# Acid Dissociation Constant

## Objective:

To determine the Acid Dissociation Constant **(Ka)** for a weak acid.

## Background:

A weak acid **(HA)** dissolved in water ionizes as follows:

$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$

The acid dissociation constant is given by:

$$Ka = \frac{[H_3O^+][A^-]}{[HA]}$$

If one can make **[HA ]** = [ A⁻ ] , then the above equation simplifies to:

$$Ka = [H_3O^+]$$

Thus, by determining the **[ $H_3O^+$]**, (via pH meter measurement) at the point when **[HA ]** = [ $A^-$ ] one can get a value of **Ka** for the weak acid.

How can one make **[HA ]** = [ $A^-$ ]?

Since **HA** is a weak acid, when it is added to water: **[HA ]** >> [ $A^-$ ]

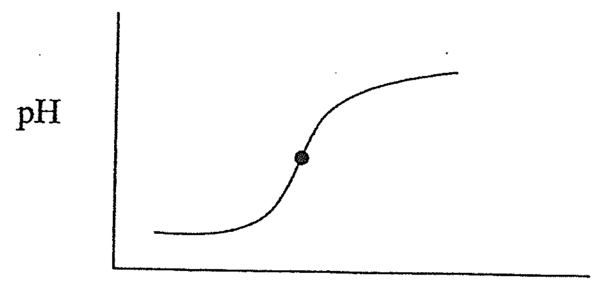
If **HA** is completely neutralized (the equivalence point) by adding a base then: **[HA ]** << [ $A^-$ ]

At exactly halfway through the neutralization process, halfway towards the equivalence point, **[HA ]** = [ $A^-$ ]. At this point the pH value can be used to determine **Ka.**

For a weak acid the pH and the volume of base added are measured and graphed. From the graph both the pH at the equivalence point and the pH at halfway towards the equivalence point (when **[HA ]** = [ $A^-$ ], and **Ka** = **[$H_3O^+$]**), can be estimated. See next page.

**Results:**

1. Plot volume of base added vs. pH.




2. From the midpoint of the "step" determine the volume of the base needed to neutralize the acid. Volume base ___19.4___ mL.

