The term work shall consist of the following:

List of Practical:-

(A) Determination of

(1) P_H and Alkalinity
(2) Total hardness and its components
(3) Chlorides
(4) Chlorine demand and residual chlorine
(5) Sodium or Potassium or Calcium using flame photometer
(6) Turbidity and optimum dose of alum.
(7) Most Probable Number (MPN)
(8) Fluorides or Iron
(9) Ambient air quality monitoring for Suspended particulate matter, SOX, NOX and Ambient noise levels.

(B)Site visit to water treatment plant.

(C) Study of Software or programming for analysis of water distribution system or programming for design of water treatment units.

Practical examination will be based on above exercises.

Lab- in –Charge:-Prof. S.M.BAMBARY.
B.E.Civil. M.Tech.Env.

Experiment:-01

Determination of P_H and Alkalinity of given water sample.

Aim: - (a) To determine P_H of a given water sample.

Introduction:

The term P^H refers to the measurement of hydrogen ion concentration in a solution and defined as the negative log of $H^{+¿}$ ions concentration in water and waste water. The values of P^H 0 to a little less than 7.0 are termed as acidic and the values of P^H a little above 7.0 to are termed as basic. When the concentration of $H^{+¿}$ and $OH^{-¿}$ ions are equal then it is termed as neutral P^H and its value will be 7.0

Environmental Significance:

Determination of P^H is one of the objectives in biological treatment of the waste water. In anaerobic treatment, if P^H goes below 5.0 due to excess accumulation of acid, the process is severely affected. Shifting of P^H beyond 5.0 to 10.0 up sets the aerobic treatment of the waste water. In these circumstances, the P^H is generally adjusted by addition of suitable acid or alkali to optimize the treatment of the waste water. P^H Value of range is of immense importance for any chemical coagulation, disinfection, water softening and corrosion control are governed by P_H adjustment. Dewatering of sludge's, oxidation of cyanides and reduction of hexavalent chromium into trivalent chromium also need a favourable P_H range. It is used in the calculation of carbonate, bicarbonate, carbon dioxide corrosion, stability index and acid base equilibrium. Lower value of P_H below 4.0 will produce sour taste and higher value above 8.5 a bitter taste. Higher values of P^H hasten the scale formation in Water heating apparatus and also reduce the germicidal potential of chlorine. High P_H induces the formation of trihalomethanes, which are Causing Cancer in human beings.


Shree Ramchandra Education Society
Lonikand, Pune

Principle:

The P_H electrode used in the P_H measurement is a combined glass electrode. It consists of sensing half-cell, together from an electrode system. The sensing half-cell is a thin P_H sensitive semi permeable membrane, separating two solutions viz., the outer solution, the sample to be analyzed and the internal solution enclosed inside the glass membrane and has a known P^H value. An electrical potential is developed inside and another electrical potential is developed outside, the difference in the potential is measured and is given as the P^H of the sample.

Material Required:

(1) Apparatus required and
(2) Chemical required

(1) Apparatus Required:

(a) P_H Meter,
(b) Thermometer, 1no
(c) Std. flasks, 1 no
(d) Magnetic stirrer, 1 no
(e) Funnel, 1 no
(f) Beaker, 3 no's
(g) Test tubes, 3no's
(h) Wash bottle, 1 no
(i) Tissue papers etc.,

Chemicals Required:

(a) Std. buffer solution such as P_H = 4.5, P_H = 7.0 and P_H = 9.2,
(b) Distilled water etc.,
(c) Universal Indicator.

Sample Handling and Preservation:

(1) Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, and changes may occur during handling and storage.
(2) The characteristics of the water sample change.
(3) To reduce the change in samples taken for the determination of P^H keeps the sample at 4_O C. Do not allow the sample to freeze.
(4) Analysis should begin as soon as possible.

Precautions.

The following precaution should be observed while performing the experiment

(1) Temperature affects the measurement of P_H at two points; the first is caused by the change in electrode output at different temperature. This interference can be controlled by the instruments having temperature compensation or by calibrating the electrode instrument system at the temperature of the samples. The second is the change of P_H inherent in the sample at different temperature. The type of error in sample dependent and cannot be controlled. Hence both the point and temperature at the time of analysis should be note.

(2) In general, electrode is not subjected to solution interferences like color, high salinity, colloidal matter, oxidants, and turbidity or reluctant.

(3) Oil and grease, if present, in the electrode layer, should be removed by gentle wiping or detergent washing followed by raising with distilled water, because it could impair the electrode response.

(4) Before using, allow the electrode to stand in dilute hydrochloric acid solution for at least two hours.

(5) Electrodes used in the P_H meter are highly fragile, hence handle it carefully.

Procedure:

(1) Preparation of reagents,
(2) Calibrating the instruments,
(3) Testing of samples.

(1) Preparation of Reagents:

a) Buffer Solution of P_H 4.0

i) Take 100ml Std. measuring flask and place a funnel over it.
ii) Use the forceps carefully and transfer one buffer tablet of P_H 4.1 to the funnel.
iii) Add little amount of water, crush the tablet and dissolved it.
iv) Make up the volume to 100ml using distilled water.

b) Buffer Solution of P^H 7.0

i) Take 100ml Std. measuring flask and place a funnel over it.
ii) Use the forceps carefully and transfer one buffer tablet of P^H 7.1 to the funnel.
iii) Add a little amount of water, crush the tablet and dissolve it.
iv) Make up the volume to 100ml using distilled water.

c) Buffer Solution of P^H 9.20

i) Take 100ml Std. measuring flask and place a funnel over it.
ii) Use the forceps carefully and transfer one buffer tablet of P_H 9.2 to the funnel.
iii) Add little amount of water, crush the tablet and dissolved it.

iv) Make up the volume to 100ml using distilled water

2) Calibrating the Instrument:

Using the buffer solution calibrate the instrument. Step:-01

i) In a 100ml beaker take P_H 9.20 buffer solutions and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well.
ii) Now place the electrode in the beaker containing the stirred buffer solution and check for the reading in the P_H meter.
iii) If the instrument is not showing P_H value of 9.20, using the calibration knob gently adjust the reading to 9.20.
iv) Take the electrode from the buffer solution, wash it with distilled water and then wipe gently with soft tissue paper.

Step:-02

i) In a 100ml beaker take P_H 7.0 buffer solutions and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well.
ii) Now place the electrode in the beaker containing the stirred buffer solution and check for the reading in the P_H meter.
iii) If the instrument is not showing P_H value of 7.0, using the calibration knob gently adjust the reading to 7.0.
iv) Take the electrode from the buffer solution, wash it with distilled water and then wipe gently with soft tissue paper.

Step:-03

i) In a 100ml beaker take P_H 4.0 buffer solutions and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well.
ii) Now place the electrode in the beaker containing the stirred buffer solution and check for the reading in the P_H meter.
iii) If the instrument is not showing P^H value of 4.0, using the calibration knob gently adjust the reading to 4.0.
iv) Take the electrode from the buffer solution, wash it with distilled water and then wipe gently with soft tissue paper.

3) Testing of Samples:

Methods:

(a) By Colorimetric method and
(b) By Electrometric method.

Method:-I

(a) Colorimetric method:

This is probably the most single method in which some universal indicator is added to the water sample and the colour of the solution is compared with the Standard colours of known P_H value. These Standard coloured may be in the form of coloured liquids in glass tubes, coloured glass discs or coloured charts supplied by the manufacturer with each indicator.

Testing of Sample.

i) Take test tubes, and fill them with one-forth each with sample water to be tested. Let these tubes be marked as 'A', 'B', and 'C, respectively.
ii) Add 15 drops of universal indicator in different test tubes of different water sample.
iii) Mix the sample in all the test tubes thoroughly by turning them up and down.
iv) Now the colour of different water sample will change.
v) Observe the tinge of colour developed in the test tubes, and match them with the colour scale given on the indicator bottle itself.
vi) The colour scale given on the bottle will give the P_H value directly. This is the rough estimation of P_H value.

(b) Electrometric method:

i) In a clean dry 100ml beaker take water sample and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well.
ii) Now place the electrode in the beaker containing the water sample and check for the reading in the P_H meter.
iii) Wait until you get a stable reading.
iv) Take the electrode from the water sample, wash it with distilled water and then wipe gently with soft tissue.

Table:-01

Sr.No.	Particulars	Temperature. in $^{\circ}C$	P^H	
			By P^H meter	By P_H universal indicator
01	Bore well water			
02	Tape water			
03	River water			

Interpretations of Results:

The P_H of the given water sample:

(a) Bore well water____
(b) Tap water_____
(c) River water_____

Inference:

P_H is a measure of hydrogen ion concentration in water. Values lower than 7 indicates acidity and values higher then 7 indicates alkalinity .Drinking water with a P_H between 6.5 and 8.5 is generally considered satisfactory .Acidic water tends to corrosive to plumbing and faucets, particularly, it the P_H is below 6. Alkaline water are less corrosive. Water with a P_H above 8.50 may feed to have a bitter taste.

The P^H of the water samples are well with the limit of the drinking water standards.

The P^H of the ground water is slightly towards the alkaline side because of some soil and rocks chemicals might have dissolved in it. In case of the P_H of the fresh water, aquatic plants uses up hydrogen molecules for photosynthesis, which causes the concentration of hydrogen ions to decreases and therefore the P_H is towards the alkaline side. The sea water is mostly alkaline in nature because of the presence of different type of salts.

Experiment:-01

Aim: - (b) To Determine Alkalinity of a Given Water Sample.

Introduction:

Alkalinity is primarily a way of measuring the acid neutralizing capacity of water. In other words, its ability to maintain a relatively constant P_H . The possibility to maintain constant P_H 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 and calcium ions both come from calcium carbonate or lime stone. So water that comes in contact with lime stone 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 P^H changes. Higher alkalinity levels in surface water will buffer acid rain and other acid wastes and prevent P_H changes that are harmful to aquatic life. Large amount of alkalinity imparts bitter taste in water. The principal objective of alkaline water is the reactions that can take between alkalinity and certain cations in water.

Principle:

The Alkalinity of water can be determined by titrating the water sample with sulphuric acid of known value of P_H , volume and concentration. Based on stoichiometry of the reaction and number of moles of sulphuric acid needed to reach the end points, the concentration of Alkalinity in water is calculated.

When a water sample that has a P^H of greater than 4.50 is titrated with acid to a P^H 4.50 end point all $OH^{-¿}$, $CO_3^{2-¿}$ and $HCO_3^{-¿}$ be neutralized.

For the P_H more than 8.30, add 8 phenolphthaleinPge indicator, the colour. This pink colour is due to the presence of hydroxyl ions. If sulphuric acid is added to it, the pink colour disappears i.e. $OH^{-¿}$ ions are neutralized.

Then add mixed indicator, the presence of CO_3^{2-} and HCO_3^- ions in the solution changes the colour to blue. While adding sulphuric acid, the colour changes to red, this colour change indicates that all the CO_3^{2-} and HCO_3^- ions has been neutralized. This is the end point.

Material Required:

(1) Apparatus required,
(2) Chemicals required.

(1) Apparatus required:

(a) Burette with burette stand, 1 no
(b) Pipette with elongated tips, 1 no
(c) Pipette bulb, 1 no
(d) Conical flask, 4 no
(e) 250 ml graduated cylinder,1 no
(f) Wash bottle, 1no
(g) Beaker, 4no
(h) P_H Meter,
(i) Thermometer.

(2) Chemicals Required.

(a) Std. Sulphuric Acid (H_2SO_4) 0.02 N,
(b) Phenolphthalein indicator ($C_{20}H_{14}O_4^-$,
(c)Mixed indicator / Methyl orange indicator,
(d) Distilled water etc.,

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. The characteristics of the water sample may change. To reduce the change in samples taken for the determination of Alkalinity keep the sample at 4^oC . Do not allow the sample to freeze. Analysis should begin as soon as possible.

Precautions.

The following precautions should be observed while performing the experiment,

(1) Do not keep the indicator solution open, since it contains the alcohol which tends to evaporate.
(2) The mixed indicator solution is containing dye in it; care should be taken, so that it is not spilled to your skin.
(3) If it spills on your skin, the scar will remain at least for two or three days.

Procedure:

Two major steps are involved in the experiment. They are

(1) Preparation of Reagents, and
(2) Testing of sample.

