Acid-base titration

Colorimetric titration of a strong acid by a strong base

Titration of strang acide with a strang base

Before any handling, look at the pictograms and safety instructions for each product discuss it with the teacher in order to take all protective measures.

1- Introduction :

In everyday life, we regularly use acidic or basic solutions: descaler, vinegar, lemon juice, ammonia, soda, etc. An acid is strong if its reaction with water can be considered complete and only its conjugate base remains in solution. The reaction of this strong acid AH is then written as follows:

$$\mathbf{AH + H_2O \rightarrow A^- + H_3O^+}$$

2- Definitions:

2-1- Definitions of acid and base:

An acid is a substance that dissociates in water in the form of the H+ ion.

$$HCl \rightarrow H^+ + Cl^-$$

A base is a substance that dissociates in water as OH- ions.

$$NaOH \rightarrow Na^+ + OH^-$$

2-2- The strength of acids and bases: A strong acid is one that dissociates completely into positive and negative ions, such as hydrochloric acid (HCl). A strong base breaks apart completely in positive and negative ions, such as sodium hydroxide (NaOH).

On the other hand, most acids and bases dissociate very little in aqueous solution.

Let's take for example acetic acid (CH_3COOH) which only has part of its ions (1.3%)

which dissociate in water. It is knows as a weak acid. The same phenomenon occurs with ammonia (NH_3) which dissociates into two parts

NH_4^+ and OH^-. Most of its molecules do not react. Ammonia is knows as a weak base.

2-3- Principle of The titration:

To titrate a solution is to determine the concentration of a chemical species A that it contains. To do this, we use a chemical reaction between species A and another chemical species B. The burette contains a solution containing species B whose concentration is precisely known rated C_B. The burette allows you to precisely measure the volume V_B that will be poured.

The beaker contains a certain quantity of material of species A denoted n_A, this quantity of material is unknown, but the volume of solution is precisely known and denoted V_A.

When a few drops of solution B are added, species B reacts with species A in the beaker.

The species B poured will react as long as there is species A left in the beaker. To be able to carry out a dosage:

- The reaction between A and B must be the only reaction that takes place,
- This reaction must be **rapid**,
- This reaction must be **total**.

When species A has completely reacted with species B added, we will say that we have reached **equivalence**. This means that a quantity of material n_B will have been poured exactly respecting the **stoichiometric proportions** given by the equation of the reaction between A and B.

2-4- Acid-base titration:

To measure an aqueous solution of an acid or a base is to determine its concentration in carrying out an acid-base reaction.

At equivalence the number of moles H_3O^+ provided by the acid must be equal to the number of moles OH^- brought from the base. This implies :

$$C_A V_A = C_B V_B$$

With:

- C_A the molar concentration of the acid, by V_A the volume of the acid,
- C_B the molar concentration of the base, by V_B the volume of the base,

An acid-base dosage can be followed by:

▪ pH-meter: we follow the evolution of the pH during the reaction.

▪ Colorimetry: a colored indicator is used.

2-5- Colored indicator :

A color indicator is a reagent whose color depends on the pH. It can be used to identify the end of a dosing if the equivalence is reached in its turn zone.

Acid-base indicators (also known as pH indicators) are substances that change color with pH. These are usually weak acids that dissociate slightly in water giving ions. These acid-base couples are characterized by a value called pKa.

The acid form and its conjugate base have different colors. The solution will take the color of

the predominant form determined by the pH of the solution:

- if pH < pKa the solution takes the color A of the acid form
- if pH > pKa the solution takes the color B of the basic form
- if pH = pKa then we have a mixture of the two colors A and B, this is the turning zone of the indicator.

We generally consider a zone of one to two pH units.

Examples of colored indicators

indicator	Colour		pH range	pKa
	Acid	Base		
Thymol Blue	red	yellow	1,2- 2,8	1,5
Methyl Red	red	yellow	4.2- 6.2	5,1
Bromophenol Blue	yellow	blue	3.0- 4.6	7,0
Phenol Red	yellow	red	6.8 - 8.2	7,9
Phenolphthalein	colorless	pink	8.0 - 10	9,4

3- Experimental Part:

- **Colorimetric determination of hydrochloric acid by sodium hydroxide**

Tools: Burette, Erlenmeyer flask, beaker, test tube, wash bottle, NaOH solution (0.1N), solution of HCL and colored indicators

Titration in the present of of phenolphthalein Indicator:

1- Rinse the equipment. Burette, Erlenmeyer flask...etc.

2- Fill the burette with the (NaOH) solution (C_B=0.1N) up to the zero graduation.

3- Take (VA=10 ml) the solution to be dosed (HCl) and pour it into a 100 ml Erlenmeyer flask.

4- Add 2 to 3 drops of colored indicator (phenolphthalein).

5- Place the Erlenmeyer flask on a white sheet below the burette.

6- Perform a rapid assay to estimate the equivalence volume.

7- Note the volume V_B of (NaOH) poured.

8- In the presence of a pH paper, read the pH of the solution every 2ml until coloring


4- Results and calculations:

1- what is the purpose of the TP?

2- Write the reaction equation.

3- Calculate the Concentration (C_A) and Normality (N_A) of the HCl solution.

4- Complete the table below:

V_B(ml)	0	2	4	6	8	10	12	14	16
pH									

5- Draw the graph representing the pH value= f(V_B) on graph paper.

6- Determine the V_E volume and the pH at equivalence using the graph.

7- What does a turning zone mean to you?