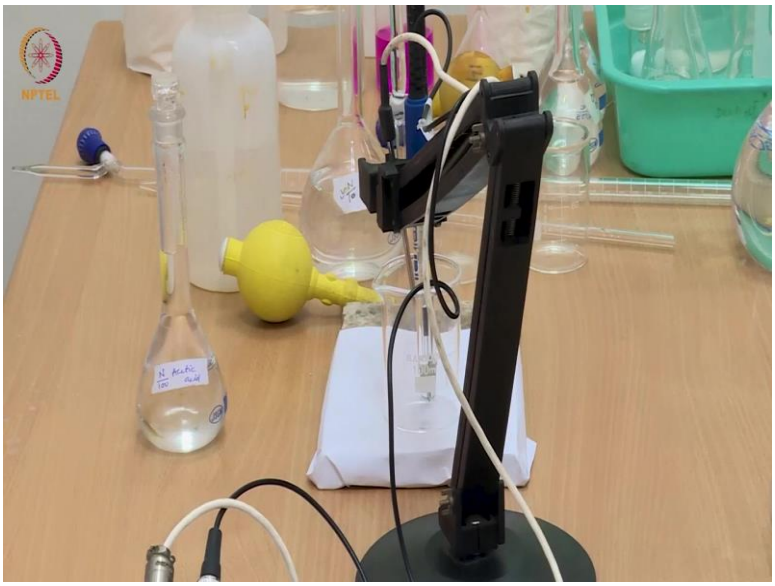

And we saw that the end point was reached with about 1.6 ml and I would like to again emphasize this that when you are doing a Potentiometric titration one has to use a 10 times stronger solution in the burette for the estimation. So, that the starting point and endpoint the change in volume is very little because pH is quantity which not only depends on the number of H plus ions, it depends on the number of H plus ions per unit volume that is concentration of H plus ions.

So, while doing a titration as you know, we are using NaOH so, amount of number of H plus ion is reducing simultaneously if the volume of the solution continuously increases, then there will be an error in measurement of pH that is why we use 10 times concentration of solution.

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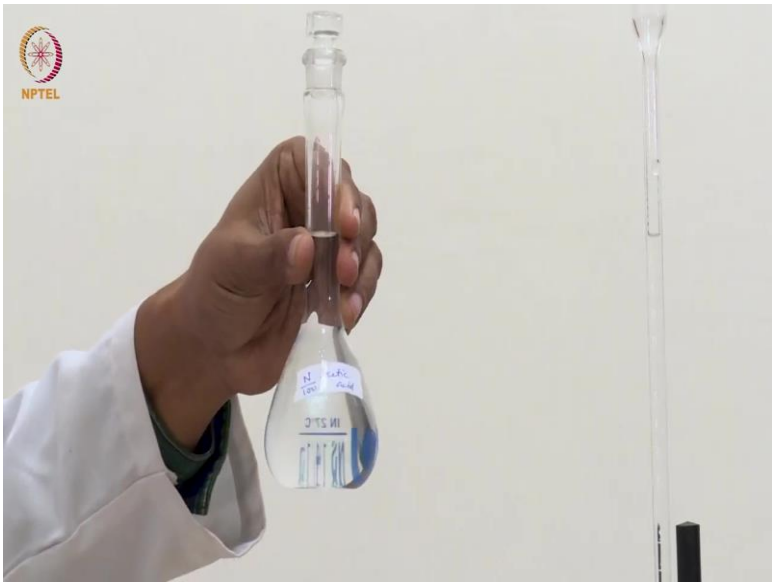