(1) Preparation of Reagents:

Sulphuric Acid Solution (H_2SO_4) 0.02N:

(a) Take approximately 500 ml of distilled water in a 1000 ml Std. flask.
(b) Pipette 20 ml of concentrated 0.1 Normality Sulphuric acid and add slowly along the sides of the std. flask.
(c) Then make up to 1000 ml mark.
(d) Now the strength of the solution is 0.02 N

Phenolphthalein Indicator:

(a) Weigh 1gm of phenolphthalein and add to 100ml of 95% ethyl alcohol or to 100ml of distilled water.
(b) Use the readymade Phenolphthalein indicator available in market.

Mixed indicator:

(a) Dissolve 100mg of Bromocresol green and 20gm of methyl red in 100ml of 95% ethyl alcohol or use 100ml of distilled water.
(b) Mixed indicator also readily available in the market.
(c) So it can be used as indicator in this experiment.

(2) Testing of water sample.

(a) Determine the temperature of sample. And also determine the P_H of the given water sample.
(b) Take 25ml of sample in a conical flask.
(c) If P_H of sample is above 8.30 add two drops of Phenolphthalein indicator and the color of sample will be pink and it contains Phenolphthalein alkalinity and proceed the next step. If pink colour does not appear, note down that Phenolphthalein alkalinity is zero.
(d) Titrate against Std. Sulphuric Acid (H_2SO_4) 0.02 N, till pink colour disappears.
(e) Record 'X' ml of titrant used to achieve the point in the observation table.
(f) To the same flask constantly add two to three drops of Methyl orange indicator, the yellow colour is obtained if alkalis are 10 present.
(g) Continue titration against 0.02N until a light orange colour is obtained.
(h) Record 'Y' ml of titrant used to achieve the point.

Calculation:

Case I: When 'X' present and 'Y' is zero:

In this case, the type of alkalinity present is hydroxide (OH^-)

$\therefore$ OH^- alkalinity= ('X' ml x 0.02 x 50 x 1000) / (Sample taken in ml)in mg/l as $CaCO_3$

Case II: When 'X' is greater than 'Y':

Then type of alkalinity present is (OH^-) + (CO_3^{--}),

Total alkalinity = (('X' +'Y') ml x 0.02N X 50 X 1000) / (Sample taken in ml) in mg/l as $CaCO_3$

$\therefore CO_3^{--}$ alkalinity = ('Y' ml x 0.02 x 50 x 1000) /(Sample taken in ml) in mg/l as $CaCO_3$

$\therefore OH^-$ alkalinity = Total alkalinity – alkalinity due to CO_3^{--} in mg/l as $CaCO_3$

Case III: When 'X' is equal to'Y':

Then type of alkalinity present is CO_3^{--} onely.

$\therefore CO_3^{--}$ alkalinity = ('X' ml x 0.02 x 50 x 1000) / (Sample taken in ml.) in mg/l as $CaCO_3$

Case:-4 When 'X' is smaller than 'Y':

Then type of alkalinity is (CO_3^{--}) + (HCO_3^-).

$\therefore$ Total alkalinity = (('X' +'Y') x 0.02 x 50 x1000) / (Sample taken in ml)

$\therefore CO_3^{--}$

$\therefore HCO_3^-$

= ('X' ml x 0.02 x50x1000) / (Sample taken in ml.)

= (Total alkalinity) – (CO_3^{--})

Case:-5 when 'x' is zero and 'Y' present only:

Then type of alkalinity is HCO_3^-

$\therefore HCO_3^-$ Alkalinity = ('Y' ml x 0.02 x 50 x1000) / (Sample taken in ml)

Observation

Table:-02

Sr. no.	Description	P	Burette readings In ml			Burette readings In ml			Alkalinity		
									Bicarbonate in mg/l as $CaCO_3$	Carbonate in mg/l as $CaCO_3$	Hydroxide in mg/l as $CaCO_3$
			Initial reading	Final reading	Difference 'X'	Initial Reading	Final Readings	Difference 'Y'	$-¿$ $HCO_3^{¿}$	$--¿$ $CO_3^{¿}$	$-¿$ $OH^{¿}$
01	Sample-01										
02	Sample-02										
03	Sample-03										

Result:

Conclusion:

Experiment:-02

Determination of Hardness and its components of a given water sample.

Aim:-To determine total hardness and its components of a given water sample.

Introduction:

Water that has high mineral content is known as hard water. Hard water contains bicarbonate, Chlorides and Sulphates of Calcium and Magnesium. When treated hard water with soap, it gets precipitated in the form of insoluble salts of calcium and Magnesium. Hardness of water is a mixture of total concentration of the Calcium and Magnesium ions expressed as Calcium carbonate.

There are two types of hardness.

(1) Temporary hardness: Temporary hardness is due to the presence of bicarbonate of calcium and magnesium**.** It can be removed by boiling the water.

(2) Permanent hardness: Permanent hardness is due to the presence of chlorides and sulphates of calcium and magnesium. This type of hardness cannot be removed by boiling.

Environmental Significance:

(1) Scales are formed as inner coating of pipelines prevents corrosion.

(2) Absolutely soft water is corrosive and dissolves the metals.

(3) More cases of cardio vascular diseases are reported in soft water areas.

(4) Hard water is useful to growth of children, due to the presence of calcium.

(5) Hard water causes excessive consumption of soap used for cleaning purpose sodium soap react with multivalent metallic cations to form a precipitate there by lose their surfactant properties. Lathering doesn't take place until all hardness ions precipitate out. 13

(6) This precipitates adheres to surfaces of tubes, sinks cloths.

(7) Scales formed mainly due to carbonate hardness act as insulations and cause enormous loss of fuel in boiler.

(8) Scales deposited mainly due to increase in P_H to 9.00 at which bicarbonates are converted as carbonates are formed in distribution mains reducing their carrying capacity.

Principle:

A water sample is buffered to P_H 10 and taken into a conical flask. If an indicator dye like EBT, when added to solution containing calcium and magnesium ions, the colour of the

solution turns to wine red. EDTA the titrant, complexes with magnesium and calcium ions removing them from association with the indicator. When all the Mg and Ca are complexes with EDTA, the indicator will turn blue. This is the end point of the titration.

Materials Required:

(1) Glassware Required and
(2) Chemicals Required

(1) Glassware Required:

(a) Burette with burette stand, 1 no
(b) Pipette with elongated tips, 1 no
(c) Pipette bulb, 1no
(d) Conical flask, 3 no's
(e) 250 ml Graduated Cylinder, 1 no
(f) Wash bottle, 1 no
(g) Beaker, 3 no's

Chemicals Required:

(a) Ammonia buffer solution,
(b) Erichrome Black T-Indicator(EBT),
(c) Std. Ethylene dia mine tetra acetic acid (EDTA) 0.02 M and
(d) Std. Calcium Carbonates Solution ($CaCO_3$ ¿ 0.02N.

Interrelationship of Alkalinity and Hardness:

(1) Both alkalinity and hardness are expressed in mg/l as $CaCo_3$.
(2) The part of total hardness that is chemically equivalent to the bicarbonate plus carbonate alkalinity present in water is considered to be carbonate hardness.
(3) Temporary carbonate hardness =Carbonate alkalinity + Bicarbonate alkalinity.
(4) When total alkalinity is less then total hardness, then carbonate hardness is equal to total alkalinity.
(5) When total alkalinity is more than total hardness, then carbonate hardness is equal to total hardness.
(6) Permanent hardness=Total hardness – carbonate hardness.

Sampling 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. If analysis is to be carried out in two hours of collection, cold storage is not necessary. If analysis cannot be started with in the two hours of sample collection to reduce the change in sample, keep all samples at 4 $^{\circ}C$. Do not allow sample to freez. Do not sample bottle before analysis. Begin analysis within six hours of sample collection.

Precautions:

(1) Here we are handling ammonia solution, so necessary precaution should be taken for preventing the inhalation.
(2) It causes irritation if inhaled.
(3) Do not pipette out the buffer solution using measuring cylinder, automatic pipette or pipette with a sucker.
(4) Always store EDTA solution and buffer solution in a plastic or resistant glass container.
(5) Discard the buffer solution if it is turbid or if it is stored for a very long period of time.

Procedure:

Two major steps are involved in the experiment. They are

(1) Preparation of Reagents, and

(2) Testing of sample.

(1) Preparation of Reagents:

Ammonia Buffer Solution:

(a) Switch on the electronic balance, keep the weighing pan, and set the reading to zero.

(b) Measure 50 ml of distilled water and transfer it to the beaker.

(c) Weigh 1.179 of EDTA. Transfer the contents to the beaker having 50 ml of distilled water and dissolve it thoroughly

(d) Weigh 16.90 gm of ammonium chloride. Add it to the contents in the beaker. And dissolve it thoroughly.

(e) Weigh 780 mg of magnesium sulphate and transfer it to the beaker.

(f) Measure 143 ml of ammonium hydroxide solution in a measuring cylinder and add it to the content in the beaker.

Erichrome Black-T.

(a) Weigh 0.5 gm of Erichrome black-T.

(b) Transfer it to 100 ml Std. flask using funnel.

(c) Add distilled water in the Std. flask make the volume exactly up to 100 ml mark.

(d) Put the lid and shake the contents well.

(e) Transfer the solution to a clean reagent bottle and it named EDT.

Standard EDTA Solution (0.02 N or0.01 M).

(a) Switch on the electronic balance, keep the weighing pan, and set the reading to zero.

(b) Weigh 3.723 gm of EDTA sodium salt.

(c) Transfer the entire content to 1000 ml Std. flask.

(d) Fill with distilled water up to 1000ml of mark.

(e) Put the lid and shake the contents well.

(f) For easy handling take the EDTA solution in a 250 ml beaker.

(2) Testing of Water Sample.

A. Sample Titration:

(a) Take 25ml of hard water sample in a conical flask.

(b) Add one or two ml of Ammonia buffer solution to make the sample P_H between 9 to 10

(c) Add few grains of dry Std. Erichrome Black T-Indicator and mix it till the wine red colour is obtained. 15 acid (EDTA) till the end point. (Sky blue(d)TitrateagainstStd.Ethylenediaminetetra colour is obtained). Pag

(e) Record 'X' ml of Std. Ethylene dia mine tetra acetic acid (EDTA) 0.01 M used in the tabular column.

B. Blank Correction:

(a) Take 25ml of distilled water.

(b) Add one ml. to two ml. of Ammonia buffer solution to make P_H 9 to 10

(c) Add few grains of dry Std. Erichrome Black T-indicator as indicator and mix it till the wine red colour appears.

(d) Titrate against Std. Ethylenediamine tetra acetic acid (EDTA) 0.01 M solution till the end point (Sky blue colour is reached).
(e) Record 'Y' ml of Std. Ethylene dia mine tetra acetic acid (EDTA) 0.01 M used in the tabular column.

C. Standardization of EDTA Solution:

(a) Take 10 ml of 0.02 N of Std. calcium carbonate $CaCo_3$ solutions in the flask.

(b) Add one or two ml of Ammonia buffer solution to give P^H of 9 to 10

(c) Add few grains of Std. Erichrome Black T-indicator as Indicator and mix it till wine red colour is obtained.
(d) Titrate against EDTA solution till the end point (Sky blue colour is obtained).
(e) Record 'Z' ml of EDTA.

Calculation.

(1) Normality of EDTA,

$$N = \frac{Ml\ of\ CaCO_3 \times Normality\ of\ CaCo_3}{(Z - Y)}$$

(2) Total hardness as $CaCo_3$

$$= \frac{(X - Y) \times N \times 50 \times 1000}{Sampletaken} \text{ mg/l}$$

(3) Total Alkalinity as $CaCo_3$

$$= \frac{(X + Y) \times N \times 50 \times 1000}{Sampletaken} \text{ mg/l}$$

Observation.

Table:-03

Sample No.	Description.	Burette Reading In ml.								
		Initial	Final	Difference 'X'	Initial	Final	Difference 'Y'	Initial	Final	Difference 'Z'
01										
02										
03										
04										

Table:-04

Sample No.	Description	Total Hardness mg/l as $CaCo_3$	Total Alkalinity mg/l as $CaCo_3$	Carbonate hardness mg/l as $CaCo_3$	Non Carbonate hardness mg/l as $CaCo_3$	Remark
01						

02						
03						

Carbonate hardness = Total hardness,
Non-carbonate hardness = Total hardness – Total alkalinity.

Result:

The hardness of the given sample of water is_____ *mg/ l*

Conclusion:

Experiment:-03

Determination of Chlorides in a given Water Sample by Mohr's Method.

Aim: To determine the amount of Chlorides present in the given water sample.

