* Purpose:

1. Measure the change in the pH of acidic solutions (weak & strong) upon titration with different basic solutions (weak & strong).
2. Draw a titration curve showing the variation of pH vs. the volume of titrant added.
3. Find the equivalence point for each titration curve.
4. Choose the correct indicator for each titration.
5. Find the pKa of a weak acid from the titration curve.

* Theory:

Acid – Base Titration, a volumetric technique using volume as a basis of method, is a quantitative method employed to measure the concentration of an unknown analyte (titrand) by adding gradual amounts of a titrant with a known concentration and observing the change in pH using a pH meter. A pH-meter has a sensing element composed of 2 electrodes: the reference electrode called the calomel electrode and the second electrode called the glass electrode. A titration curve plot can be drawn, giving a clear idea on the indicator to be used because the pKa of an indicator, which is itself a weak acid, is about the same as the pH at end point of the titration.

1. **Titration of Strong Acid(HCl)/ Strong base(NaOH):**

* Procedure:

1. Rinse the 50ml burette with distilled water then with the titrant NaOH.
2. Fill the burette with NaOH till full.
3. Rinse a 100ml beaker with distilled water.
4. Using a 10 ml volumetric pipette and a pump, transfer 20 ml of HCl to the beaker. Then, add 20 ml of distilled water to immerse electrode (using a 10 ml volumetric pipette).
5. Calibrate the pH meter and place the electrode in the beaker. Make sure it touches neither the bottom nor the magnetic bar.
6. Start titration by adding 2ml of NaOH every time until 10ml are reached. Record pH after each drop while stirring.
7. Proceed with titration by adding 1 ml each time until 20ml are reached. Record pH after each drop while stirring.
8. **Titration of Weak Acid(CH3COOH)/ Strong base(NaOH):**

* Procedure:

1. Rinse the 50ml burette with distilled water then with the titrant NaOH.
2. Fill the burette with 0.2NaOH till full.
3. Rinse a 100ml beaker with distilled water.
4. Using a 10 ml volumetric pipette and a pump, transfer 20 ml of CH3COOH 0.2 M to the beaker. Then, add 20 ml of distilled water to immerse electrode (using a 10 ml volumetric pipette).
5. Calibrate the pH meter and place the electrode in the beaker. Make sure it touches neither the bottom nor the magnetic bar.
6. Start titration by adding 1ml of NaOH every time until 20ml are reached. Record pH after each drop while stirring.
7. Proceed with titration by adding 3 ml. Record pH while stirring.
8. **Titration of Strong Acid(HCl)/ Weak base(NH3):**
9. Rinse the 50ml burette with distilled water then with the titrant HCl.
10. Fill the burette with HCl till full.
11. Rinse a 100ml beaker with distilled water.
12. Using a 10 ml volumetric pipette and a pump, transfer 20 ml of NH3 to the beaker. Then, add 20 ml of distilled water to immerse electrode (using a 10 ml volumetric pipette).
13. Calibrate the pH meter and place the electrode in the beaker. Make sure it touches neither the bottom nor the magnetic bar.
14. Start titration by adding 1ml of HCl every time until 10ml are reached. Record pH after each drop while stirring.
15. Proceed with titration by adding 1 ml each time. Record pH after each drop while stirring

Table of Data & Results:

|  |  |
| --- | --- |
| Volume of acid (HCl) in the beaker | 20ml |

|  |  |  |  |
| --- | --- | --- | --- |
| Volume of base (NaOH) added (in ml) | pH | Volume of base (NaOH) added(in ml) | pH |
| 0 | 1.08 | 13 | 12.90 |
| 2 | 1.18 | 14 | 12.91 |
| 4 | 4.1 | 15 | 12.94 |
| 6 | 12.59 | 16 | 12.92 |
| 8 | 12.80 | 17 | 12.94 |
| 10 | 12.84 | 18 | 12.95 |
| 11 | 12.85 | 19 | 12.95 |
| 12 | 12.87 | 20 | 12.95 |