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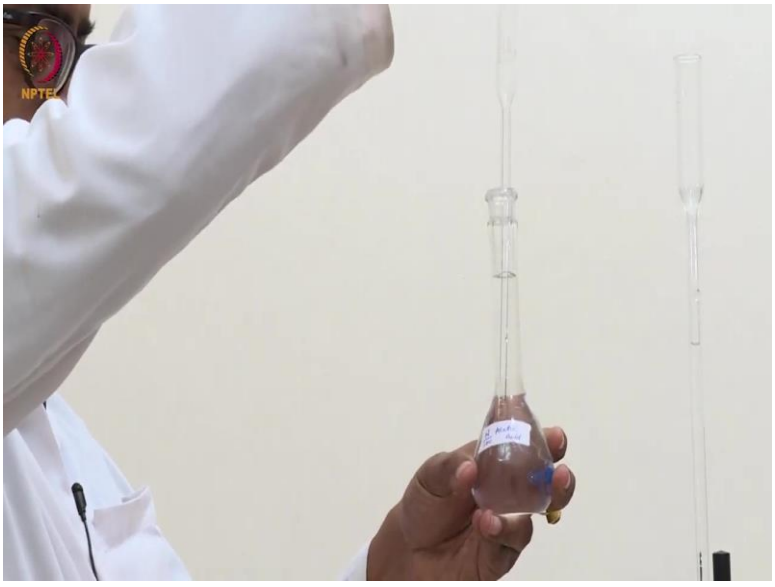
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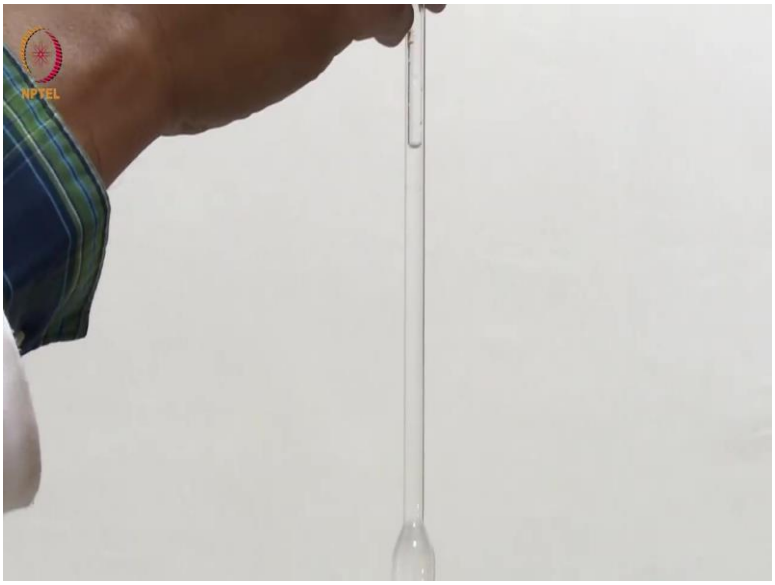

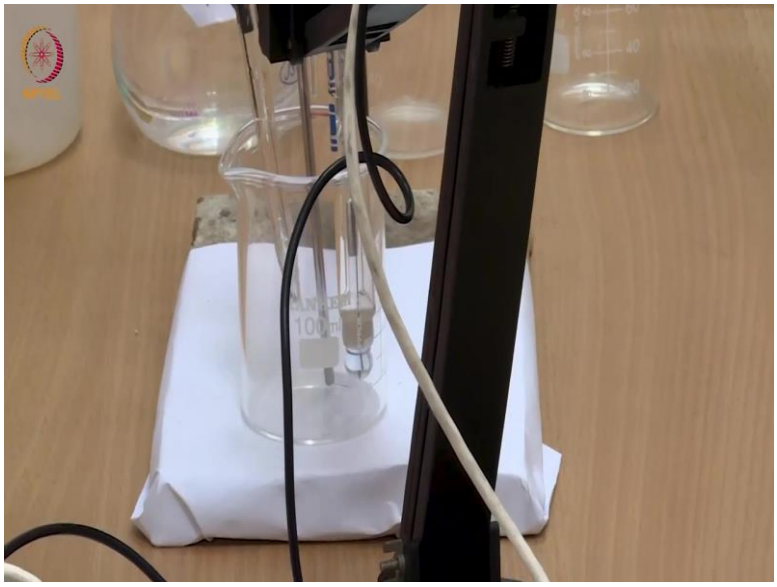

So, now in this second experiment, I am going to use this N by 10 acetic acid solution, which is of course, approximately N by 10 acetic acid this we will take about 10 ML using a pipette in this beaker in which we have kept the conductivity we have kept the pH electrode immodest. We will use this pipette pump as before to pipette out exactly 10 ml of acetic acid solution we should carefully reduce the height to the mark and then transfer this acetic acid solution to this beaker in which we will be doing the titration.