Introduction:

Chlorides are widely distributed as salts of calcium, Sodium and Potassium in water and waste water. In portable water, the salty taste produced by chloride concentrations is variable and dependent of the chemical composition of water. The major taste produced salts in water are
sodium chloride and calcium chloride. The salty taste is due to chloride anions and associated cations in water.

In some water which is having only 250 *mg/ l* of chloride may have a detectable salty taste, if the cation present in the water is sodium. On the other hand, a typical salty taste may be absent even if the water is having very high chloride concentration for example 1000 *mg/ l* .

Environmental Signification:

Chlorides associated with sodium chloride exert salty taste when its concentration is

more than 250 mg/l in water supplies intended for public water supply. In many cases

of the world water supply are scarce, sources containing as much as 2000 mg/l are used for domestic purposes without the development of adverse effect, once the human system becomes adopted to the water.

It can also corrode concrete. Magnesium chloride in water generates hydrochloric acid after heating which is also highly corrosive and creates problems in boilers.

Chlorides determines in natural water are useful in the selection of water supply for human use.

Chlorides determination is used to determine the type of desalting apparatus to be used.

Chloride determination is used to control pumping of ground water intrusion of sea water is a problem.

Chlorides interfere in the determination of chemical oxygen demand.

Principle:

The amount of chloride present in water can be easily determined by titrating the given water sample with silver nitrate solution. The silver nitrate reacts with chloride ions according to one mole of $AgNO_3$ reacts with one mole of chloride, the titrant concentration is generally 0.02 M silver chloride is precipitated quantitatively. Before red silver chloride is formed. The end of titration is indicated by formation of red silver chromate from excess silver nitrate. The results are expressed in mg/l of chloride. (Cl^- with a molecular weight of 35.453 g/mol)

Materials required:

(1) Glassware required.

(2) Chemicals required.

(1) Glassware required:

(a) Burette 50 ml, 1 no

(b) Pipette, 1 no

(c) Conical flask, 1 no

(2) Chemicals required:

(a) Std. Silver nitrate Solution 0.0282 N,

(b) Potassium chromate (K_2CrO_4) Indicator,

(c) Std. Sodium chloride Solution,

(d) 1 N H_2SO_4 or 1N NaoH.

Sampling handling and preservations:

Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage. If analysis is to be carried out in two hours of collection, cold storage is not necessary. If analysis cannot be started with in the two hours of sample collection to reduce the change in sample, keep all samples at 4°C. Do not allow sample to freeze. Do not open sample bottle before analysis. Begin analysis within six hours of sample collection.

Precautions:

(1) Silver nitrate should be stored in a brown amber bottle and should not be exposed to

sun light.

(2) While handling $AgNO_3$, care should be taken, so that it is not spilled on your skin.

(3) If it spills on your skin, the scar will remain at least for ten to fifteen days.

Procedure:

Two major steps are involved in the experiment. They are

(1) Preparation of Reagents and
(2) Testing of sample.

Preparation of Reagents:

Standard Sodium Chloride 0.0141 N:

(a) Switch on the electronic balance, keep the weighing pan, and set the reading to zero.
(b) Transfer the contents to the beaker containing distilled water, using glass rod dissolve the contents thoroughly.
(c)Transfer the content in the beaker to a 100 ml Std. flask.
(d) Fill distilled water up to 100 ml mark.
(e)Transfer it to 100 ml Std. flask using funnel.

Standard Silver Nitrate (0.0141 N).

(a)Weigh 4.791 gm of silver nitrate and transfer it to the beaker with distilled water.
(b) Transfer the contents in the beaker to a 100ml Std. flask; fill distilled water up to the 100ml mark.
(c) Standardize it against 0.0141 N Nacl solutions.
(d)Store it in an amber bottle.

Potassium Chromate Indicator.

(a) Weigh 25 gm Potassium chromate and transfer it to the beaker contains distilled water.
(b) Add few drops of silver Nitrate solution until slight real precipitate is formed.
(c) Allow it to stand for 12 hours.
(d) After 12 hours filter the solution using filter paper and dilute the filtrate to 1000 ml using distilled water.

(2) Testing of Water Sample.

A. Standardization of Silver Nitrate Solution.

(1) Take 10 ml of Std. Sodium chloride solution (0.0141 N Nacl) in a conical flask.
(2) Add 100ml of distilled water.
(3) Check it's $P_H it$ should be between 7 to 8. If required correct it by adding 1N NaOH or
1N $H\ SO_2\ _4$ as required. 19
(4) Add one ml of potassium chromate indicator. Page
(5) Titrate against silver nitrate solution.
(6) End point is reached when reddish is formed.
(7) Record the amount of titrate solution 'X' ml.

B. Blank Correction:

1. Take 100 ml of distilled water.
2. Check it's P_H, it should between 7.0 to 8.0.Correct it by adding 1N $H_2\ SO_4$ or 1N NaOH as required.
3. Add 1 ml of Potassium chromate solution as indicator.

4. Titrate against Silver nitrate solution.
5. End point is reached when reddish yellow precipitate is formed.
6. Record the amount of titration as 'Y'.

C. Sample Titration:

1. Take 10ml of sample in a conical flask.
2. Add 100 ml of distilled water. Check its P_H , it should be between 7 to 8
   Correct it by adding 1N $H_2 SO_4$ or 1N NaOH as required.
3. Add one ml. Potassium chromate indicator.
4. Titrate against Silver nitrate solution.
5. End point is reached when reddish yellow precipitate is formed.
6. Record the amount of titration used as 'Z'.

Calculation:

1. Normality:

$$N = \frac{10 \times 0.0141\ N\ NaCl\ \ Agno_3}{X - Y}$$

2. Chloride conc. in water sample:

$$= \frac{(X - Y) \times N \times 35.45}{Sampletaken}\ \text{mg/l}$$

Observation:

Table:-05

Sample	Description	Burette reading in ml.								
		Initial	Final	Difference 'X'	Initial	Final	Difference 'y"	Initial	Final	Difference 'Z'
01	Bore well water									
02	Tap water									

Interpretation of Result:

1. The Chloride Concentration in Bore well water is_____ *mg/ l*
2. The Chloride Concentration in Tap water is_____ *mg/ l*

Conclusion:

Experiment-04
Determination of Chlorine Demand and Residual Chlorine.

Aim: To determine the Chlorine Demand and Residual Chlorine of a given water sample.

Introduction:

(2) Treated or filtered water is deemed to be fit for consumption only, if it is devoid of diseases producing microorganism.

(3) Chlorination is primarily adopted to destroy or deactivate disease producing microorganisms in the public water supplies and polluted river.

(4) Chlorine is usually added to water in gases form or as sodium or calcium hypo chlorite.

(5) It has been practiced over several years.

(6) When chlorine is added to water, some of the chlorine reacts first with organic materials and metals in water and is not available for disinfection. This is called the chlorine demand of the water.

(7) The remaining chlorine concentration after the chlorine demand is accounted for is called total chlorine.

(8) The total chlorine is further divided into

(9) The amount of chlorine that has reacted with nitrates and is unavailable for disinfection which is called combined chlorine and

(10) The free chlorine, which is the chlorine available to inactivate diseases causing organisms and thus a measure in determine the portability of water.

(11) The world “Residual” means “Remainder” or “that which is left” and as the name suggests the chlorine residual test is used to measure in the ware at the time the test is made.

(12) The chlorine residual is usually tested in finished water which is ready to be released into the distribution system, although operates residual at the extreme ends of the distribution system.

(13) Although the pros and cons of disinfection with chlorine have been extensively debated, it remains the most widely used chemical for disinfection of water.

(14) Excess chlorination may produce adverse effects potentially carcinogenic compounds such as chloroform may be formed.

(15) To fulfill the primary purpose of chlorination and to minimize any adverse effect, it is essential that proper testing procedures be used.

(16) Several methods for measurement of total residual chlorine are available including Iodometric methods, Amperometric titration methods and Ndiethyl-P-phenylenediamine (DPD)

(17) In this model we are going to learn iodometric method of residual chlorine determination.

Environmental Significance:

(1) Chlorine residuals determination is used to control chlorination of domestic and industrial waste water.

(2) Active chlorine (free and combined) should be determined at each stage in the treatment process of drinking water and in the water mains in order to guarantee water bacteriologic ally impeccable water.

(3) Chlorine determined is important to avoid bad odor and check in the tank of water.

(4) It is determined in the swimming pools to avoid ill effects due to excess chlorination.
(5) Determination of chlorine residual in water distribution is useful to find the source of contamination or leakage points, so as to supply wholesome water to the consumer.
(6) Thus, the main purpose for the chlorination of water supply and polluted water serves primary to destroy or deactivate diseases producing microorganism.

Principle:

(1) The starch –iodide titration method, one of the oldest methods for determining chlorine is very non-specific for oxidant and generally is used for total chlorine testing at levels above 1 mg/lCl_2

(2) Chlorine will liberate free iodine from potassium iodide solution at P_H 8.0 or less. The liberated iodine is titrated with a standard solution of sodium thiosulphate with starch as the indicator.
(3) This method is based on reaction with thiosulphate solution.
(4) The end point of titration is indicated by the disappearance of the blue-colored, starch-iodide complex.

Material required:

(1) Glassware,
(2) Chemicals required.

(1) Glassware required.

(a) Burette 50 ml, 1 no
(b) Graduated pipette 5 ml, 1 no
(c) Measuring cylinder 1000 ml,
(d) Beaker 200 ml, 500ml,
(e) Glass rod etc.,

(2) Chemicals required:

(a) Conc. Acetic acid (CH_3COOH),
(b) Potassium iodide (KI) crystal,
(c) Chlorine solution (Cl),
(d) Sodium thiosulphate ($Na_2S_2O_3$) 0.001 N,
(e) Starch indicator $(C_6H_{10}O_5)_n$,
(f) Potassium dichromate 0.1N ($K_2Cr_2O_7$),
(g) Sulphuric acid H_2SO_4 , Page 2 2
(h) Universal indicator.

Sampling handling and preservations:

Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage. If analysis is to be carried out in two hours of collection, cold storage is not necessary. If analysis cannot be started with in the two hours of sample collection to reduce the change in sample, keep all samples at 4°C. Do not allow sample to freeze. Do not open sample bottle before analysis. Begin analysis within six hours of sample collection.

Precautions:

(1) Do not expose the potassium iodide crystals in the air; If possible do the experiment in iodine flask instead of conical flask.

(2) Chlorine in water solutions is not stable. As a result, its concentration in sample decreases rapidly.

(3) Sample to be analyzed for chlorine cannot be stored or preserved.

(4) Tests must be started immediately after sampling. Therefore, sample taken for the chlorine residual test must be grab samples only and excessive agitation must be avoided.

(5) Exposure to sunlight or other strong light, air or agitation with further reduces the quantity of chlorine present in solution.

Procedure:

Two major steps are involved in the experiment. They are

(1) Preparation of Reagents,

(2) Testing of sample.

(1) Preparation of reagents:

Sodium Thiosulphate Solution. (0.001 N):

(1) Weigh approximately 2.482 gm of sodium thiosulphate.

(2) Transfer to the beaker and dissolve it in boiled distilled water.

(3) Transfer to the standard flask and make it up to 1000 ml mark.

(2) Testing of Sample:

A. Standardization of Sodium Thiosulphate:

(1) Place 2 gm of potassium iodide crystal in a flask.

(2) Add 100 ml of distilled water.

(3) Add 10 ml of 10% Sulphuric acid.

(4) Add 10 ml of 0.001 N Potassium dichromate.

(5) Add 100 ml distilled water (to reduce making of starch end point by greenish trivalent chromium ions (Cr^{+++} *wait for* 5 *min* ¿ .

$$6\,KI + 7\,H_2SO_4 + K_2Cr_2O_7 \rightarrow\rightarrow\rightarrow Cr_2(SO_4)_3 + 4\,K_2SO_4 + 7\,H_2O + 3\,I_2$$

(This is a slow reaction, wait for 5 min. to allow all the dichromate added to release an equivalent amount of free iodine)

(6) Titrate against 0.001N Sodium thiosulphate using one to two ml of starch indicator.

(7) Record volume of titrate used to endpoint, 23 Pag say 'X' till disappearance of blue Colour.

Normality of Sodium thiosulphate:

$$N = \frac{0.001 \times 10}{Ml\ of\ Sodium thiosulphate used\ (X)}$$

Note: - 10 ml of Potassium dichromate.

B. Determination of Concentration of Chlorine in Chlorine Solution:

(1) Take 10 ml of chlorine solution in a beaker.

(2) Add 100 ml of distilled water.

(3) Add 1ml to 2ml Conc. Acetic acid to lower the P_H to 3.0 to 4.0.

