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To determine the dissociation constant of weak acid: A brief review

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Abstract
The ratio of dissociated iron to original acid is known as dissociation constant. It is abbreviated as K_a. This K_a value shows the strength of dissociated acid [1].

Keywords: Dissociation constant, weak acid, brief review

Introduction

Weak acids are acids that don't completely dissociate in solution. The strength of weak acid depends upon how much eat dissociate. If a acid is more dissociate it is a strong acid but if it is not dissociate then it is weak acid.

Henderson Hasselbalch equation is help us to know the strength of acid means with help of this equation we can estimates that our acid is strong or weak.

History

In 1908 Lawrence Joseph Henderson derived an equation and in 1971 Karl Albert Hasselbalch rewrote this formula in logarithamic term.

Derivation of Henderson Hassalbalch equation is:

Dissociation of weak acid (HA)

$$HA \leftrightarrow H^+ + A^-$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_a \frac{[HA]}{[A^-]} = [H^+]$$

$$[H^+] = K_a \frac{[HA]}{[A^-]}$$

Taking (-) log on both side

$$-\log [H^+] = -\log [K_a] \frac{[HA]}{[A^-]}$$

$$-\log [H^+] = -\log K_a - \log \frac{[HA]}{[A^-]}$$

$(-\log [H^+] = pH$ & $-\log [K_a] = pK_a)$

$$\text{So } pH = pK_a - \log \frac{[HA]}{[A^-]}$$

$$\text{Or } pH = pK_a + \log \frac{[A^-]}{[HA]}$$

$$pH = pK_a \pm \log \frac{[salt]}{[acid]}$$

$$[\text{Ionized acid}]pH = pK_a + \log \frac{}{[\text{Unionized acid}]}$$

Or

$$pK_a = pH - \log \frac{[\text{Ionized acid}]}{[\text{Unionized acid}]}$$

$$pk_a = pH - \log \frac{[A-]}{[HA]}$$ where ; pK_a = dissociation constant

When half of neutralization finished means at half (50%) neutralization point; the ratio of ionized acid and unionized acid is equal. Show that value of dissociation constant and pH is being equal. So that, [ionized acid] = [unionized acid]

Therefore, $pK_a = pH$

We can also measured the dissociation constant (pK_a) at half neutralization point. In this neutralization reaction, weak acid is neutralized by hydroxide (ex:-NaOH, KOH, LiOH) In a reaction a (OH-) iron are regarded as strong base and their react with acid(HA).

(Reaction)*

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

For example we want to know the dissociation constant of salicylic acid.

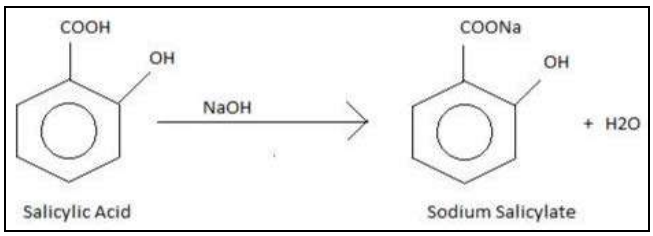
Principal

To know dissociation constant of salicylic acid; salicylic acid is neutralized with NaOH or titrate with NaOH that make a buffer.

Apparatus and Chemicals

Conical flask, burette, pipettes, pHmetter, salicylic acid, standard NaOH solution, indicator (methyl red).

Reaction



Procedure

1. prepare 0.5%w/v solution of of salicylic acid in methanol, take the 10 ml salicylic acid solution in conical flask with the help of pipette carefully Note:- because of methanol is toxic, do not sucked it with mouth.
2. Feel the burette with 0.5 N NaOH solution.
3. Titrate the solution of salicylic acid with 0.5N solution using methyl red as indicator.
4. When neutralization occurs the red colour of solution is converted into yellow colour.
5. Note the burette readings.
6. Further take 0.5%w/v, 10 ml salicylic acid solution and titrate it against standard 0.5N NaOH solution (add half of sodium hydroxide solution then be consumed or add in previous titration)
7. The pH of this half neutralization is not down and record with the help of pH metre at room temperature.

Calculation

The pk value of acid is derived by using given equation:-

$$pH = pK_a + \log \frac{[Salt]}{[Acid]}$$

At mid point concentration of Salt and concentration of Acid are same, Hence

$pH = pK_a$

References

1. Patrick Sinko J. Martin's Physical Pharmacy and Pharmaceutical Science, edition-5, 245.