Non aqueous titration:

1-Non-aqueous titrations are a type of volumetric analysis conducted in solvents that do not contain water.

2-Non-aqueous titration is a **volumetric analysis technique** used to determine the strength of weak acids and weak bases that are **sparingly soluble or unstable in water**. This method uses **non-aqueous solvents** to improve solubility and sharpness of end point.

3-Non-aqueous titration is a type of titration that uses non-aqueous solvents instead of water. This technique is useful for analyzing substances that are poorly soluble in water or react with water.

Water is an amphiprotic solvent, meaning it can act as both a weak acid and a weak base

Principle

- Some acids and bases are too weak to dissociate completely in water → resulting in indistinct or no sharp end point.
- Non-aqueous solvents:
  - Increase **acid strength** (if solvent is basic)
  - Increase **base strength** (if solvent is acidic)
    → Produces a **clearer end point**.

Solvents in Non-Aqueous Titration

The choice of solvent is critical and is based on the nature of the substance being analyzed. Solvents are classified into four main types:

- **Aprotic Solvents:** These are chemically inert and do not donate or accept protons. Their primary role is to dissolve the sample. Examples include **benzene** and **chloroform**.
- **Protophilic Solvents:** These solvents are basic and readily accept protons. They are used to enhance the acidity of very weak acids. Examples include **pyridine** and **ethylenediamine**.
- **Protogenic Solvents:** These solvents are acidic and can donate protons. They are used to enhance the basicity of very weak bases. An example is **glacial acetic acid**.
- **Amphiprotic Solvents:** These solvents can act as both an acid and a base. An example is **alcohols**.

Type of Solvent	Examples	Role
Protophilic (Basic)	Ammonia, Ethylenediamine, Pyridine	Accepts protons → increases acid strength
Protogenic (Acidic)	Glacial acetic acid, Formic acid	Donates protons → increases base strength
Aprotic (Neutral)	Benzene, Chloroform, Carbon tetrachloride	Inert medium, no proton donation/acceptance
Amphiprotic	Alcohols (Methanol, Ethanol)	Can act as proton donor or acceptor

Indicators Used

- Crystal Violet and Quinaldine Red
- Malachite Green
- Methyl Orange (in some systems)

Non-Aqueous Acidimetry

Acidimetry: This involves the quantitative determination of weak bases by titrating them with a standard acid solution in a non-aqueous medium. The titrant of choice is typically **perchloric acid** in glacial acetic acid. The reaction is essentially a proton transfer from the acidic solvent to the weak base, enhancing its basicity and allowing for a clear titration.

Used for **bases** that are very weak and cannot be titrated in water.

- **Titrant:** Perchloric acid in glacial acetic acid
- **Solvent:** Glacial acetic acid
- **Examples of Analytes:** Ephedrine HCl, Chlorpheniramine maleate, Atenolol
-
- **Reaction:** Base + $HClO_4$ → Salt

Non-Aqueous Alkalimetry

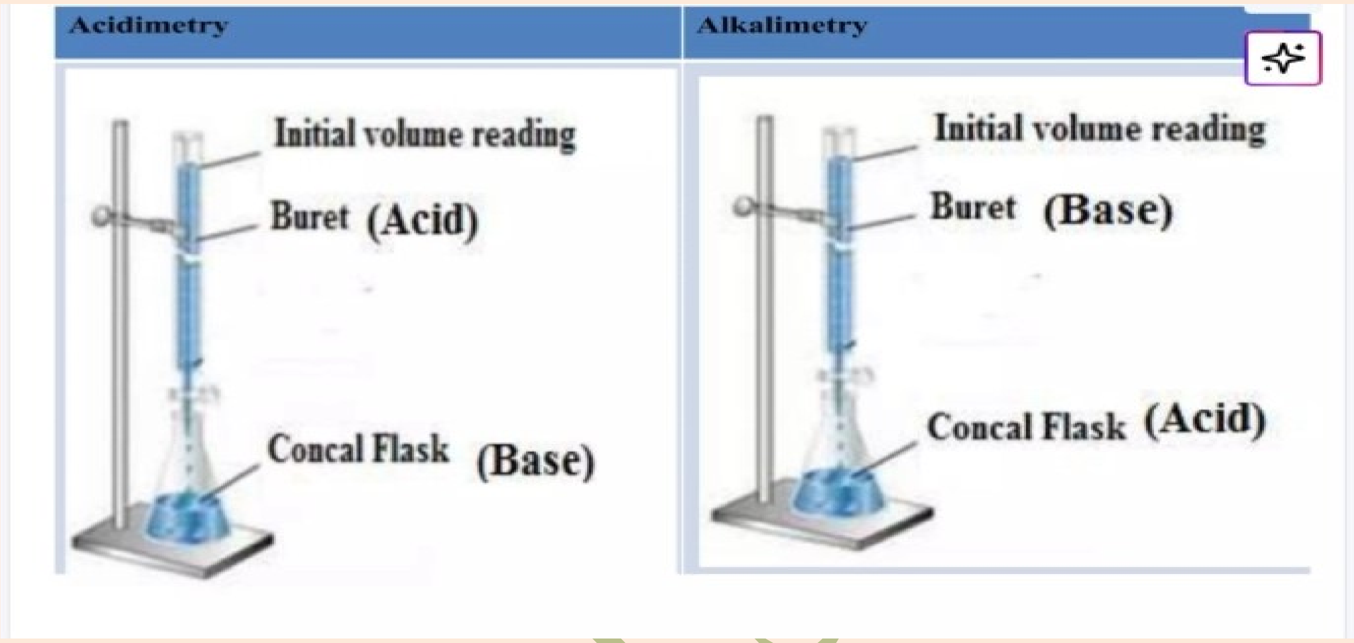
Alkalimetry: This involves the quantitative determination of weak acids by titrating them with a standard base solution in a non-aqueous medium. The titrant is often **sodium methoxide** in a protophilic solvent like dimethylformamide (DMF), which enhances the acidity of the sample.