(4) Add 2 gm Potassium iodide crystals (yellow colour indicates liberation of iodine).

(5) Titrate against Std. Sodium thiosulphate using 1ml to 2ml of starch indicator.

(6) End point blue to colourless.

(7) Let the amount of Sodium thiosulphate used be 'Y'.

C. Conc. of Chlorine in chlorine solution.

$$= \frac{(Y - Z) \times N \times 35.35 \ x \ 1000}{Ml \ of \ chlorine \ sample \ taken (10 \ ml)} \quad mg/l$$

D. Blank correction:

(1) Take100 ml of distilled water in a beaker.

(2) Add 1ml to 5ml Conc. Acetic acid to lower the P_H to 3.0 to 4.0.

(3) Add 2gm Potassium iodide crystals (yellow colour indicates liberation of iodine).

(4) Titrate against Std. Sodium thiosulphate using one ml of starch indicator.

(5) End point blue to colourless.

(6) Let the amount of Sodium thiosulhate used be 'Z' ml (Z=0):

E. Determination of Residual chlorine and chlorine demand:

(1) Take four beakers 'P', 'Q', 'R', 'S' pour 200 ml of raw water in each.

If the concentration of chlorine in chlorine solution is say if, 100 mg/l then

1 ml = 0.1 mg of CL_2

(2) Add 1 ml, 2ml, 3ml, 4ml of chlorine solution to beaker 'P', 'Q','R' and 'S'.

CAUTION:-Chlorine solution is very toxic, do not suck. Use pipette.

(3) Determine the dosage of chorine applied.

E.g. If chlorine solution Conc. is say 100 mg/l.

$$\text{Applied dosage} = \frac{(Ml \ of \ chlorine \ solution \ X \ Conc. \ Chlorine)}{(Ml \ of \ raw \ water)}$$

$$\text{Applied dosage for 'P'} = \frac{(1 \ ml \ x \ 100 mg/l)}{(200 \ ml)} = 0.5 \ mg/l$$

$$\text{Applied dosage for 'Q'} = \frac{(2 \ ml \ x \ 100 \ mg/l)}{200 \ ml} = 1.0 \ mg/l$$

$$\text{Applied dosage for 'R'} = \frac{(3 \ ml \ x \ 100 \ mg/l)}{(200 \ ml)} = 1.5 \ mg/l$$

Applied dosage for 'S' = $\frac{4\ ml \times 100\ mg/l}{}$ = 2.0 mg/l

(4) Stir and allow a contact period of 10 minutes.

(5) Add one ml of Acetic acid to drop the P_H to 3.0 to 4.0.

(6) Add 2 gm of Potassium iodide crystal to the beaker(If any residual CL_2 is present, free iodine is liberated producing an yellow colour)

(7) Titrate against Std. Sodium thiosulphate using 1 ml starch as an indicator

(8) End point as blue to colorless.

(9) Let the amount of titrate used be beakers 'P' 'Q' 'R' and 'S' be 'A. 'B' 'C' and 'D' ml (Z).

Calculation:

Applied dosage for 'P' =0.5 mg/l

Applied dosage for Q' =1.0 mg/l

Applied dosage for 'R' =1.5 mg/l

Applied dosage for 'S'=2.0 mg/l

Calculations:- $\frac{A \vee B \vee C \vee D \times N \times 35.453}{Sampletaken\ 200\ ml} \times 1000$

Residual Chlorine =

Observations:

25 Table:-06

Beaker	Sample taken in ml			Dose of Chlorine solution in mg/l	Contact Time minutes	
				(3)	(04)	
(1) P	(02) 200			0.5	10	
Q	200			1.1	10	
R	200			1.5	10	

		Chlorine in mg/l	Demand in mg/l
Residual	Chlorine	(5)	(06)=(03)-(05)

S	200	2.0	10		

Result:

Conclusion:

Experiment: 26 **-05**

Determination of Sodium or Potassium or Page **Calcium using Flame Photometer**.

Aim:-To determine Sodium or Potassium or Calcium from a given sample of water by using Flame Photometer.

Materials required:

(2) Apparatus required,
(3) Chemicals required.

Apparatus required:

Chemicals required:

(1) Sodium,
(2) Potassium and
(3) Calcium

Preparation of Standard Solutions:

Since flame Photometer measures the concentration of sodium, potassium and calcium in terms of quantity of element itself in position. Standard solutions are prepared from the salts of their metals must be made, so as to contain the concentration in terms of quantity of element Na, K or C.

Sodium (Na).

2.542 gm of dry 'Analar' quantity Nacl should be accurately weighted. Dissolve in pure distilled water and fill it in a 1000 ml flask. Make the volume up to the 1000 ml mark.

Std. Sodium Solution:

Dilute 10 ml of stock solution to one litre. 1ml = 0.1mg as Na

$\frac{1\ ml}{50\ ml}$ = 0.2 mg/l as Na

Stock Potassium Solution.

Dissolve 1.907 gm dry potassium chloride in one litre of de-ionised water.

Std Potassium Chloride solution.

Dissolve 10 ml of stock solution in to one litre. 1 ml =0.1mg as Kcl

$\frac{1\ ml}{50\ ml}$ = 2 mg/l as Kcl

Procedure:

(4) Follow the instructions given by the manufacturer.
(5) Start the electric supply and switch on air compressor.
(6) Stabilize the air.
(7) The needle should be steady at mark.
(8) Switch on the gas and maintain the gas air mixture so that separate canes of blue flame are seen through viewing window.
(9) Aspirate the distilled water and adjust meter reading to zero.
(10) Calibrate the instrument by aspirating the standard and meter reading to 100.
(11) Aspirate the deionised water to bring the meter reading to zero.
(12) Aspirate standard and sample and note down the corresponding readings.
(13) Put off fuel supply first, Followed by air and then main switch.
(14) Plot a graph of conc. v/s meter reading.
(15) From the graph, find out the conc. of the unknown sample.

Operating the FP114.

(1) After the instrument has been properly installed.

(2) Before operating FP114, please read all the preceding sections, site preparation, Installation, FP114 over view carefully.

(3) Switch ON the power to flame photometer. The ON/OFF switch is mounted on the back penal of instrument.

(4) When the power is switched ON the instrument performs self diagnosis. The instrument performs a slave test and hence it is necessary to Press any key with in 10 secs. The user has the option to disable the slave test

(5) The instrument will automatically load the last method in use, if it is saved as the default method. To load or create another method please referearlier section titled 'Methods' Flame Ignition.

(6) Switch on air compression, Turn ON the LPG cylinder regulator. Press air key to start flow.

(7) Always first start air compressor and then the LPG cylinder to avoid gas accumulation. The presence of air and gas on analyses mode screen.

(8) Ignite the flame using the ignition knob mounted on the Right side of rhe instrument. Alternatively you ignite the flame using a lighter and inserting it through the ignition window.

(9) Ensure that you get blue colored flame with blue cones over the burner head. Please refer the section titled optimization if you do not get the blue colored flame.

(10) It is recommended that the instrument performance be optimized using the optimization procedure outlined in the optimization section before starting analyses.

(11) BLANK ZEROING: Irrespective of the selection method's attributes, it is required to aspirate the blank before starting the analysis.

(12) The instrument will indicate as such to the user in the status window at the bottom of the display with the 'Aspirate Blank' message.

(13) To avoid any confusion it is recommended that the sample cups be labeled as Rinse, Blank, Standard or sample.

Observation:

Table: 07

Sr.No.	Sample	Na	K	Ca
01	Tape water	5.6	5.7	0
02	Aqua guard	3.0	3.3	0
03	Leachate Sample	5.5	4.5	0

Result: The concentration of Sodium and Potassium in the given sample of water is Conclusion:

Experiment:-06

Determination of Turbidity 29 and Optimum dose of alum.

Aim: - (a) To determine Turbidity of a given waterge sample using Nephelometer. P

Introduction:

Turbidity is the technical term referring to the cloudiness of a solution and it is a qualitative characteristic which is imparted by solids particles obstructing the transmittance of light through a water sample. Turbidity often indicates the presence of dispersed and suspended solids like clay, organic matter, silt, algae and other microorganisms.

Environmental Significance:

When the turbid water in a small, transparent container such as drinking glass is held up to the light, an aesthetically displeasing opaqueness or milky coloration is apparent. When the

water in a small, transparent container such as drinking glass is held up to the light, an aesthetically displeasing opaqueness or milky coloration is apparent. The colloidal material which exerts turbidity provides adsorption sites for chemicals and for biological organism that may not be harmful. They may be harmful or cause undesirable tastes and odours. Disinfection of turbid water is difficult because of the adsorption characteristics of some colloids and because the solids may partially shield organisms from disinfectant. In natural water bodies, turbidity may impart a brown or other colour to water and may interfere with light penetration and photosynthetic reaction in streams and lakes. Turbidity increases the load on slow sand filters. The filter may go out of operation, if excess turbidity variation in raw water supplies is useful to determination whether a supply requires special treatment by chemical coagulation and filtration before it may be used for a public water supply. Turbidity measurement is used to determine the effectiveness of treatment produced with different chemicals and the dosage needed. Turbidity measurement helps to gauge the amount of chemicals needed from day today operation of water treatment works. Measurement of turbidity in settled water prior to filtration is used in controlling chemicals dosage so as to prevent excessive loading of rapid sand filters. Turbidity measurement of the filtered water is needed to check on faulty filter operation. Turbidity measurement is useful to determine the optimum dosage of coagulant to treat domestic and industrial waste water. Turbidity determination is used to evaluate the performance of water treatment plant.

Principle:

Turbidity is based on the compression of the intensity of light scattered by the sample under defined conditions with the intensity of the light scattered by a standard reference suspension under the same conditions. The turbidity of the sample is thus measured from the amount of light scattered by the sample taking a reference with standard turbidity suspension. The higher the intensity of scattered light the higher is the turbidity. Formalin polymer is used as the primary standard reference suspension.

Materials Required:

(1) Apparatus required and
(2) Chemicals required.

(1) Apparatus required:

(a) Turbidity Meter,
(b) Sample cells,
(c) Std. flask,
(d) Funnel,
(e) Wash bottle,
(f) Tissue paper etc.,

(2) Chemicals Required:

(a) Hexamethylenetetramine,
(b) Hydrazine Sulphate,
(c) Distilled water.

Sampling Handling and Preservations:

Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage. If analysis is to be

carried out in two hours of collection, cold storage is not necessary. If analysis cannot be started with in the two hours of sample collection to reduce the change in sample, keep all samples at 4℃. Do not allow sample to freeze. Do not open sample bottle before analysis. Begin analysis with in six hours of sample collection.

Precautions:

The following precautions should be observed while performing the experiments.

(1) The presence of colored solutes causes measured turbidity values to be low precipitation of dissolved constituents (for example Fe) causes measured turbidity value to be high.

(2) Light absorbing materials such as activated carbon in significant concentration can cause low reading.

(3) The presence of floating debris and course sediments which settle out rapidly will give low readings. Finely divided air bubbles can cause high reading,

Procedure:

(1) Preparation of reagents and
(2) Calibrating the instruments
(3) Testing of samples.

(1) Preparation of Reagents: Hydrazine Sulphate.

(a) Weigh accurately 1 gm of hydrazine sulphate and dissolve it in turbidity free distilled water.
(b) Take 100 ml std. measuring flask and place a funnel over it.
(c) Transfer it to a 100 ml std. flask and make up to 100 ml using turbidity free distilled water.

Hex methylenetetra mine.

(a) Weigh accurately 1 gm of Hex methylene tetra mine and dissolve it in turbidity free distilled water.
(b) Take 100 ml std. measuring flask and place a funnel over it.
(c) Transfer it to a 100 ml std. flask and make up to 100 ml using turbidity free distilled water.

Standard 4000NTUsolution.

(a) Mix 5 ml of Hydrazine sulphate solution and 5ml of Hexamethylenetetramine solution in a 100 ml std. measuring flask.
(b) Allow the mixture to stand for 24 hrs.
(c) After 24 hours, make up the volume to 100 ml using turbidity free distilled water.
(d) The standard 4000NTU solution is ready.

(2) Calibration of turbidity meter.

Using the standard solution calibrate the instrument**.**

(a) The instrument is having two knobs out of which the one knob in the right is zero knob, this is for setting the instrument to zero.
(b) The one which is there in the top left hand side is the calibration knob used for

the calibration.

(c) The one in the middle is the knob for setting the detection range. It is adjusted to 200NTU/1000 NTU range.

