BATNA2 University
Faculty of Natural and Life Sciences (L1)
Academic year 2023-2024

Lab Practical 2: Titration of a Strong Base by a Strong Acid

❖ Objectives

At the end of this lab practical, the student will be able to:

- **Recognize** the titration process.
- **To follow** changes in coloration during titration while adding a strong acid to a strong base.
- **Carry out** a colorimetric titration according to an experimental technique.
- **Identify** the **Equivalence point**.

❖ Principle:

- In this experiment, you will determine an **unknown solution's concentration**.

I- Theoretical part

I-1- Acids and Bases definition

The terms acid and base have been defined differently, depending on the particular way of looking at the properties of acidity and basicity.

- Based on **Arrhenius**'s definition, acids produce hydrogen ions (H^+ ions) while bases produce hydroxide ions (OH^- ions).
- The **Lowry-Bronsted** definition states that an acid donates a proton whereas a base accepts one.
- According to the **Lewis** definition, acids are those that take electron pairs whereas bases are those that donate them.

Conjugate acids and bases: To create a conjugate acid, a proton is added to a base, and to create a conjugate base, a proton is taken from an acid.

Acid + Base → Conjugate base + Conjugate Acid

I-2- The pH scale

- The **pH scale** quantifies how many hydrogen ions are present in a given solution.

pH= - log [H_3O^+], or the negative logarithm of the hydrogen ion concentration in moles per liter, is the unit of acidity and basicity.

- A substance's acidity or basicity can be measured using the pH scale. The pH scale runs from **1 to 14**, the **most acidic** chemical known has a pH of **1**, whereas the **most basic** has a pH of **14**. The pH of pure water is 7 (neutral substance would also be 7).

I-3- Acid-base neutralization, Titration

Terms you will need to be familiar with in order to understand a discussion of titration are:

- **Titration:** a technique used to measure the volume of a solution of **known concentration** that is required to react with a measured amount (mass or volume) of an **unknown substance** in solution.
- **Colored indicator:** a substance that is added to the reaction system in small amounts; it indicates that the reaction is complete (has reached the equivalence point) by changing color.

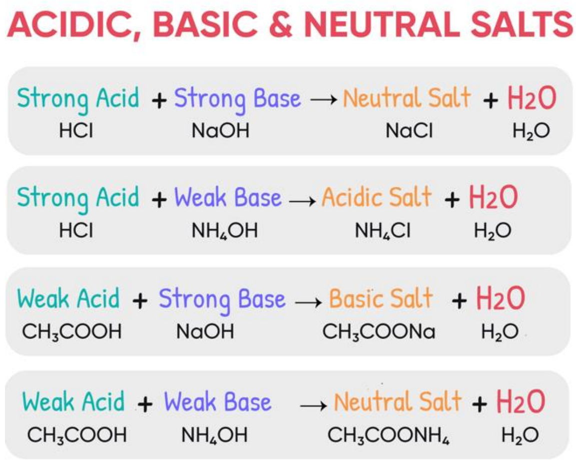
- **Equivalence point:** the stage in the titration at which the **color of the indicator** is observed, indicating that the reaction is complete.
- **Strong acid:** An acid that completely dissociates in water.
- **Strong base:** A base that completely dissociates in water.

A- Acid-base titration:

Acid-base neutralization is when acid reacts with base to produce <u>water and salt</u>.

Acid + Base $\rightarrow$ Salt + H_2O

The "neutralization" term does not mean neutral pH, but the state in which the same mole numbers of both acid and base have been mixed. To detect the moment of neutralization, we use an **indicator,** which for example, can change its color when neutralization is reached.



B- Equivalence Point:

When a strong acid and a strong base react with each other or any of the strong partners react with the weak one (acid or base), an essentially irreversible quantitative reaction takes place. The **titration** is a measurement of the reactant solution concentration. The titration process is stepwise addition from a burette (drop by drop) of a standardized solution (solution with known concentration) of acid (or base) to an Erlenmeyer flask containing a known volume of base (or acid) solution, in the presence of proper indicator. To calculate the concentration of the examined solution we use the formula:

$$N_1 \times V_1 = N_2 \times V_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

N_1: unknown normality of base (or acid) in the Erlenmeyer flask.

N_2: known normality of acid (or base) in the burette.

$$N = x \times C \ (x = 1)$$

Equation (1) becomes as follows: $C_1 \times V_1 = C_2 \times V_2$.

$$C_1 = C_2 x V_2 / V_1$$

C_1: unknown concentration of base in the Erlenmeyer flask.

C_2: known concentration of standardized acid solution in the burette.

V_1: volume of the base solution in the Erlenmeyer flask.

V_2: volume of the standardized acid solution added from the burette to the Erlenmeyer flask.

C- Indicators

Indicators are conjugated acid-base pairs added to a titration mixture in small molar amounts, in order to monitor the pH. The acidic and basic forms of indicators have different colors. The pH range, at which a colored indicator begins to change, depends on its **pK** (pH at which the indicator molecule is dissociated in

50 %). Generally, we must select the proper indicator for the kind of titration: the indicator should change its color at or near the equivalence point.

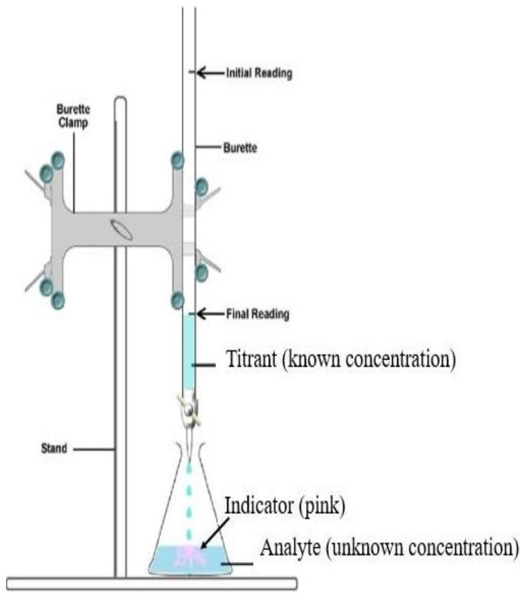
Indicator	Color of Acidic form	Color of Basic form	Range color Change	pK
Methyl orange	Red	Yellow	3.1-4.4	3.7
Bromophenol blue	Yellow	Blue	3.0-4.6	4.0
Methyl red	Red	Yellow	4.2-6.3	5.1
Bromothymol blue	Yellow	Blue	6.0-7.6	7.0
Phenolphthalein	Colorless	Pink	8.3-10.0	9.7

II- Practical part (Experimental protocol)

Material	**Products**
- Erlenmeyer flask, - graduated cylinder - Graduated burette, -Funnel.	- NaOH solution, - HCl solution. - Colored Indicator.

To begin the experiment, carefully:

- Put 10 mL of sodium hydroxide NaOH(unknown concentration) into a clean Erlenmeyer flask using a graduated cylinder.
- Incorporate a quantity of 2 to 3 drops of a colored indicator.
- Fill the graduated burette after rinsing it with the HCl (unknown concentration) hydrochloric acid solution.
- Dosing the solution should continue until the indication color changes.
- Note the amount of HCl that has been dispensed was poured.
- Two identical experiments will be conducted.



Report

The report must contain:

-A cover page according to the model below.

- A detailed response to the questions at the end of the Lab Practical session.

Annex: If a commercial HCl solution has a 36% purity rate and a relative density of d=1.29, what is its molarity?

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