

Aim :- To estimate the moisture content in the given soil sample

Apparatus :- Weighing balance, Tongs, Petri dish, Hot Air Oven, Spatula, Dessericator.

Theory :- Water plays a very significant role in soil growth relationship. It forms major part of plant itself essential for physiological activities, acts as a solvent and nutrient carrier and maintains turgidity of the plant. In fact, water is a regulator of physical, chemical and biological activities in the soil. Moisture content varies with the climatic conditions. Moisture is of two types External and Internal moisture. External moisture evaporates in atmosphere when soil is exposed to atmosphere. To soil now contains the inherent moisture which can be removed only by heating the soil sample in an oven at 105°C and it is dried to constant weight. The weight difference is considered to be water present in soil.

Moisture content of soil is expressed in two types, as % of wet weight and % of dry weight.

$$\text{Wet weight moisture \%} = \frac{(w-d)}{w} \times 100$$

$$= \frac{(\text{Loss in weight})}{(\text{Initial weight})} \times 100$$

where, w = Initial weight

d = Loss in weight.

Procedure :- 1) Dry the Petri dish in an oven.

2) Take the weight of the empty Petri dish and note it.

Observation & Calculations :-

- 1) Weight of Petri Dish = 31.02 g
- 2) Weight of Petri Dish + soil = 37.40 g
- 3) Weight of soil = ② - ① \Rightarrow 6.38 g
- 4) Weight of dried soil + Petri Dish \Rightarrow 36.74 g
- 5) Weight of moisture = ② - ④ \Rightarrow 0.66 g

$$\% \text{ of moisture} = \frac{0.66}{6.38} \times 100 \\ \Rightarrow \underline{10.34 \%}$$

- 3) Put some soil sample in Petri Dish & weigh immediately to avoid loss in moisture content.
- 4) Calculate the weight of soil sample
- 5) Place the Petri Dish in a preheated oven for drying at 105° for about 1 hr.
- 6) Take out the dish with the help of a pair of tongs & keep it in a desiccator for cooling
- 7) Measure the combined weight of dish & dried soil sample.
- 8) Evaluate the weight of dried soil.
- 9) The difference of wet weight & dried soil will be the quantity of moisture content present in soil.

Result :- The amount of moisture present in soil is 10.34 %

Precautions :- ① Petri Dish should be perfectly dry.
 ② Petri Dish should be taken out carefully by using pair of tongs.

Implications :- ① The natural moisture content will give an idea of the state of soil in the field. The natural water content also called the natural moisture content, is the ratio of wt. of water to the wt. of the solids in the given mass of soil. The ratio is usually expressed as %.

② The liquid limit is the moisture content at which the groove, formed by a standard tool into the sample of soil taken in the standard cup, closes for 10 mm on being given 25 blows in a standard manner. This is limiting moisture content at which the cohesive soil passes from liquid state to plastic state.

Importance:- ① Soil water serves as a solvent and carrier to food nutrients for plant growth

② Yield of crop is more often determined by the amount of water available rather than the deficiency of other nutrients.

③ Soil water acts as a nutrient itself.

④ Soil water regulates soil temperatures

⑤ Soil forming processes & weathering depend on water.

⑥ Microorganisms require water for their metabolic activities.

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Temperature (°C)	0.1N	0.01N	0.001N
20	7.46 ppt	0.813 ppt	84.4 ppm
25	8.25 ppt	0.903 ppt	93.4 ppm
30	9.03 ppt	0.993 ppt.	103.0 ppm

Experiment → 02

Aim: To determine the TDS of given water sample.

Apparatus: TDS meter, Beaker, stirrer

Chemicals: KCl solutions, distilled water, Sample Water.

Theory: TDS indicates total dissolved salt in any sample of water. It includes Chloride, sulphate, carbonate, Bicarbonate of Ca, Mn, Fe, etc.

Total dissolved solids is a measure of the impurities present in a sample of water. Various kinds of minerals salt present in water also contribute to TDS of a given sample.