Step:-01

To the sample cells, add the turbidity free distilled water up to the horizontal mark, wipe gently with soft tissue paper. Place it in the turbidity meter such that the vertical mark in the sample cell should coincide with the mark in the turbidity meter and cover the sample cell. Now use the set zero knob, adjust the reading to zero.

Step:-02

According to our need, prepare a standard solution. In this case, a 200 NTU solution is prepared by diluting the standard 4000 NTU solution and added to the sample cells up to the horizontal mark, wipe gently with soft tissue. Place it in the turbidity meter such that the vertical mark in the sample cell should coincide with the mark in the turbidity meter and cover the sample cell.

Repeat the procedure for two to three
times. Now the instrument is calibrated.

(3) Testing of water sample:

(a) To the sample cells add sample up to the horizontal mark, wipe gently with tissue.

(b) And place it in the turbidity meter such that the vertical mark in the sample cell should coincide with the mark in the turbidity meter and cover the sample cell.

(c) Now check the reading in the turbidity meter, wait until you get a stable reading.

(d) Now enter the reading in the observation table.

Observation:

Table:08

Sample. No.	Description	Temperature in °C	Turbidity in NTU
01			
02			
03			

Interpretation of results:

For sample (01) the temperature of the sample is___ °C and turbidity value is ____NTU.

For sample (02) the temperature of the sample is___ °C and turbidity value is ____NTU.

For sample (03) the temperature of the sample is___ °C and turbidity value is ____NTU.

Inference:

Turbidity is a measure of light transmission and indicates the presence of suspended materials such as clay, silt, finely divided organic material. If turbidity is high be aware of possible bacterial contamination, normally the ground water is clear in nature and it will satisfy the code's need. The ground water may get contaminated by intrusion of domestic or industrial waste water causing turbidity of the sample. Turbidity in water in excess of 5 NTU is usually objectionable for aesthetic reasons. In case of fresh water lakes and ponds due to contamination and algal growth, the turbidity of these water increases to very high levels. The clarity of sea water is very low because of huge amount of suspended particles, thereby increasing turbidity.

Aim: - (b) To determine the optimum dose of Alum required for a sample of water by Jar test apparatus.

Apparatus.

Jar test apparatus,

Turbidity meter, 33 Beakers,

Wash bottle, etc., Page

Reagents required.

Alum solution (1 ml contain 10 mg of alum),

Lime solution ($Ca(OH)_2$),

Distilled water.

Theory.

The most conventional method caused by colloidal and fine suspended impurities in the particle size range of 10_{-7} to 10_{-3} cm is by coagulation and flocculation and followed by neutralization of negative charges on colloidal impurities. The jar test is a laboratory test which comprises of coagulation, flocculation and clarification. The purpose of test and is to determine the optimum dose i.e. the lowest coagulant dose which gives maximum clarification so that the essential turbidity will be in range of 5- 10NTU suitable load on filter. If raw water is deficient in natural alkalinity then the deficient should be made good by adding alkalinity should being the form of ash or quick lime or hydrated lime.

Procedure.

1. Take 500 ml of given sample in six beakers.
2. Find the P_H of the sample and adjust it to6.0 to 8.50.
3. Now add 1 ml, 2 ml, 4 ml, 8 ml, 10 ml, 12 ml, of alum respectively in each one of the beaker.
4. Now insert the paddle of the jar testing apparatus inside the beaker and start it.
5. Initially maintain a speed such that the paddles rotate at an angular velocity of 1000rpm for a time of one minute.
6. Now adjust the speed such that the paddles at 40 rpm for a time of nine minutes.
7. Now allow the beakers to settle down for ten minutes.
8. Make an observation as of which of the six beakers is most clear. Also measure the turbidity of each beaker using a turbidly meter and tabulate your results. Plot a graph settling v/s coagulation dosage.

Observation.

Table:- 09

Sl.No.	Jars	Sample quantity	Turbidity of sample in NTU	Alum dose in mg/l	Lime solution in mg/l	Residual turbidity
01	A	500 ml				
02	B	500 ml				
03	C	500 ml				
04	D	500 ml				
05	E	500 ml				
06	F	500 ml				

Graph.

Result.

The optimum value of coagulant dosage from the graph should be reported.

The optimum value of coagulant generally lies between 8.0 to 10.0 for normal water from

river.

Conclusion.

Aim:-To determine the Most Probable Number of a given sample of water. Introduction.

The Most Probable Number of coliform organisms in water sample is stastical estimate of the density of bacteria most likely to produce a particular result of some significance, associated with the bacterial quality of water.

The quality of drinking water becomes suspects because of the presence of micro-Organisms such as Escherichia presence of coli fecal strip to coli and anaerobic pore forming latridum

purifying less expected from the intensities of warm blooded animals including man and also birds. Water supply for human consumption must be free from these organisms by themselves is generally harmless. Their presence in water indicates the sewage contaminated and is assumptions evidence of pathogenic organisms such as salmenelita typhi, Shingellady sentries, uiardia, Lambliae, Hospital viruses A, B, C , Non B, polio viruses type 1,2,3 parasite flues or flat warms uatridium tetanis, Egg of warms.

When pathogens are presents in sewage they are always out numbered by experimental organisms E- Collie and other Coli forms which are harder more resistant and longer lasting. These coli form organisms all casier to detect in water. If thus are not found in water samples if can be inferred that pathogens are also absent.

Principle:

Coli form bacteria(which are germ negative, non- Spore forming and rod shaped) are bile tolerant and capable of fermenting lactose in 48 hours at 37 ^{o}C with the production of acid and gas. Production of gas is evidence of presence of coliform organisms.

Bacterial standards for drinking water

BIS. Equipment:-

Biological incubator,

Auto clave,

P_H Meter.

Glass ware required.

Fermentation tubes with glass stopper or screw caps,

Alternatively the following serves the purpose:-

50 ml graduated cylinders (without) with closing fitting stoppers- 05 no's

25 ml graduated cylinders (without) with closing fitting stoppers- 05 no's

10 ml graduated cylinders (without) with closing fitting stoppers- 05 no's

100 ml graduated cylinders (without) with closing fitting stoppers- 02 no's

Burn ham tubes, 5 mm diameter 3 cm long,

Graduated pipettes: 10 ml-01 no, 5 ml-01 no, 1 ml-01 no Conical flask etc.,

Chemicals:-

1. Lactose: - Food for bacteria Lactose is down to produce acids (Chiefly CH_3COOH) And gases ($^{36broken}CO_2$ and H_2),
2. Peptone: - Nutrient essential for bacterial growth.
3. Bile salt: - Inhibits growth of non –intestinal organisms
4. Sodium Chloride: - Preservative, prevents vegetative growth.
5. Neutral red: - Indicator, Indicates production of acids turning from red to rosy pink and with more production of acids to yellow.
6. Dilution water.

Stock buffer:-

Dissolve 34 g $K H_2 PO_4$ in 500 ml of distilled water, adjust the P_H to 7.40 – 7.50 using 1N NaoH and dilute to one litre with distilled water and mix.

Working dilution water:-

Add 1.25 ml of stock buffer solution to one litre of distilled water and mix.

Preparation of medium (McConkey Broth), per 100 ml of sample to be tested.

1. Take 250 ml of working dilution water in a 500 ml conical flask –A
2. Add peptone (10 g), bile salt (2.5g), Sodium chloride (2.5g),
3. Boil the mixture for two minutes.
4. Add lactose (5g) and allow the Broth to cool to room temperature.
5. Add 1% Neutral red till the broth becomes dark red.
6. Take out 50 ml of double strength Broth in a sterile beaker (B) and add an equal volume of boiled and cooled working dilution water.

Sterilisation of glass ware:

All glass ware used for bacteriological tests (including sample bottles) should be thoroughly washed using a good detergent and hot water, rinsed with hot water to remove detergent residues and finally rinsed with distilled water.

All glass ware washed as above, should be sterilised in an autoclave at 160 $^{\circ}C$ (Not less then 121 $^{\circ}C$) and a pressure of 1.05 kg/cm_2 for not less than for 15 minutes (Sterilisation for two hours is recommended as a standard practice)

Procedure for presumptive test.

The MNP test consists of the following four steps:

Sampling.

1. Collect bacteriological samples in sterile glass bottles with ground glass stoppers protected with a piece of linen, Aluminum foil or paper. A 300 ml capacity B.O.D. bottles are ideals for sampling.
2. Start MPN test within one hour of sampling.
3. If the samples are to be transported from a distance, hold the sample below 10 $^{\circ}C$ during a transportation period not to exceed six hours.
4. Keep such samples in a refrigerator on receipt in the laboratory.
5. Start the test within two hours (Under unavoidable circumstances however, the duration of time between collection of sample and their examination may be extended up to a maximum of thirty hours).

Inoculation:

1. Arrange sterilized Fermentation test tubes to form three sets. 50 ml tubes for set-A,
   25 ml tubes for set-B,
   10 ml tubes for set-C.
2. Pour 25 ml of double strength Mac Conkey Broth into each 50 ml tubes in set- A.
3. Pour 25 ml of single strength MacConkey Broth into each 25 ml tube in set-B.
4. Pour 5 ml of single strength Mac Conkey Broth into each 10 ml tube in set-C.

5. Shake the sample bottles to distribute the micro-organisms, if any, most evenly extract 100 ml of the sample into a sterile graduated jar.
6. Using 10 ml pipette inoculate 10 ml of the sample into each of the tubes in set-A.
7. Using 5 ml pipette, inoculate 1 ml of samle In to each of the tubes in set-B of pipette inoculate 0.1 ml of the sample
8. Using 1 ml pipette, inoculate 0.1 ml of the sample into each of the tubes in set-C.
9. Insert a sterile Burn ham tubes, upside down into each fermentation tubes.
10. Firmly stopper each fermentation tube.Turn the tube upside down and shakes and hold it till the Burn ham tubes is completely filled with the Mac Conkey Broth with no air bubbles trapped inside.
11. The entire work of inoculation should be done under sterile condition.

Incubation.

1. Place the inoculation fermentation tubes at 37 $^{\circ}C$ in a thermostatically controlled biological air incubator.
2. Examine after 24 hours for production of gas and also change in the colour of MacConkey Broth. Any gas produced is seen trapped in the inverted Burn ham tubes.Fermentation results in a drop in P_H of the MacConkey Broth,which is indicated by a rosy-pink or in a more advanced stage, Yellow colouration.
3. Continue inoculation for 24 hours more.
4. Again examine all the tubes for production of gas and also for change in colour of the MacConkey Broth.

Observation.

1. After 48 hours of inoculation, count the positive results i.e. the number of tubes producing gas set, irrespective of the amount of gas produced.
2. A negative result is indicated by number of tubes producing no gas and no change in the colour of the medium.

Record the result.

Referring the MNP statistical tube and read out MNP index /100 ml of sample.

Observation:

Table:-10

Sample No.	Description of sample	No of tubes giving positive results out of 3			Most Probable Number	Remark
		5 of 10 ml	5 of 1 ml	5 of 0.1 ml		
01	Water	03	02	01	17	Treatment required.

Reference table:-11

Number of tubes giving positive results out of							
5 of 10 ml each	5 of 1 ml each	5 of 0.1 ml each	MPN Index per	5 of 10 ml each	5 of 1ml each	5 of 0.1 ml each	MNP index per

			100ml				100 ml
0	0	0	¿ 2	2	0	0	5
0	0	1	2	2	0	1	7
0	1	0	2	2	1	0	7
0	2	0	4	2	1	1	9
1	0	0	2	2	2	0	9
1	0	1	4	2	3	0	12
1	1	0	4	3	0	0	8
1	1	1	6	3	0	1	11
1	2	0	6	3	1	0	11
3	1	1	14	5	1	2	63
3	2	0	14	5	2	0	49
3	2	1	17	5	2	1	70
3	3	0	17	5	2	2	94
4	0	0	13	5	3	0	79
4	0	1	17	5	3	1	110
4	1	0	17	5	3	2	140
4	1	1	21	5	3	3	180
4	1	2	26	5	4	0	130
4	2	0	22	5	4	1	170
4	2	1	26	5	4	2	220
4	3	0	27	5	4	3	280
4	3	1	33	5	4	4	350
4	4	0	34	5	5	0	240
5	0	0	23	5	5	1	350
5	0	1	31	5	5	2	540
5	0	2	43	5	5	3	92
5	1	0	33	5	5	4	1600
5	1	1	46	5	5	5	¿ 2400

Conclusion:

MNP index per 100 ml for given sample is 17 as per BIS for 66 no's Drinkable water, No sample should contain E-coli in 100ml and no sample should contain more than 10 E- coli organism per 100 ml.