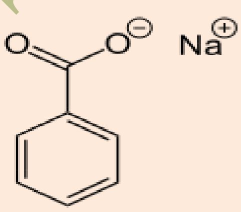
Used for **weak acids**.

- **Titrant:** Strong base (0.1 N Sodium/ Potassium Methoxide in methanol)
- **Solvent:** Non-aqueous (Methanol, Benzene, Dioxane)

- **Examples of Analytes:** Sodium benzoate, Salicylic acid, Aspirin

Reaction:
Acid + CH_3ONa → Salt + CH_3OH





Estimation of Sodium Benzoate *(C6H5COON)*

Reaction Flow Chart:

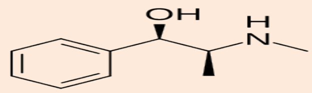
- **Sample preparation:** A precisely weighed amount of sodium benzoate is dissolved in glacial acetic acid.
- **Titration:** The solution is titrated with 0.1 M perchloric acid using an indicator like **crystal violet** or **1-naphtholbenzein**.
- **Endpoint:** The titration is continued until the indicator changes color. For crystal violet, the color changes from violet to emerald green.

- **Reaction:**
- $C_6H_5COONa + HClO_4 \rightarrow C_6H_5COOH + NaClO_4$
  (Sodium Benzoate) + (Perchloric Acid) → (Benzoic Acid) + (Sodium Perchlorate)

The reaction is a simple acid-base neutralization

Calculation:

$$\text{Normality (N)} = \frac{\text{Weight of sample} \times 1000}{\text{Equivalent weight} \times \text{Volume used (ml)}}$$



Estimation of Ephedrine HCl 💊

Ephedrine HCl is a weak base that can be estimated by non-aqueous titration using acidimetry.

- **Principle:** The chloride ion (Cl^-) in ephedrine hydrochloride is a very weak base, making it difficult to titrate directly in glacial acetic acid with perchloric acid. To address this, a substance like **mercuric acetate** is added. Mercuric acetate reacts with the chloride ions to form a weakly ionized mercuric chloride, and in the process, it replaces the weakly basic chloride ions with strongly basic acetate ions. These acetate ions are then readily titrated with perchloric acid, allowing for a sharp endpoint.
- **Reaction Flow Chart:**
    - **Sample preparation:** A weighed amount of Ephedrine HCl is dissolved in a mixture of mercuric acetate solution and a suitable solvent like acetone.
    - **Titration:** The solution is titrated with 0.1 M perchloric acid.
    - **Indicator: Methyl orange** is used as an indicator.
    - **Endpoint:** The titration is complete when the color changes from yellow to red.

Reaction:

2(C10H15NO·HCl) + (CH3COO)2Hg → 2(C10H15NO·CH3COOH) + HgCl2
(Ephedrine HCl) (Mercuric Acetate) (Ephedrine Acetate) (Mercuric Chloride)

The ephedrine acetate then reacts with perchloric acid in the titration:

(C10H15NO·CH3COOH) + HClO4 → (C10H15NO·HClO4) + CH3COOH
(Ephedrine Acetate) (Perchloric Acid) (Ephedrine Perchlorate) (Acetic Acid)