EXPERIMENT NO- 2

(1) Aim: Determination of alkalinity of water sample containing carbonate (CO_3^{2-}) and hydroxide (OH^-) ions.

(2) Objective: To determine the alkalinity of the given water sample containing carbonate (CO_3^{2-}) and hydroxide (OH^-) ions by titrating it against standard [N/10] HCl solution using phenolphthalein and methyl orange as indicators by acid–base titration.

(3)Theory: Each student should collect additional information related to theory of the experiment from library and other literature sources and add it.

(i) Alkalinity means basicity. Alkalinity of water is mainly due to presence of carbonate ions, bicarbonate ions, hydroxyl ion, combination of carbonate and hydroxyl ions or due to combination of carbonate and bicarbonates ions.

(ii) The alkalinity in the given water sample may be estimated by titrating it against standard solution of N/10 HCl using phenolphthalein and methyl orange as indicator.

(iii) When alkaline solution containing carbonate (CO_3^{2-}) and hydroxyl (OH^-) ions is titrated against N/10 HCl in presence of phenolphthalein, the disappearance of pink colour shows phenolphthalein end point. Conversion of hydroxyl ions to water and carbonate to bicarbonate occurs at this point.

$$CO_3^{2-} + H^+ \xrightarrow[\text{8.1 to 10.0 (pH)}]{\text{Phenolphthalein}} HCO_3^-$$

$$H^+ + OH^- \xrightarrow[\text{8.1 to 10.0 (pH)}]{\text{Phenolphthalein}} H_2O$$

(iv) On further titrating it against standard HCl in presence of methyl orange indicator, appearance of wine red colour indicate the methyl orange end point. Neutralization of all bicarbonate ions takes place at this point. The following chemical reaction takes place.

$$HCO_3^- + H^+ \xrightarrow[\text{3.1 to 4.4}]{\text{Methyl orange}} H_2O + CO_2$$

The overall reaction is as follows:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$$Na_2CO_3 + HCl \rightarrow NaHCO_3 + NaCl$$

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

(4)Experimental Setup:

(a) Apparatus: Burette, pipette, conical flask, beaker, funnel, burette stand.

(b) Chemicals: Water sample containing carbonate and hydroxyl ions, standard HCl [N/10].

(c) Indicator: Phenolphthalein and Methyl orange.

(5) Schematic Diagram: Left hand side. Each student should draw the overall diagram experiment.

(6) Experimental Procedure:

i) Pipette out 10ml of water sample containing carbonate and hydroxyl ions in a coni flask and add 1 drop of indicator in it. A pink colour will appear.

ii) Fill the burette with N/10 HCl.

iii) Titrate the sample solution with standard N/10 HCl with continuous shaking till th pink colour disappear, note down this reading and this will be the phenolphthalein end point.

iv) Now add 2 drops of methyl orange indicator to the same solution a light colour will appear. Start titrating the solution against N/10 HCL with continuous shaking till th wine red colour appears. This is the methyl orange end point. All the bicarbonate io are neutralized.

v) Note down the reading. This will be the methyl orange end point.

(7) Observation:

Vol. of sample solution (ml)	Burette Reading (ml)				$y=y^1-x$ (ml)	Volume of HCl used by CO_3^{2-} (2y) ml	Volume of HCl used by OH^- (x-y)ml
	Phenolphthalein		Methylorange				
	Initial	Final (x ml)	Initial (x ml)	Final (y^1 ml)			

(8) Calculation:

According to Normality equation:

For CO_3^{2-} ions

N_1V_1 = N_2V_2

(Water sample) (HCl solution)

N_1 = N_2V_2/ V_1

Strength of given solution (g/l) = N X Eq. weight (30)

---------- gm/ liter

……..x 1000 mg/L

For OH^- ions

N_1V_1 = N_2V_2

(Water sample) (HCl solution)

N_1 = N_2V_2/ V_1

Strength of given solution = N X Eq. weight (17) = -------gm/liter.

……..x 1000 mg/L

(9) Result: The alkalinity of the given water sample due to carbonate ions =…… mg/L, and due hydroxyl ions ……..mg/L .

Total alkalinity =alkalinity due to carbonate ions + alkalinity due to hydroxyl ions.

(10) Result analysis and Discussion: This part should be written by students.
Experimental result reveals that the water sample contains .....CO_3^{-2} and OH^- ions.....mg/L. The quality of water is judged by the absence of alkalinity of water.

(11) Inference and Conclusion: This part should be written by students.
Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemical system present in natural waters is one where carbonates, bicarbonates and hydroxides are present. The bicarbonate ion is usually prevalent. However, the ratio of these ions is a function of pH, mineral composition, temperature and ionic strength. Water may have a low alkalinity rating but a relatively high pH or vice versa, so alkalinity alone is not of major importance as a measure of water quality. High alkalinity waters may have unpleasant taste. Based on the testing, it is found that the total alkalinity of the sample is .....mg/L.
As per the provisional code, alkalinity should not exceed 200 mg/ L for potable water. For the fresh water alkalinity ranges between 20 –100 mg/L. Alkalinity of tested sample is not within the limits specified in the standards. Hence the water sample is not fit for drinking purpose.

(12) Learning Outcome: This method is applied to find out alkalinity in drinking water and the water which is used in industry for different purpose.

(13) Applications:
(i) To check the alkalinity of water which is used for drinking purpose because large amount of alkalinity imparts bitter taste in water.
(ii) To check the alkalinity of water which is used in industry because highly alkaline water may lead to caustic embrittlement and may causes deposition of scales/sludges in boiler tubes and pipes

(14) Precautions:

i. Wash the glass apparatus with distilled water before the experiment.
ii. Wash the glass apparatus with distilled water before the experiment.
iii. Since the solution is more alkaline initially, so Phenolphthalein indicator is used first due to its higher pH range.
iv. Use only 1 or 2 drops of indicators in each titration.