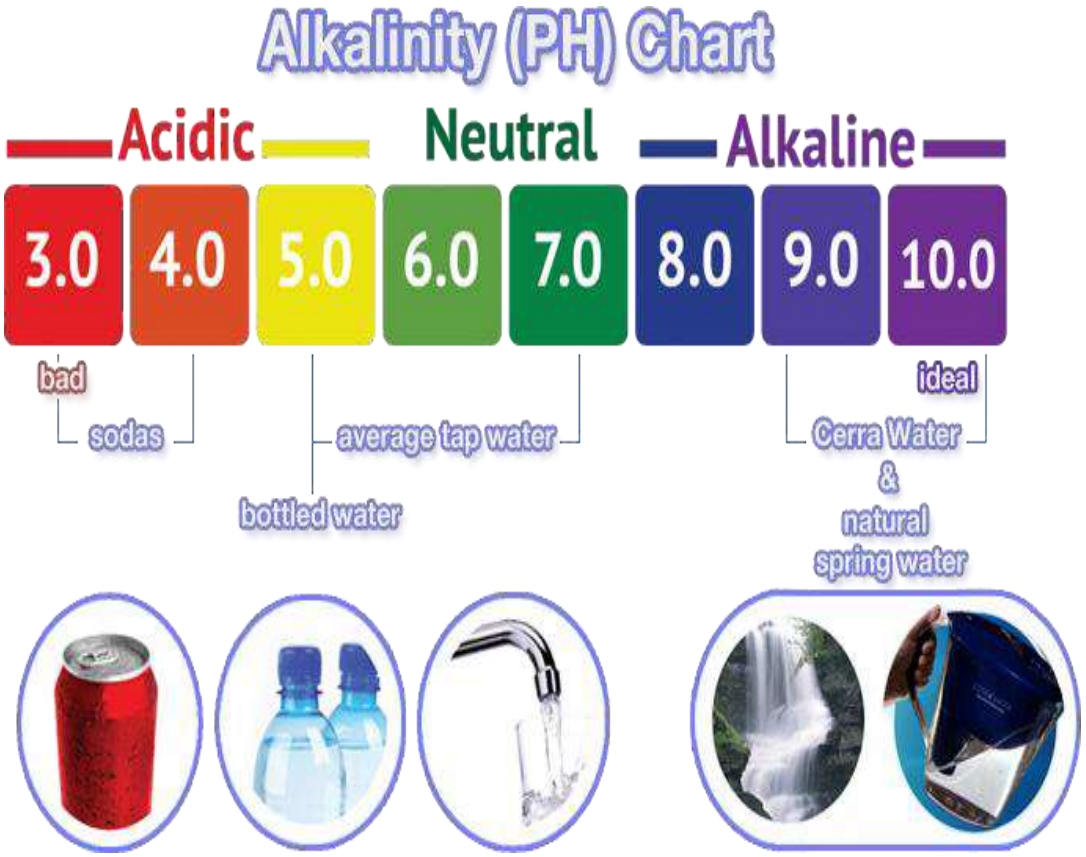
Experiment 6
Determination of Alkalinity in Water



Introduction:
Alkalinity is primarily a way of measuring the acid neutralizing capacity of water. In other words, its ability to maintain a relatively constant pH. The possibility to maintain constant pH is due to the hydroxyl, carbonate and bicarbonate ions present in water. The ability of natural water to act as a buffer is controlled in part by the amount of calcium and carbonate ions in solution.
Carbonate ion and calcium ion both come from calcium carbonate or limestone. So water that comes in contact with limestone will contain high levels of both Ca^{++} and CO_3^{2-} ions and have elevated hardness and alkalinity.

Environmental significance:
Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes. Higher alkalinity levels in surface waters will buffer acid rain and other acid wastes and prevent pH changes that are harmful to aquatic life. Large amount of alkalinity imparts bitter taste in water. The principal objection of alkaline water is the reactions that can occur between alkalinity and certain actions in waters. The resultant precipitate can corrode pipes and other accessories of water distribution systems.

Wastewaters containing excess caustic (hydroxide) alkalinity are not to be discharged into natural water bodies or sewers. Alkalinity as carbonate and bicarbonate of saline water is very important in tertiary recovery processes for recovering petroleum. Alkaline water offers better wetting to the formation rock and improve oil release. As an additional benefit, ions that provide alkalinity absorb on rock surfaces occupying adsorption sites and decrease the loss of recovery chemical by adsorption. The alkalinity value is necessary in the calculation of carbonate scaling tendencies of saline waters.