The permissible limit of TDS is drinking water sample (as per ISI) is 500 ppm..... If TDS of sample increases beyond permissible limit the water sample is not considered to be safe.

Procedure: ① Shorten on the instrument and allow at least 15 min warm up.

- ② Connect the lead of the TDS meter to the cell.
- ③ Rinse the cell first with double distilled water and then with the standard KCl solⁿ, on which you are going to calibrate.
- ④ Adjust the readings in respective TDS range with the help of calibration knobs as per the standard KCl solⁿ chart in measurement/TDS selection range.
- ⑤ It is advisable to ~~calibrate~~ with the value of nearby standard KCl solⁿ to obtain better accuracy and then go for testing of sample.
- ⑥ Clean and rinse the electrode thoroughly and the instrument. Electrode is ready for testing of samples.

Observation Table and Inference

S.No.	Sample	TDS (ppm)
1	Sample 1 (Tap Water)	282 ppm
2	Sample 2 (Drinking Water 1)	25.3 ppm
3	Sample 3 (Drinking Water 2)	40.4 ppm

TDS Value of KCl solution at different temperature
 Molecular Weight of KCl = 74.55

Precaution: To avoid cross contamination between samples never invert the electrode in next sample without proper cleaning.

Implications: ① High TDS levels generally indicates hard water which can cause scale build up in pipes, valves and filter reducing performance and adding to system maintenance cost.

② TDS effect can be seen in aquariums, spas, swimming pools and reverse osmosis water treatment system. In the cause of hydroponics and aquaculture.

③ TDS is often monitored in order to create a water quality environment favourable for organism productivity.

④ For hydroponics uses TDS is considered one of the best indices of nutrient availability for the aquatic plants using grown.

Result → Sample 1 → TDS: 282 ppm

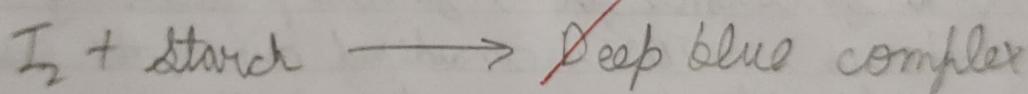
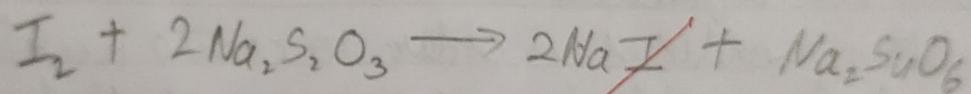
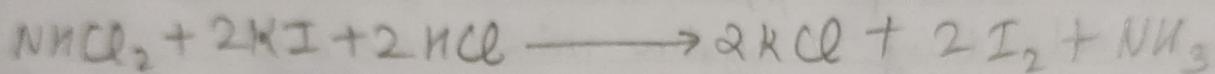
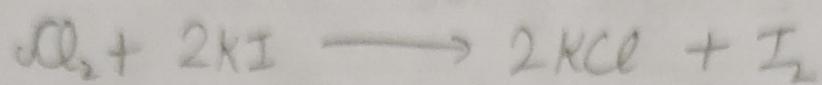
Sample 2 → TDS: 25.3 ppm

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Sample 3 → TDS: 40.4 ppm

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Experiment - 03

Aim: Determination of total residual chlorine in water.

Apparatus: Burette, pipette, conical flask and beakers.

Chemicals: N/100 $\text{Na}_2\text{S}_2\text{O}_3$, Glacial acetic acid, KI, conc. HCl.

Theory: The estimation of residual chlorine is based on oxidation of KI by residual chlorine, i.e. by iodometric titration.

When the water sample containing residual chlorine is treated with KI, residual chlorine (both free and combined) oxidizes KI and liberates I_2 in equivalent amount.

The liberated I_2 is treated against hypo solution, using starch as indicator.

The end pt. is disappearance of blue color.