1. Table of Data & Results:

|  |  |
| --- | --- |
| Volume of acid (CH3COOH) in the beaker | 20ml |

|  |  |  |  |
| --- | --- | --- | --- |
| Volume of base(NaOH) added (in ml) | pH | Volume of base(NaOH) added (in ml) | pH |
| 0 | 2.98 | 11 | 5.07 |
| 1 | 3.65 | 13 | 5.37 |
| 2 | 3.9 | 14 | 5.57 |
| 3 | 4.12 | 15 | 5.89 |
| 4 | 4.28 | 16 | 7.16 |
| 5 | 4.41 | 17 | 11.46 |
| 6 | 4.52 | 18 | 11.75 |
| 7 | 4.65 | 19 | 11.98 |
| 8 | 4.75 | 20 | 12.08 |
| 9 | 4.87 | 23 | 12.26 |
| 10 | 4.96 |  |  |

1. Table of Data & Results:

|  |  |
| --- | --- |
| Volume of acid (H3PO4) in the beaker | 25ml |

|  |  |  |  |
| --- | --- | --- | --- |
| Volume of acid (HCl) added (in ml) | pH | Volume of acid (HCl) added (in ml) | pH |
| 0 | 1.97 | 6 | 6.48 |
| 0.5 | 2.1 | 6.5 | 6.67 |
| 1 | 2.27 | 7 | 6.85 |
| 1.5 | 2.71 | 7.5 | 7.04 |
| 2 | 4.42 | 8 | 7.41 |
| 2.5 | 5.05 | 8.5 | 8.09 |
| 3 | 5.34 | 9 | 8.92 |
| 3.5 | 5.6 | 9.5 | 9.55 |
| 4 | 5.83 | 10 | 9.99 |
| 4.5 | 5.99 | 10.5 | 10.27 |
| 5 | 6.14 | 11 | 10.45 |
| 5.5 | 6.3 | 11.5 | 10.6 |

1. Table of Data & Results:

|  |  |
| --- | --- |
| Volume of base (NH3) in the beaker | 20ml |

|  |  |  |  |
| --- | --- | --- | --- |
| Volume of acid (HCl) added (in ml) | pH | Volume of acid (HCl) added (in ml) | pH |
| 0 | 11.17 | 12 | 9.34 |
| 1 | 10.65 | 13 | 9.26 |
| 2 | 10.39 | 14 | 9.14 |
| 3 | 10.25 | 15 | 9.04 |
| 4 | 10.08 | 16 | 8.91 |
| 5 | 9.98 | 17 | 8.74 |
| 6 | 9.88 | 18 | 8.52 |
| 7 | 9.79 | 19 | 8.15 |
| 8 | 9.70 | 20 | 5.41 |
| 10 | 9.52 | 21 | 2.75 |
| 11 | 9.44 | 22 | 2.43 |
|  |  | 25 | 2.02 |

The Equivalence Point:

Definition: The equivalence point is the point in a [titration](http://chemistry.about.com/cs/glossary/g/bldeftitration.htm) where the amount of [titrant](http://chemistry.about.com/od/chemistryglossary/a/titrantdef.htm) added is enough to completely [neutralize](http://chemistry.about.com/od/chemistryglossary/a/neutralizationd.htm) the [analyte](http://chemistry.about.com/od/chemistryglossary/g/Analyte-Definition.htm) [solution](http://chemistry.about.com/od/chemistryglossary/a/solutiondef.htm).

The equivalence point is the point where the number of moles of base equal the number of moles of acid. The end point is the point where the indicator being used changes color (also 'indication point)'.   
If the indicator is chosen correctly, the end point will essentially be ~~exactly~~ as near as possible at the equivalence point.   
The point of the titration is to find the equivalence point -- the end point is just a very close approximation to it. This is because the pH of the solution changes very rapidly close to the equivalence point.   
Therefore, the indicator will change color very close to the equivalence point because of the steepness of the pH change

Glassware & Apparatus Used:

* Graduated Cylinder
* Burette
* Erlenmeyer Flask
* pH meter
* Magnetic Bean
* Colored Indicators

Chemicals Used:

* HCl
* NaOH
* CH3COOH
* Diprotic Acid (H2SO4)
* Triprotic Acid
* Discussion and sources of error

We can see from the results that the plaster of Paris did not absorb any water molecules in addition to the ½ molecule initially present. This may be explained by the fact that the watch-glass was not thoroughly cleaned which affected the process of absorbing water. In addition, the paste must have not been well mixed which led to minimizing the supposed interaction between the salt and the water molecules.