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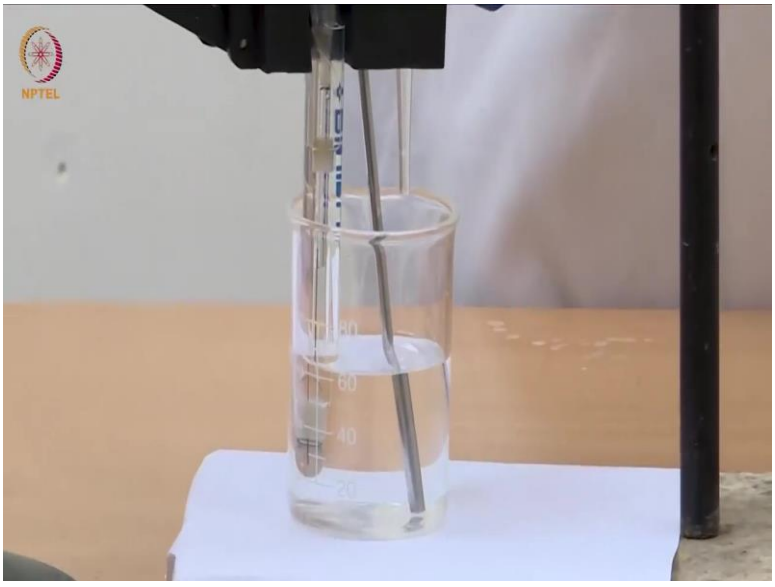
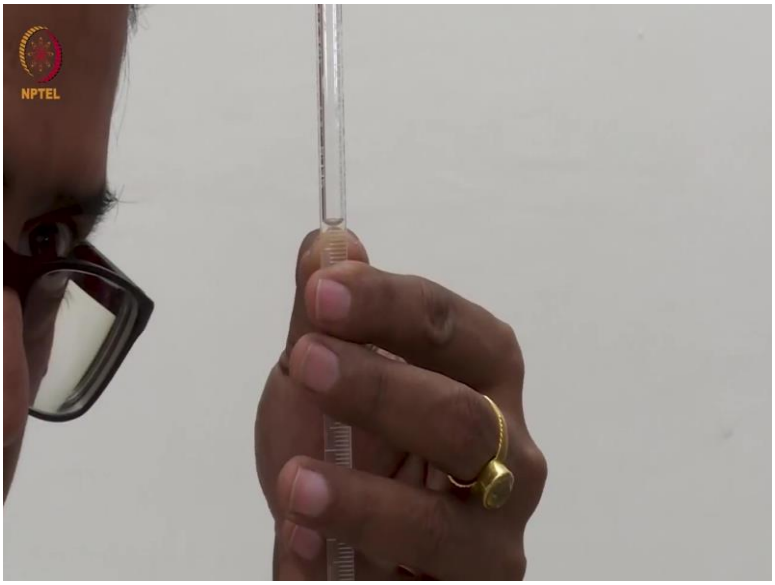
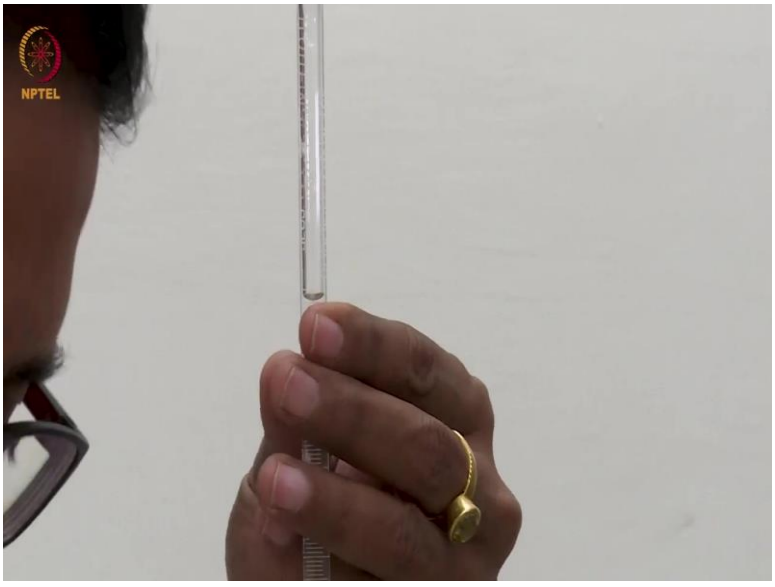
pH/CON METER
pH =+ 3.70
mV =+ 188.8 *
23.5°