Experiment:-08
Determination of Fluorides and Irion.

Aim: (a) To determine Fluoride in a given sample of water.

Introduction:

Fluorides in drinking water must neither be totally absent nor should exceed an optimum value of about 1 mg/l. To ensure this, fluorides are added to water found deficient in fluoride concentrations, under a process known as Fluoridation. When, however, the fluoride concentration in given water exceeds the limiting value of 1 to 1.5 mg/l, the fluorides are removed from water under a process known as Defluoridation.

Fluoridation:

For decades, it has been believed that when fluorides concentration, in water supply is less than an optimum value of about 1 mg/l, the water proves to be harmful, as it may result in dental caries in children. It has, thus, been believed that during the formation of permanent teeth in children, scarcity of fluoride in consumed water, may lead to formation of weaker tooth enamel leading to early tooth decay. It had also been widely suggested that fluoride also proves beneficial to older people in reducing hardening of the arteries and as fluoride stimulates bone formation, it is helpful in the treatment of osteoporosis. Due to such age old beliefs about the advantages of fluorides, its presence in public water supplies has been ensured by the addition of extra outside dose of fluoride, wherever the water was found to be deficient in fluoride concentration. It is believed that optimum benefits of fluoride are obtained, when fluoride concentration is achieved at about 1 mg/l.

This addition of external fluoride to public water supplies is known as fluoridation. Today, over 250 million peoples, drink over the world, artificially fluoridation water; which practice is largely adopted in western Countries. In the U.S. alone, for example, over half of the water supplies are fluoridated, since the natural water in this region are usually found to contain fluoride concentrations to be much below the optimum level of 1 mg/l.

Most recent research has, however, suggested that fluoridation does not make a very significant difference in the incidence of tooth decay (USEPA, 1991). The primary explanation gives being, is the present wide spread use of fluoridated tooth paste, Fluoride supplements and better dental hygiene in the community. In any case, after the age of 12 years, calcification of teeth ceases, and fluoride provides no for their benefits. Therefore, it does seem more appropriates to provide fluoride medication solely for children, rather than its mass-medication approach by fluoridation of public water supplies.

These considerations have now a day's reduced fluoridation practices. In Western Continental Europe, the fluoridation has virtually been terminated. Even in U.K. at present, hardly 10% public supplies are being fluoridated (Dept. Of Environmental 1997).Northern Irelsand is not at all fluoridating its supplies.

The fluoridation is achieved by the addition of outside fluoride compounds. The Compounds which may be used for adding fluoride to the water are Sodium fluoride (NaF) etc., Of these compounds, Sodium fluoride is most widely used, and is generally fed under pressure as a solution, through a chemical feed equipment.

However, the dose of fluoride should be carefully worked out, because the presence of excess fluoride above 1 mg/l to 5 mg/l is also harmful, as to cause spotting and discolouration (motting) of teeth. The long term exposure may result in permanent gray to black discolouration

of enamel (dental fluoridise).Children who drink fluoride water in excess of 5 mg/l may also develop severe pitting of the enamel. Still larger and continued use of excess fluoride(30 mg/l to 50 mg/l) may lead to gastroenteritis, skin irritations, deformation of bones and other skeletal abnormalities.

Defluoridation:

Fluoride mainly enters the human body through drinking water. 96% to99% of it combines with bones, since fluoride has affinity for calcium phosphate inthe bones. Excess intake of fluoride can lead to dental fluorosis skeletal fluorosis, or non-skeletal fluorosis. Dental fluorisis is characterised by discoloured ,blackened, mottled or chalky white teeth .Skeletal fluorisis leads to severe and permanent bone and joint deformation .non skeletal leads to gastro-intestial problems and neurological disorders .Fluoride can damage a foetus and adversely affect the IQ of children .

Fluorisis can be detected in the neck ,spine , knee, pelvis ,shoulder and small joints of hands and feet ,gastro- intestinal symptoms include abdominal pain ,diarrhoea ,constipation ;while some of the neurological manifestations include nervousness ,excessive thrist and tendency to urinate frequently

Inspite of all these symptoms ,fluorisis commonly remains un diagonosed for a long time .Often , patients get misdiagonosed with arthritis , spondylilits ,or non-specific backache .

A2001 study about fluorisis notes down as under “the occurrence of fluorisis can vary widely among different locations having almost the same fluoride concentrations in drinking water and can be affected by factors such as climate , individual susceptibility and biological response ”. This study also conclude that “poor nutrition also plays an important role in aggrevating endemic fluorisis “,thus explaining as to why poor people are often the most effected . fluorisis is infact an irreversible disease and it has no cure

Inorder to avoid contracting such disease , it is necessary to provide drinking water to the people , which does not contain fluoride in excess of its permissible value of 1-1.5 mg/l {preferably 1mg/l . However , when the available water supply contains fluoride in excess limit , it becomes imperative to remove the excess fluoride from the water before the same is consumed by the people whereas the public water supplies in western countries are found to be deficient in fluoride ,the Indian water supplies , which are usually drawn through wells and tube wells , are found to contain heavy doses of fluoride . Since the ground waters in countries like India and Bangladesh are found to contain large quantities of fluoride form water ,wherever the waters are to be polluted with excess fluorides , as to make the water safe for drinking .The technique of removal of fluoride from water is known as Defluoridation

9.30.2.1Methods of Defluoridation

The following technologies are generally used for removing fluorides from water:

1. Absorption by activated alumina (AA),commonly known as Prasanti technology
2. ION Exchange absorption method
3. Nalgonda technique and
4. Reverse osmosis process

Environmental Significance.

Principal.

Apparatus.

Spectrophotometer, Test tubes,

Beakers etc.,

Chemicals required:

Std.Fluoride solution,

Spadns solution,

Zirconyl acid reagent,

Sodium arsenite solution etc.,

Sampling handling.

Preservations.

Precautions.

Procedure.

Preparation of Reagents:

Stock Fluoride Solution:

Dissolve 442 mg of anhydrous NaF in distilled water and dilute to one litre. 1ml = 200micro gram of Fluoride.

Standard Fluoride Solution:

Dilute 100 ml stock Fluoride Solution to 1000 ml 1 ml = 20 microgram of Fluoride

Acid Zirconyl- Alizarin Reagent:

Dissolve 300 mg Zirconyl Chloride Octahydrate in 50 ml of distilled water contained in one litre volumetric flask.

Dissolve 70 mg of Sodium salt of 3- alizarin Sulhonic acid (alizarin red) in 50 ml of distilled water and pour slowely into the volumetric flask while stirring.

Mixed Acid Solution:

Add 101 ml of Conc. HCL to 400 ml of distilled water. Add 33.3 ml of Conc. H_2SO_4 to 400 ml of distilled water. Cool and mix the two acid dilutions.

To the Zirconyl- alizarin reagent in the volumetric flask add the mixed acid solution and dilute with distilled water up to mark. The reagent changes colour from res to yellow within an hour and ready for use. (The reagent can be used for six months, when stored away from sunlight).

Sodium- Arsenate Solution:

Dissolve 5 gm of NaASO2 and dilute to one litre (Caution: Poisons do not inject)

This is for removing residual chlorine in the sample. Use 0.05ml of dropes of NaASO2 solution per 0.1 mg of chlorine.

Alternatively Na2S2O3 5H2O in concentration not exceeding 100mg/l may be used for dechloring the sample.

Fluoride Graded Standards for Comparison:

A. **Calibration of Spectrophotometer**.
   With reference solution, adjust 100% transmission at 570 mm wavelength in Spectrophotometer.

B. **Preparation of calibration graph**.
   1. Prepare standard Fluoride solutions in the range of 0.2mg/l, 0.4mg/l, 0.6mg/l, 0.8mg/l, 1.0mg/l,1.2mg/l, and 1.4mg/l respectively.
   2. Add each 5ml Spadns solution and Zirconyl reagent.
   3. Measure the present transmission of each standard solution and

1 Plot a standard graph of Fluoride concentration V/S present transmission of each standard solution.

C. **Determination of Fluoride content in a given sample of water**.

1. Take 50ml of given sample of water in beaker, add one drop of sodium arsenite solution to remove residual chlorine interference.
2. In the above solution add 10ml of Spadns and Zirconyl acid.
3. Mix and measure the transmission at 570mm on Spectrophotometer.
4. Find the Fluoride content in the given sample of water by referring the calibration graph.

Observation table.

Sl.no.	Std. Fluoride solution added in ml	Std. Fluoride solution in mg/l	% Transmission.
01	1ml	0	0
02	2ml	0.50	0.212
03	3ml	1.00	0.290
04	4ml	1.50	0.289
05	5ml	2.00	0.283
06	6ml	2.50	0.258
07	7ml	3.00	0.238
08		3.50	0.233
09		4.00	0.234
10		4.50	0.200
11		5.00	0.199
	Sample		0.219
	Sample		0.102
	Sample		0.104
	Sample		0.042

Calculation.

1ml of Std. Fluoride solution =10 µgm of Fluoride.

Fluoride, 03a

F= (Mg. of fluoride X1000) /Ml. of sample.

Graph.

Result.

The Fluoride content in the given sample water is _____mg/l

Conclusion.

Aim :-(b) To determine Iron in a given sample of water.

Introduction.

Natural waters contain variable, but minor, amounts of iron, despite its universal distribution and abundance. Iron in ground waters is normally present in the ferrous (Fe^{2+}), or soluble state, which oxidizes easily to ferric (Fe^{3+}) iron on exposure to air. Iron can enter a water system from leaching of natural deposits, iron-bearing industrial wastes, effluents of pickling operations, or from acidic mine drainage. Iron in domestic water supply systems stains laundry and porcelain, causing more of a nuisance than a potential health hazard. Taste thresholds of iron in water, 0.1 mg/L for Fe^{2+} and 0.2 mg/L for Fe^{3+}, result in a bitter or astringent taste. Water used in industrial processes must contain less than 0.2 mg/L of total iron. Three methods of colorimetric iron analysis are used in Hach procedures. The 1, 10- Phenanthroline Method is the best-known test for iron. The Fe^{2+} procedure uses Ferrous Iron Reagent Powder containing 1,10-Phenanthroline as an indicator. Total iron determination or analysis uses FerroVer Iron Reagent. FerroVer Iron Reagent contains 1,10-Phenanthroline, combined with a reducing agent, to convert all but the most resistant forms of iron present in the sample to Fe^{2+}. The Ferro Zine Method for total iron is more than twice as sensitive as the 1, 10-Phenanthroline Method. Researchers at Hach have patented a process to manufacture high purity Ferro Zine Iron Reagent, ideal for iron measurement, in economical quantities. Ferro Zine is highly specific for iron, forms an intensely-colored stable complex and performs in the pH range of 3–7.5. The Ferro Zine Method requires boiling to dissolve rust. The TPTZ Method for total iron has the advantages of simplicity, sensitivity and freedom from common interferences. Iron in the sample, including precipitated or suspended iron such as rust, is converted to Fe^{2+} by a reducing agent. A highly colored Fe^{2+} -TPTZ complex is formed. Hach Methods also include a high-range titration procedure utilizing sulfosalicylic acid as

Environmental
Significance. Principal.

Materials required.

Glassware and Apparatus.

Nessler cylinder / Tubes,
Burette,
Graduated pipette,
Conical flask,
Hot plate,
Beakers etc.,

Reagents.

Conc. Hydrochloric acid or Conc. Sulphuric acid, Hydroxyl amine solution,
Ammonium acetate buffer solution,
Phenontholine solution monohydrate dissolved in 100ml Distilled water plus two drops of Hydrochloric acid
Stock iron solution (A) etc.,

Procedure.

Preparation of sample.

1. Take 100 ml of sample in a flask.
2. Add 2ml of Conc. Hydrochloric acid or 112ml of Conc.Sulphuric acid to each tube.
3. Add 1ml of Hydroxylamine solution.
4. Heat and reduce to 50%.
5. Add 10ml Ammonium acetate buffer solution.
6. Add 9ml to10ml Phenohlphalin.
7. The organic regent forms orange red complex ions with ferrous ions in solution.
8. Dilute to10ml, mix and allow a reaction (B)
10. Match the same colour with the colour std. Solution, interpolate if necessary. Note.

If iron concentration in the sample is greater than 2mg/l, then dilute the sample to get the result within the range of std. Prepared and then multiply the result by the dilution factor

Result.

Conclusion.

Experiment:-09

Determination of Ambient air quality monitoring for Suspended particulate matter SO_X **,** NO_X

area covering polluted area / density.