3. Volume at ½ neutralization ___9.6___ mL.

4. pH at ½ neutralization ___4.75___

5. Ka of unknown acid ___$1.78 \times 10^{-5}$___

$HA + OH^- \rightarrow H_2O + A^-$

½ way $[HA] = [A^-] \Rightarrow K_a = [H_3O^+]$

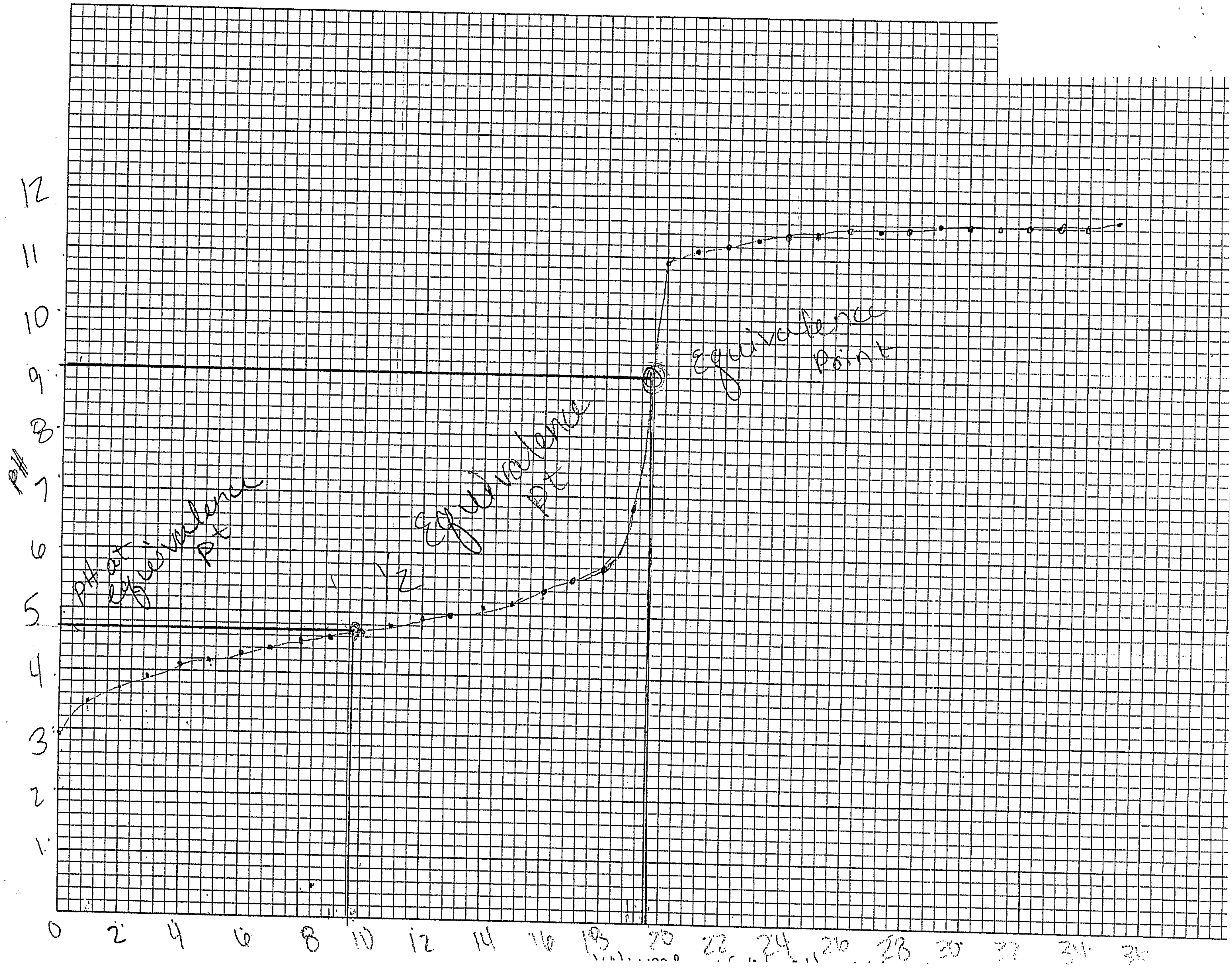
$[H_3O^+]_{1/2} = 10^{-pH_{1/2}}$

$K_a = [H_3O^+]_{1/2}$

$[H_3O^+] = 10^{-4.75} = 1.78 \times 10^{-5}$

**Data Table:**

| Volume of Based Added | pH |
|---|---|
| 0.0 mL | 2.9 |
| 1.0 ml | 3.5 |
| 2.0 ml | 3.7 |
| 3 ml | 3.9 |
| 4 ml | 4.1 |
| 5 ml | 4.2 |
| 6 ml | 4.3 |
| 7 ml | 4.4 |
| 8 ml | 4.5 |
| 9 ml | 4.6 |
| 10 ml | 4.7 |
| 11 ml | 4.8 |
| 12 ml | 4.9 |
| 13 ml | 5.0 |
| 14 ml | 5.1 |
| 15 ml | 5.2 |
| 16 ml | 5.4 |
| 17 ml | 5.6 |
| 18 ml | 5.8 |
| 19 ml | 6.8 |
| 20 ml | 10.9 |
| 21 ml | 11.1 |
| 22 ml | 11.2 |
| 23 ml | 11.3 |
| 24 ml | 11.4 |
| 25 ml | 11.4 |
| 26 ml | 11.5 |
| 27 ml | 11.5 |
| 28 ml | 11.5 |
| 29 ml | 11.6 |
| 30 ml | 11.6 |
| 31 ml | 11.6 |
| 32 ml | 11.6 |
| 33 ml | 11.6 |
| 34 ml | 11.6 |
| 35 ml | 11.7 |
| ml | |
| ml | |



pH
pH at ½ equivalence pt
equivalence pt
equivalence point
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
1
2
3
4
5
6
7
8
9
10
11
12