LABINDIA
pH/CON METER
pH =+ 3.79 R3 a
mV =+ 184.0 * 23.6°



Now, you can see that after transplanting this 10 ml of acetic acid in this beaker, the electrode is not dipped inside the solution. So, we should add sufficient amount of water to make sure that the electrode is immersed and the pH meter reads the correct pH of this solution. So, this is the pH that is 3.0 at the moment 3.80 At the moment without addition of any NaOH. Let us wait for a while when it stabilizes and we will start the titration after that.

Let us note down this value as before addition of any NaOH that is volume of NaOH is added 0 added volume of NaOH is 0 and the pH is 3.74. Now, we will start addition of sodium hydroxide solution as before carefully by small amounts at a time and that is just about 0.02 ml each time, what we have done is we have filled this burette if a 10 ml burette using the standard NaOH solution.

So, after adding 0.02 ml of NaOH we need to write down the pH of this solution which turns out to be 3.79. If you remember in the previous experiment, when we had done it using this strong acid HCL our starting pH was much less it was like 2.7 and here the starting pH itself is like 3.74. So, like before we should continue addition of NaOH each time by about 0.02 ml very carefully, one drop at a time and then shake the solution well and let it equilibrate to give you the changed pH after addition of every 0.02 ml of solution.

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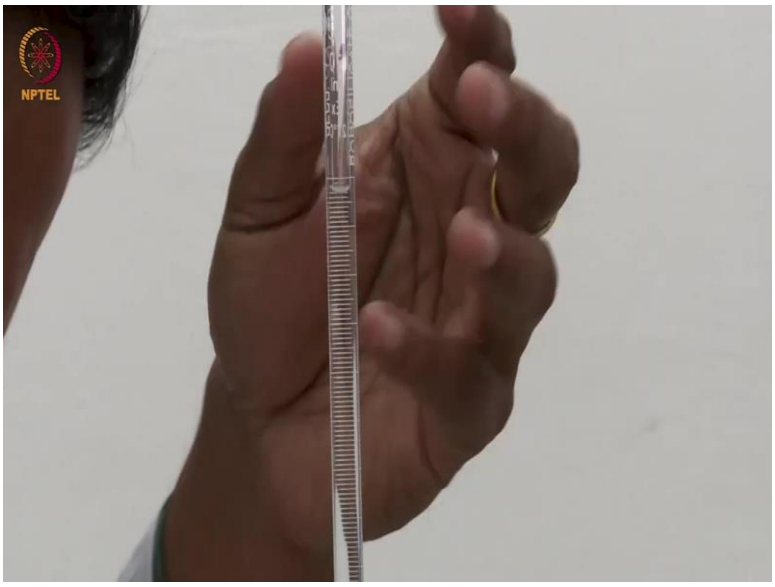