Aim: - (a) To determine suspended particulate matter (SPM) from air. Apparatus.

High volume sampler with flow matter and elapsed time meter, Thermometer,

Desiccators to condition the filter paper,

Glass fiber filter(25 cm X20 cm)

Principle:

The particulate matter emitted into the atmosphere from various sources is one of the air pollutants. It is collected through the filter paper with the help of vacuum cleaner type mot or fitted on High Volume Sampler. Stroke's law offers the basic approach to collection by these techniques.

Indian Air Quality Standards.

Category	Area	Concentrations in $\mu g/ m^3$			
		SPM	SO_2	NO_X	CO
A	Industrial and mixed use	500	120	120	5000
B	Residential and rural	200	80	80	2000
C	Sensitive	100	30	30	1000

Procedure.

1. Check the filter paper for any irregularity.
2. Put the number of filter paper and desiccators the filter paper for 24 hours.
3. Weight the filter paper up to one milligram accurately without going record the weight number of filter paper (W_1).
4. Open the rod it is loosen by using nuts and put the filter papers below the face plate.
5. Fasten by using nuts and close the roof of shutter.
6. Set the on/off times to sampling for prescribed time and record the initial time.
7. Maintain the required initial flow rate with the help of flow control device. (Manometer and Calibration chart provided by manufacturer of the instrument)
8. After 5 minutes record the initial flow rate 700 liters per minutes to 1200litres per minutes.
9. At the end of sampling period record the length of sampling period and final flow rate.
10. Remove the face plate, filter plate and filter paper.
11. Do not tear or touch collected scar ware of paper.
10. Weight the filter paper (W_2)

Observation.

46

Table.

Initial flow	Final flow	Sampling time	Volume of our sample	Initial weight of filter paper	Final weight of filter paper	Concentration of SPM
Q^i	Q^f	'T'	V	W_1	W_2	$\frac{W^f - W^i}{V} \times 10^6$

m^3 / Sec	m^3 / Sec	minutes	m^3	mg	mg	μ mg/l

Calculation.

Volume of air sample.

$$V = \left(\frac{Q^i + Q^f}{2}\right) \times T \text{ in } M^3$$

Concentration of Suspended particulate matter,

$$SPM = \frac{W^f - W^i}{V} \times 10^6 \ \mu mg/l$$

Result.

The concentration of SPM is found to be---------- μ mg/l

Conclusion.

As per CPCB the standard specified concentration for residential area is 200 mg/l. The concentration of SPM is found to be ---------- .There for air is not polluted / polluted.

Aim. (b) To determine Concentration of Sulphur dioxide from air. Principle:

When Sulphur dioxide from atmosphere air is dissolved in a Sodium tetrachloro-mecrate solution, It forms a stable dichlorosulpitomercurate. The amount of Sulphur dioxide is estimated by the colour produced P- Rosaline dihydrochloride is added to the solution. The colour is estimated by reading from spectrometer for which calcium curve has already being prepared.

Indian Air Quality Standards.

Category	Area	Concentrations in $\mu g/ m^3$			
		SPM	SO_2	NO_X	CO
A	Industrial and mixed use	500	120	120	5000
B	Residential and rural	200	80	80	2000
C	Sensitive	100	30	30	1000

Apparatus.

1. High volume sampler,
2. Spectrometer capable of measuring absorbance of 540 mm

Glass Ware:

1. Volumetric flask 50 ml, 100 ml, 200 ml, 500 ml, 1000 ml,
2. Graduated cylinder 1000ml,
3. Pipettes 1 ml 2 ml,3 ml, 4 ml, 10 ml and 15 ml,
4. Test tubes,

Chemicals required.

1. **Absorbing reagents:**
   0.1 M R Sodium tetra Chloromate (TCM)), dissolved 27.2 gm of Hg Cl_2 and 11.70 gm of NaCl in 1000 ml prescribed bottle.
2. **P-Rosaline dehydrochloride:**
   Dissolve 0.2 gm of P-Rosaline dihydrochloride in 100 ml distilled water. Filter the solution after two days. Prepare 20 ml of this into 100 ml volume flask. Add 6 ml conc. HCl. Allow to stand for 5 min and then dilute the mark with distilled water. This solution should be pale yellow store it in amber bottle.
3. **Formaldehyde solution**:
   Dilute 5 ml of formaldehyde solution into one litre.
4. **Sodium Sulphide solution:**
   Dissolve 640 mg of sodium mega-bi-sulphate in one litre of distilled water gives 0.4 of $SO_2 mg/ l$ Standardized with 0.01 N Iodine solution and adjust the normality of sulphite solution 0.012 N
5. **Starch Solution:**
   0.25 gm of soluble starch in 100 ml water.
6. **Iodine solution**:

0.01 N freshly prepared.

Procedure.

A. Preparation of calibration curve.

1. Prepare 2 ml of standard sulphide solution into 100 ml of volumetric flask and dilute to mark the absorbing reagent.
2. Their final solution containing 3 ml of Sulphur dioxide/ 1 ml of reagent.
3. Take four 10 ml volumetric flask.
4. Add 0.5, 1.0ml, 1.5ml and 2 ml of solution prepared in step 1. of flask and dilute to mark of volumetric flask 5 ml, 50 ml, 100 ml, 250 ml respectively
5. Add 1 ml P-Rosaline dihydrochloride solution and mix well.
6. Prepare blank with 10 ml TCM by adding same chemical.
7. After 20 minutes read the absorbance at 560 mm.
8. Plot absorbance as ordinate against of Sulphur dioxide 10 ml of absorbing solution.
9. Calculate the slope of straight line.

B. Sampling.

1. Assemble the sampling train including the impingers.
2. Take 50 ml of absorbent reagent into impengers.
3. Instrument is kept at required location.
4. Connect one end of impinges to suction pump.
5. Start suction pump and maintain the flow gate between 0.2 to 2.0 liters / minute, the atmospheric air will pass through the impengers in the form of buffer.
6. At the end of sampling period (generally 8 hours) disconnect the impengers.
7. Bring the impengers and sampling to laboratory.

C. Analysis.

1. Replace any water last by evaporation.
2. Take 10 ml portion in beaker, add 1 ml P-Rosaline hydrochloride and 1 ml Formaldeide solution and mix well.
3. Prepare blank in same manner after 20 minutes read absorbance of spectrophotometer to blank as reference.
4. Calculate the micro liter of Sulphur dioxide sample of multiplying absorbance of calibration chart.

Calculation.

Micro liter of Sulphur dioxide
= Absorbance of sample x Slope of calibration curve

$$= 50 \times \frac{1}{100}$$

$$= 0.50$$

VS = Flow rate x Duration of sampling.

$$= 0.039 \; m_3$$

Sulphur dioxide in ppm = $\frac{\text{Micro litreof sulphur dioxide}}{VS}$

Result.
Absorption of sample =
From calibration curve slope =
Micro liter of Sulphur dioxide =
Sulphur dioxide in PPM =
Sulphur dioxide Micro gm/m_3 =

Consultation. As per CPCB standard permissible maximum Sulphur dioxide in ambient air for residential zone is 80 mg/m_3 . Hence as per code air is not polluted.

Aim. (c) To determine Concentration of Nitrogen oxide from air.

Apparatus.

1. High Volume Sampler,
2. Spectrophotometer capable of measuring absorbance of 540 mm.

Indian Air Quality Standards.

Category	Area	Concentrations in $\mu g/m^3$			
		SPM	SO_2	NO_X	CO
A	Industrial and mixed use	500	120	120	5000
B	Residential and rural	200	80	80	2000
C	Sensitive	100	30	30	1000

Glass Ware:

Volumetric flask 50 ml, 100 ml, 200 ml, 250 ml 500 ml.
Graduated cylinder 1000 ml,
Pipettes 1 ml, 2 ml, 3 ml, 10 ml,15 ml.
Test tube 20 mm x 150 mm.

Regents.

1. Sodium hydroxide AR reagent grade,
2. Sodium Arsenate AR reagent grade,
3. Absorbing reagent .Dissolve 4 gm Sodium hydroxide in a distilled water and add 1 gm of sodium Arsenate and dilute to 1000 ml with distilled water.
4. Sulphanilamide: m.p. Of 165 $^{\circ}C$ to 167 $^{\circ}C$.
5. N (1-Napthyl- Ethylenediamine Dihydrochloride (NEDA) - Best grade available 5. Hydrogen peroxide-AR reagent grade 30%

6. Sodium nitrate- Assay of 97% NaN O_2 or greater.
7. Phosphoric acid: AR reagent grade, 85%

Sulphanilamide Solution:

Dissolve 20g Sulphanilamide in 700ml water. Add with mixing 50ml Concentration Phosphoric Acid and dilute to 1000ml. This solution is stable for one month, if refrigerated.

NEDA Solution:

Dissolve 0.5g of NEDA in 500ml of distilled water. This solution stable for one month, if refrigerated.

Hydrogen Peroxide Solution:

Dilute 0.2ml of 30% hydrogen peroxide to 250ml with distilled water. This solution may be used for one month, if refrigerated and protected from light.

Standard Nitrate Solution:

Dissolve sufficient desiccated Sodium Nitrate and dilute with water to 1000ml. So that a solution containing 1000 $\mu g\, NO_2 / ml$ is obtained. The amount of Na NO_2 to be used is given by:

$$G=100 \times \left(\frac{1.5}{A}\right)$$

Where:

G = amount of Na NO_2 g

1.5 = Gravimetric factor in converting NO_2 into Na NO_2

A = Assay percent.

Principle.

Nitrogen oxides as Nitrogen dioxide are collected by bubbling air through an absorbing reagent to from a stable solution of Sodium Nitrate. The Nitrate ion produced during sampling is determined Calorimerrically by reacting the exposed absorbing reagent both hydrogen peroxide, Sulphanilamide of NEDA.

Procedure.

A. Preparation of calibration curve.

1. Dilute 5 ml Std. Nitrate solution (1000 μ g NO_2 / ml) to 200 ml with absorbing reagent.The solution contained 25 μ g NO_2 /ml.
2. Pipette 1 ml, 2 ml, 5 ml, and 15 ml of 25 μ g No_2 /ml solution into 50 ml, 100 ml, and 250 ml volumetric flask.
3. Dilute to mark with absorbing reagent. The solution contains 0.5 mg, 1.00 mg, 1.25 mg and 1.5 μ g NO_2 / ml respectively.
4. Take 10 ml solution from each flask into four separate beakers.
5. Add 1 ml of hydrogen peroxide solution 10 ml of sulphanilamide solution and 1.40ml of NEDA solution with through mixing into all four beakers.
6. Prepare a blank in the same manner using 10ml of absorbing reagent.
7. Purpose a flask is same manner using 10 ml of absorbing agent.

8. After a 10 minutes colour development internal measures the % T absorbent at 540mm against the blank.
9. Plot absorbance v/s μ g NO_2 / *ml* curve.

B. <u>Sampling.</u>

1. Assemble the sampling train including impengers.
2. Take 50 ml of absorbent reagent into impengers. Instrument is kept at required location.
3. Connect one end of impenger to the suction pump.
4. Start the suction pump and maintain flow rate between 0.2 to 2 liter / minutes, the atmospheric air will pass through the impengers in form of air bubbles. (the NO_2 gets absorbed into absorbing reagent and Sodium Nitrate is formed.)
5. At the end of sampling period (generally Eight hours) disconnect impenger.
6. Bring the impenger and sampling train to laboratory.

C. <u>Analysis.</u>

1. Replace any water loss by evaporation during sampling by adding distilled water up to the calibration mark on the absorption tube.
2. Pipette 1 ml of hydrogen peroxide solution, 10ml sulphanilamide solution and 1.4 ml NEDA solution with through mixing after adding of each reagent.
3. Prepare blank sample manner using 10 ml of unexposed absorbing reagent. After 10 minutes colour development interval,
4. Measure the absorbance at 540 nm against the blank.
5. Read μ g NO_2 / *ml* from calibration curve.
6. Samples with an absorbance greater than one must be re digested after eliminating on aliquot (less than 10 ml) of collected sample with exposed absorbing reagent.

