Conductometry

The principle of conductometry is based on the measurement of the electrical conductivity of a solution, which is a reflection of the concentration of ions present in the solution. Conductivity is the ability of a solution to conduct an electrical current, and it is directly related to the concentration and mobility of ions in the solution. The higher the concentration and mobility of ions, the greater the solution's conductivity.

Principle of conductometry:

Ionic Dissociation: When ionic compounds, such as salts or strong acids and bases, dissolve in water, they dissociate into their constituent ions. For example, in the case of sodium chloride (NaCl), it dissociates into sodium ions (Na^+) and chloride ions (Cl^-). This dissociation of ions increases the solution's electrical conductivity.

Strong electrolytes, which fully dissociate into ions, have high conductivity. Weak electrolytes, which partially dissociate, have lower conductivity. Non-electrolytes, which do not dissociate into ions, have minimal conductivity

Acid-base titrations

Conductometry is commonly used to determine the equivalence point in acid-base titrations.

Acid-base titrations using conductometry are a common analytical chemistry technique used to determine the concentration of an acidic or basic solution. Conductometry measures the electrical conductivity of a solution, which is related to the concentration of ions in the solution. In an acid-base titration, the goal is to find the equivalence point, which is when the number of moles of acid is stoichiometrically equivalent to the number of moles of base, or vice versa.

1. Equipment and Reagents:
    - A burette filled with a standardized solution of the acid or base of known concentration (titrant).
    - A solution of the analyte (the unknown concentration of the acid or base).
    - A conductivity cell or probe to measure electrical conductivity.
    - A conductometer to measure and record the conductivity.
2. Setup:
    - Calibrate the conductometer with a standard solution of known conductivity.
    - Place the conductivity cell in the analyte solution.
3. Titration Procedure:
    - Add a small volume of the titrant to the analyte solution and mix it well.
    - Measure the conductivity of the solution.
    - Continue to add the titrant in small increments and measure the conductivity after each addition.
    - As you add more titrant, the conductivity of the solution will change, and at some point, it will exhibit a sharp increase or decrease. This change in conductivity corresponds to the equivalence point.
4. Equivalence Point Determination:
    - Plot a graph of conductivity (y-axis) versus the volume of titrant added (x-axis).
    - The point on the graph where the conductivity changes most abruptly indicates the equivalence point.
    - You can also calculate the equivalence point by finding the volume of titrant needed to reach a certain conductivity change, often a specific percentage of the maximum change.
5. Calculations:
    - Once you've determined the volume of titrant required to reach the equivalence point, you can calculate the concentration of the analyte using the stoichiometry of the reaction between the acid and base. This is typically done using the equation: $M_1V_1 = M_2V_2$ Where:
        - M_1 = Concentration of the titrant (known)
        - V_1 = Volume of titrant added to reach the equivalence point

- M_2 = Concentration of the analyte (unknown)
- V_2 = Volume of the analyte

Conductometry is a precise method for determining the equivalence point in acid-base titrations because it directly measures the change in the solution's ionic strength. This method is particularly useful when titrating weak acids or bases that may not produce noticeable color changes, as in the case of traditional indicator-based titrations.