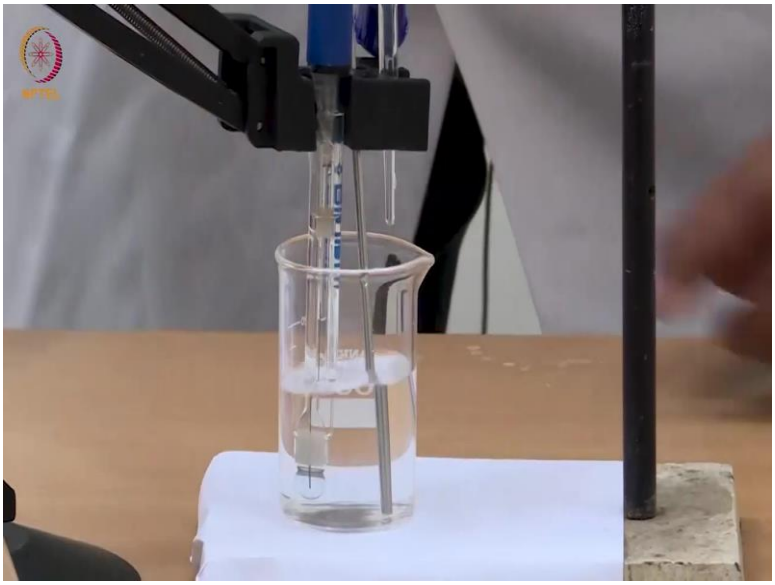


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So, now, it has become 3.83 So, what we see is the pH is increasing but it is increasing very slowly, which is always expected and we add some more drops of NaOH. So, we have added another 0.02 ml so, after addition of 0.06 ml of NaOH the pH almost does not change it stays at 3.82. So, like that we keep on adding small amounts of innovate solution from burette and keep writing down the readings till we see a drastic change is happening in the in pH.

So, now I will go a little fast so, gradually I have added 0.02 ml in each step and now I have reached a value 0.20 that is 0.2 ml of NaOH and current pH that you can see is 4.08. So, now I have reached a point where I have added up to 0.5 ml of NaOH and the current pH is 4.51. I am always repeating doing this measurement after every 0.02 ml of NaOH addition.

So, when I discuss about the results, I will show you the readings and then show you how to plot these data now I have reached 0.6 ml of NaOH and the corresponding reading is 4.66 that is pH is increasing. So, you can see that from 0 up to 0.6 ML there is a an increase of about 0.6 plus 0.3 about 0.9 in pH by addition of 0.6 ml of NaOH and we are nearing a point where there may be a sudden jump.

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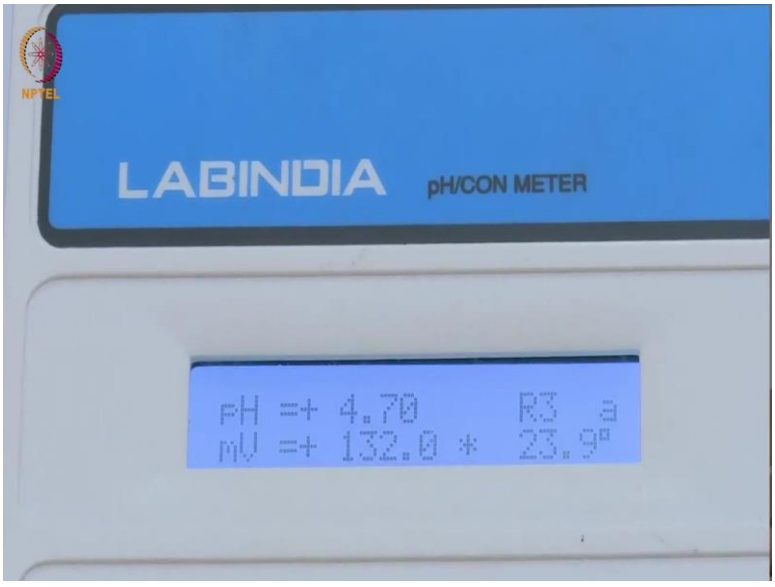
LABINDIA
pH/CON METER
pH =+ 4.70
mV =+ 132.0 *
23.9°