<u>Observation table:</u>

Sr. No.	Initial flow	Final flow	Duration of Sampling	Volume of absorbing reagent	Concentration of NO_2	Concentration of NO_2
01	*litres /min*	*litres /min*	Minutes	M^3	$\mu g/ m^3$	ppm
	F_1	F_2	T	V		

Sr. No.	Conc. of NO_2 in $\mu g/ ml$	Transmission in %
01		
02		
03		
04		
05		
06		

<u>Calculation:</u>

Volume of air Sample,

$$V = \frac{F_1 + F_2}{2} \times T \times 1000$$

Concentration of Nitrogen dioxide is given by,

$$= \frac{\mu g\ NO^2 / ml}{V \times 0.82} \times 25$$

Where: 25= Volume of absorbing reagent used in sampling
ml 0.82 = Empirical factor for collecting efficiency
Result.

Aim :-(d) To measure ambient Noise at different level.

Instrument required.

Noise level meter.

Theory.

Introduction.

Noise pollution or **Noise disturbance** is the disturbing or excessive noise that may harm the activity or balance of human or animal life. The source of most outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles, aircraft, and trains. Outdoor noise is summarized by the word environmental noise. Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential areas.

Indoor noise can be caused by machines, building 53 activities, and music performances, especially

in some workplaces. Noise-induced hearing loss can be caused by outside (e.g. trains) or inside (e.g. music) noise.

High noise levels can contribute to cardiovascular effects in humans, a rise in blood pressure, and an increase in stress and vasoconstriction, and an increased incidence of coronary artery disease. In animals, noise can increase the risk of death by altering predator or prey detection and avoidance, interfere with reproduction and navigation, and contribute to permanent hearing loss.

Source of Noise.

1. Industrialization: Most of the industries use big machines which are capable of producing large amount of noise. Apart from that, various equipments like compressors, generators, exhaust fans, grinding mills also participate in producing big noise. Therefore, you must have seen workers in these factories and industries wearing ear plugs to minimize the effect of noise.

2. Poor Urban Planning: In most of the developing countries, poor urban planning also play a vital role. Congested houses, large families sharing small space, fight over parking, frequent fights over basic amenities leads to noise pollution which may disrupt the environment of society.

3. Social Events: Noise is at its peak in most of the social events. Whether it is marriage, parties, pub, disc or place of worship, people normally flout rules set by the local administration and create nuisance in the area. People play songs on full volume and dance till midnight which makes the condition of people living nearby pretty worse. In markets, you can see people selling clothes via making loud noise to attract the attention of people.

4. Transportation: Large number of vehicles on roads, aeroplanes flying over houses, underground trains produce heavy noise and people get it difficult to get accustomed to that. The high noise leads to a situation wherein a normal person lose the ability to hear properly.

5. Construction Activities: Under construction activities like mining, construction of bridges, dams, buildings, stations, roads, flyovers take place in almost every part of the world. These construction activities take place everyday as we need more buildings, bridges to accommodate more people and to reduce traffic congestion. The down point is that these construction equipments are too noisy.

6. Household Chores: We people are surrounded by gadgets and use them extensively in our daily life. Gadgets like TV, mobile , mixer grinder, pressure cooker, vacuum cleaners , washing machine and dryer, cooler, air conditioners are minor contributors to the amount of noise that is produced but it affects the quality of life of your neighborhood in a bad way.

While this form of pollution may seem harmless, it in fact has far reaching consequences. The adverse effects on the health of the environment are quite severe. Not only is the local wildlife affected by the pollution, humans also face a number of problems due to it.

Effect of Noise Pollution.

1. Hearing Problems: Any unwanted sound that our ears have not been built to filter can cause problems within the body. Our ears can take in a certain range of sounds without getting damaged. Man made noises such as jackhammers, horns, machinery, airplanes and even vehicles can be too loud for our hearing range. Constant exposure to loud levels of noise can easily result in the damage of our ear drums and loss of hearing. It also reduces our sensitivity to sounds that our ears pick up unconsciously to regulate our body's rhythm.

2. Health Issues: Excessive noise pollution in working areas such as offices, construction sites, bars and even in our homes can influence psychological health. Studies show that the occurrence of aggressive behavior, disturbance of sleep, constant stress, fatigue and

hypertension can be linked to excessive noise levels. These in turn can cause more severe and chronic health issues later in life.

3. Sleeping Disorders: Loud noise can certainly hamper your sleeping pattern and may lead to irritation and uncomfortable situations. Without a good night sleep, it may lead to problems related to fatigue and your performance may go down in office as well as at home. It is therefore recommended to take a sound sleep to give your body proper rest.

4. Cardiovascular Issues: Blood pressure levels, cardio-vascular disease and stress related heart problems are on the rise. Studies suggest that high intensity noise causes high blood pressure and increases heart beat rate as it disrupts the normal blood flow. Bringing them to a manageable level depends on our understanding noise pollution and how we tackle it.

5. Trouble Communicating: High decibel noise can put trouble and may not allow two people to communicate freely. This may lead to misunderstanding and you may get difficult understanding the other person. Constant sharp noise can give you severe headache and disturb your emotional balance.

6. Effect on Wildlife: Wildlife faces far more problems than humans because noise pollution since they are more dependent on sound. Animals develop a better sense of hearing than us since their survival depends on it. The ill effects of excessive noise begin at home. Pets react more aggressively in households where there is constant noise.

Acceptable noise levels:

The maximum level of noise which will neither anny the occupants nor damage the acoustics of the building is termed as acceptable noise level in side the building. It depends on the following factors:

1. Nature of the noise,
2. type and use of the building,
3. time of fluctuation of the noise and
4. background noise

Below table gives the general acceptable noise levels fpr different structures from the view points of economy, comfort and practical considerations of the conditions prevailing in our country.

Table:

Noise levels for different structures

Sr.no.	Type of building	Acceptable noise level in db
01	Radio and T.V.	25 to 30
02	Auditoriums and Music room	35 to 40
03	Small offices, Court room Libraries	40 to 45
04	Hospitals	40 to 50
05	Schools	45 to 50
06	Residential buildings and Restaurants	45 to 55
07	Large public offices, Banks stores	55 to 60
08	Factories	60 to 65

Measurement of Noise.		
Procedure.		
1.	Slide the power ON/OFF/HOLD switches to the '1' position will power on the meter. '1' = Power on. '0'=Power off.	

2. Determine proper measuring range by selecting the range switches.
3. Hold the instrument in hand and point the microphone at noise source.
4. The sound level will be displayed in db units.

Observation table.

Sl.No.	Source	Noise level in dB
01	Class room	
02	Bus stand	
03	Market	
04	Railway Station	
05	Work shop	
06	Office	
07	Canteen	

Result.

1. Noise level at Class room is_____
2. Noise level at Bus stand is_____
3. Noise level at Market is _____
4. Noise level at Railway _____
5. Noise level at Work shop _____
6. Noise level at Office,_____
7. Noise level at Canteen _____

Conclusion.

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CIVIL ENGINEERING DEPARTMENT.
ENVIRONMENTAL ENGINEERING LAB.

Sl.No.	Name of Instrument	DSR no.	Qty	Amount.
01	Digital P_H meter	SRCOE/CIVIL/2013-14/PG-01/ P^H meter/01	01	4,750=00
02	Digital Turbidity meter	SRCOE/CIVIL/2013-14/PG-01/Turbidity meter/01	01	11,115=00
03	Digital Photo meter	SRCOE/CIVIL/2013-14/PG-01/Digital Photo meter/01	01	6,435=00
04	Autoclave	SRCOE/CIVIL/2013-14/PG-01/Autoclave/01	01	8,775:00
05	Aerator	SRCOE/CIVIL/2013-14/PG-01/Aerator/01	01	14,850:00
06	Jar test apparatus	SRCOE/CIVIL/2013-14/PG-01/JTA/01	01	27,405:00
07	Hot plate	SRCOE/CIVIL/2013-14/PG-01/HP/01	01	3,402:00
08	COD test apparatus	SRCOE/CIVIL/2013-14/PG-	01	17,550:00

		01/CODTA/01		
09	BOD incubator	SRCOE/CIVIL/2013-14/PG-01/BODI/01	01	65,070:00
10	Jackson Turbidity meter	SRCOE/CIVIL/2013-14/PG-01/JTM/01	01	7,650:00
11	Digital Spectrometer	SRCOE/CIVIL/2013-14/PG-02/DSPM/01	01	25,042:00
12	Conductivity meter	SRCOE/CIVIL/2013-14/PG-02/CM/01	01	6,615:00
13	Kjeldal instrument	SRCOE/CIVIL/2013-14/PG-02/KI/01	01	8,032:50
14	High Volume sampler	SRCOE/CIVIL/2013-14/PG-01/HVS/01	01	85,000:00
15	Noise level meter	SRCOE/CIVIL/2013-14/PG-01/NLM/01	01	7200:00
16	Dissolved oxygen level meter	SRCOE/CIVIL/2013-14/PG-01/DOLM/01	01	19,800:00
17	Water Distillation plant	SRCOE/CIVIL/2013-14/PG-01/WDP/01	01	14,500:00
Total cost in rupees				333191=50

Lab-in charge:-Prof.S.M.Bambary.

B.E. Civil. M.Tech.Env

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List of Chemicals.

Date:-04-01-2014 invoice no. 375

Sl.No.	Name of Chemicals.	D.S.R. No.	Rate.	Quantity.	Amount.
01	Sulphuric Acid		280=00	5000 ml	280=00
02	Hydrochloric Acid		260=00	5000ml	260=00
03	Phenapthalin sol		270=00	500ml	270=00
04	Methyl Orange sol.		185=00	500 ml	185=00
05	Silver Nitrate		3600=00	20 gm	3600=00
06	Potassium Chromate		380=00	500 gm	380=00
07	Calcium Carbonate		60=00	500 gm	60=00
08	EDTA Disodium Salt		450=00	500 gm	450=00
09	Sodium Hydroxide Flakes		70=00	100 gm	70=00
10	Erichrome Black-T		360=00	100 gm	360=00
11	Mureoride		4250=00	100 gm	4250=00
12	Sodium Thiosulphate.		55=00	500 gm	55=00
13	Acetic Acid		2800=00	2500 ml	2800=00
14	Starch Indicator		630=00	500 gm	630=00

15	Bleaching Powder		90=00	500 gm	90=00
16	Potassium Iodide.		5400=00	500 gm	500 gm
17	St. Sodium Fluoride Solution		360=00	250 ml	250 ml
18	Acid Zirconium Alizarium		180=00	100 ml	180=00
19	Oxalic Acid		160=00	500 mg	160=00
20	Ferrous Sluphate.		160=00	500 mg	160=00
21	Alum Powder		360=00	500mg	360=00
22	Aluminum Sulphate		60=00	500 mg	60=00
23	Manganese Sulphate		110=00	500 mg	110=00
24	Azide Reagent		685=00	250 ml	685=00
25	Hydroxylamine Hydrochloride Solution.		670=00	500 ml	670=00
26	Ammonium Acetate Buffer Solution.		180=00	500 mg	180=00
27	Std. Irion Salt.		450=00	500 mg	450=00
28	Potassium Per magnet		330=00	500 mg	330=00
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List of Glass Wares.

Date:-04-01-2013 invoice no. 373

Sl.No.	Name of Glass Wares.	Rate.	Quantity.	Amount.
01	Beakers 1000ml	210/-	12	2520/-
02	Beakers 500 ml	102/-	20	2040/-
03	Beakers 250 ml	165/-	20	3300/-
04	Conical flasks 250 ml	110/-	24	2640/-
05	Measuring Cylinder 500 ml	1350/-	03	4050/-
06	Measuring Cylinder 100 ml	670/-	06	4020/-
07	Measuring Cylinder 25 ml	490/-	12	5880/-
08	Measuring Cylinder 5 ml	375/-	24	9000/-
09	Burette with Stop Cock 25 ml	465/-	24	11160/-
10	Burette Stand with Clamp Complete.	560/-	24	13440/-
11	Graduated Pipette 25 ml	200/-	24	4800/-
12	Graduated Pipette 10 ml	130/-	06	780/-
13	Volumetric flask 100 ml	530/-	03	1590/-

14	Volumetric flask 500 ml		360/-	06	2160/-
15	Volumetric flask 100 ml		230/-	06	1380/-
16	Storage Bottles 1000 ml		650/-	06	3900/-
17	Storage Bottles 2000 ml		780/-	06	4680/-
18	Supporting Bottles 250 ml		85/-	24	2040/-
19	Nessellers tube 50 ml		360/-	24	8640/-
20	Nesselers tube stand		90/-	04	360/-
21	Dropper with teat		450/-	01	450/-
22	Eight inches Stir bar		230/-	06	1380/-
23	Three inch dia Funnel		65/-	06	390/-
24	Fermentation tubes			100	
25	Test Tubes			100	
26	Pipette 10 ml			10	
27	Pipette 5 ml			10	
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