The alkalinity acts as a pH buffer in coagulation and lime-soda softening of water. In wastewater treatment, alkalinity is an important parameter in determining the amenability of wastes to the treatment process and control of processes such as anaerobic digestion, where bicarbonate alkalinity, total alkalinity, and any fraction contributed by volatile acid salts become considerations.

Principle:
The alkalinity of water can be determined by titrating the water sample with sulphuric acid of known values of pH, volume and concentrations. Based on stoichiometry of the reaction and number of moles of sulphuric acid needed to reach the end point, the concentration of alkalinity in water is calculated. When a water sample that has a pH of greater than 4.5 is titrated with acid to a pH 4.5 end point, all OH^-, CO_3^{2-}, and HCO_3^- will be neutralized.

For the pH more than 8.3, add phenolphthalein indicator, the colour changes to pink colour. This pink colour is due to presence of hydroxyl ions. If sulphuric acid is added to it, the pink colour disappears i.e. OH^- ions are neutralized. Then add methyl orange indicator, the presence of CO_3^{2-} and HCO_3^- ions in the solution changes the colour to yellow. While adding sulphuric acid, the color changes to slight orange ting, this color change indicates that all the CO_3^{2-} and HCO_3^- ions has been neutralized. This is the end point.

Apparatus:

1. Burette with Burette stand and porcelain title
2. Pipettes with elongated tips
3. Conical flask
4. Measuring cylinders
5. Beakers
6. Dropper
7. Stirrer

Chemicals

1. Standard0.02N sulphuric acid
2. Phenolphthalein indicator
3. Methyl orange indicator

Sample handling and preservation:

Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage. To reduce the change in samples, keep all samples at 4°C. Do not allow samples to freeze. Analysis should begin as soon as possible. Do not open sample bottle before analysis.

Procedure:

1. Measure 50 ml or 100 ml of your sample into a 250 mL beaker or erlenmyer flask. Place your sample onto a stir plate (make sure to put a bar magnet in the flask).
2. Measure initial pH of your sample. If the sample pH is below 8.3 (if above 8.3, do step **3** first), add several drops of methyl orange indicator. If the color of the solution turned yellow, titrate your sample with 0.02 N H_2SO_4 (you may need to dilute the acid provided in the lab) until the color changes to slightly orange ting (pH 4.5). Record the total volume of acid used for the titration.
3. Measure initial pH of your sample. If the sample pH is above 8.3, add several drops of phenolphthalein indicator. If the color of the solution turned pink, titrate your sample with 0.02 N H_2SO_4 or HCl (you may need to dilute the acid provided in the lab) until color changes from pink to clear (pH 8.3). Record the volume of acid used for the titration. Then, proceed with step **2**.
4. Calculate both Phenolphthalein Alkalinity and Total Alkalinity using the formula provided above.

Calculation:

Phenolphthalein Alkalinity (mg/L as $CaCO_3$)

= Multiplying Factor (MF) x milliliter of 0.02N H_2SO_4*(added up to pH 8.3)*

Total Alkalinity (mg/L as $CaCO_3$)

=Multiplying Factor (MF) x milliliter of 0.02N H_2SO_4*(added up to pH approx. 4.5)*

Where, **M.F.** $= \dfrac{\text{Normality of } H_2SO_4 \text{ x equivalent wt.of } CaCO_3 \text{ x } 1000}{\text{mL of sample taken}}$

Assignment:

1. Discuss the importance of alkalinity in water for different treatment processes.
2. Define total alkalinity, phenolphthalein alkalinity, and methyl orange alkalinity. Discuss their dominant pH range.

DATA SHEET

Experiment Name :
Experiment Date :

Student's Name :
Student's ID :
Year/ Semester :
Section :
Group :

Table -1: Determination of Phenolphthalein Alkalinity:

Sample No and source	Volume of Sample (mL)	Burette Reading (mL)		Volume of Sulphuric acid (mL)	Phenolphthalein Alkalinity (mg/L as CaCO3)
		Initial	Final		

Table – 2: Determination of Total Alkalinity:

Sample No and source	Volume of Sample (mL)	Burette Reading (mL)		Volume of Sulphuric acid (mL)	Total Alkalinity (mg/L as CaCO3)
		Initial	Final		

Signature of the course teacher and date