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LABINDIA
pH =+ 4.93
mV =+ 118.8 *
24.1°


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So, we should be more careful and add smaller of small amount every time as usual. Let the electrode equilibrate and then give you the correct pH when the equivalent point reaches. So, now I have reached a reading of 0.8 and the pH that we see here is 4.93. So, it is still not close enough to 7 where if we will see the jump, by slow addition of 0.02 ml each time I have now reached 1.2 ml and you can see the pH reading is 5.82 on the pH meter.

So, we are now reaching close to 7 and we should continue addition in the same way till we see a significant jump in pH at the equivalence point and when it crosses the value of 7 and then goes above. So, now I have reached a point of 1.3 ml where you can see the pH has increased to 6.23. So, what we can notice here is that in case of HCL this increase towards the equivalence point was more sharper than this one and it is gradually jumping from 5.4 to 5.8 to 5.23 over the range of about 0.2 ml that is between 1 ml and 1.3 ml.

So, we should keep adding small fractions and check the pH at every step that we add. Now, we have reached 1.34 ml and the pH is 6.77. So, now we have just crossed the pH value of 7 at about 1.38 ml now, the pH is reading 7.25 As we have done in the case of strong acid versus strong base we should continue this titration till the pH reaches 9, 10 or more than 10 and we reach again a flat region when the pH will not change significantly with addition of more and more NaOH.

Then only we will be able to draw the proper S type curve for the pH versus volume of NaOH titration. So, now, I have reached 1.42 ml and the pH is 7.91. I will continue addition further. So, by stepwise addition of 0.02 ml each time now, I have reached a point 1.50 ml you can see that the pH has increased to 9.46 which indicates that the endpoint has been crossed and we are measuring the pH of a solution which is now a solution of NaOH.

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So, we should continue taking 3 or 4 more readings so, that the pH crosses 10 and then the pH does not change with addition of more and more NaOH in this solution. Then the S type plot will be will look nice. So, you have seen the last two consecutive addictions has increased the pH from 9.36 to 10.21 and now it is 10.32 and I have reached 1.56 ml maybe just two more readings will be enough for us to end this titration.

Now, I have reached 1.6 and you can see the pH is not increasing as it was increasing about the time when it was going through the equivalence point it has increased to 10.40. So, we will just take one more reading which will be suppose 10.64 we are adding 0.4 ml at the moment remember that every after every addition of the tiny amount of NaOH, you have to check the solution. Well, so, that the solution becomes homogeneous the NaOH that has been added is distributed throughout the solution and the pH that we read is the pH of the solution.

So, now, I have reached 1.64 ml and the pH is 10.47. So, what we see over the last 4 readings if you look at then we will see that the readings are 10.21, 10.32, 10.40 and 10.47 over a range from 1.54 to 1.64 ml of NaOH that is over a range of 0.1 mL of addition.

This indicates that we have reached a plateau for the pH curve towards the high end of pH. So, what we started is with 5 point what we started is with 3.74 slowly increase the pH near equivalent point it jumped up and then towards the end it has again become flat. So, with this kind of data when you have got one can plan and stop the experiment and start plotting these data and then as you have learned in the theory class, we will have to plot delta pH versus volume of NaOH to find where the jump is maximum and from that point, we will determine the end point of this experiment endpoint of this titration.

Now, this acetic acid is a weak acid which essentially means that it does not dissociate completely. So one can determine the pKa of this weak acid from this Potentiometric titration curve. This we will discuss in the theory part of the lecture. I hope you have followed this experiment and you will be able to do this experiment in future.

And in the next experiment we will demonstrate the acid base titration using dibasic organic acid where you can understand that there will be two pKa values and there will be two sudden increments in pH during the titration till then goodbye thank you.