Procedure: ① Pipette out 25 ml of the given water sample in conical flask and add 1 ml of KI sol. & about 1 ml of glacial acetic acid to maintain pH around 3-4.

- ② Cover the flask and shake it well to mix the solution.
- ③ Using a wash bottle, rinse the side of the flask.
- ④ Titrate it with N/100 $\text{Na}_2\text{S}_2\text{O}_3$ sol. from the burette till the sol. becomes straw yellow.
- ⑤ Add 1 ml of the starch sol. The sol. will turn blue.
- ⑥ Continue titration with $\text{Na}_2\text{S}_2\text{O}_3$ till the blue color disappears.
- ⑦ Note the final reading & repeat to get three concordant readings.

Observation : Normality of $\text{Na}_2\text{S}_2\text{O}_3$ solution = $\frac{N}{100}$

S.No.	Vol. of soln. taken (ml)	Burette Reading		Vol. of titrant used (ml)
		Initial Reading	Final Reading	
1	25 ml	0.0 ml	4.6 ml	4.6 ml
2	25 ml	4.6 ml	9.2 ml	4.6 ml

Concordant Reading = 4.6 ml

Calculation

Sample $\text{Na}_2\text{S}_2\text{O}_3$ (mg/ml)

$$N_1 = ? , V_1 = 25 \text{ ml} \quad N_2 = \frac{1}{100} , V_2 = 4.6 \text{ ml}$$

$$N_1 V_1 = N_2 V_2$$

$$N_1 = \frac{1}{100} \times \frac{4.6}{25} \Rightarrow 0.00184$$

$$\text{Strength} = N_1 \times \text{Eq. wt.}$$

$$\Rightarrow 0.00184 \times 35.5 \text{ g/L} \Rightarrow 0.06532 \text{ g/L}$$

$$\Rightarrow N_1 \times \text{Eq. wt} \times 1000 \text{ ppm}$$

$$\Rightarrow \underline{\underline{65.32}} \text{ ppm or mg/L}$$

Result: Amount of total residual chlorine is given by water sample is 65.32 ppm or mg/l.

(T.S.P.B)

Precaution: ① Chlorine vapours are harmful so the solution should not be sucked into the pipette with mouth.

- ② The titration should be completed rapidly in order to avoid atmospheric oxidation of iodide.
- ③ First disappearance of blue colour may be taken as end point.

Implications: Chlorination of water is widely used for disinfecting water supply. Since Cl_2 is a powerful oxidizing agent and is cheaply available.

- Cl_2 is applied to water in its elemental form or as hypochlorite.
- Excess of free chlorine in drinking water is undesirable. An overdose of Cl_2 imparts an unpleasant taste to water and is also injurious to health.
- Cl_2 determination is necessary in these samples of water that have been treated with Cl_2 or hypochlorites so that necessary adjustments in dose rate can be made accordingly.
- The estimation of free chlorine is based on oxidation of KI by free Cl_2 (i.e.) by iodometric titration.

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Observation :

$$\text{Normality of acid} = \frac{N}{50}$$

S.No.	Volume of Sample (ml)	Burette Reading		Volume of titrant (ml)
		Initial (ml)	Final (ml)	
1	10 ml	0.0 ml	11.2 ml	11.2 ml
2	10 ml	11.2 ml	20.9 ml	9.7 ml
3	10 ml	20.9 ml	30.6 ml	9.7 ml

$$\text{Concordant Reading} = \underline{9.7} \text{ ml}$$

Calculations :

Acid

Sample

$$N_1 V_1 = N_2 V_2$$

$$\frac{1}{50} \times 9.7 = N_2 \times 10$$

$$N_2 = \frac{9.7}{50 \times 10} \Rightarrow \underline{0.0194}$$

$$\begin{aligned} \text{Strength} &= 0.0194 \times 17 \times 1000 \text{ mg/L or ppm} \\ &\Rightarrow \underline{329.8} \text{ mg/L or ppm} \end{aligned}$$

Experiment - 4

Aim:

Determination of ammonia in the given sample

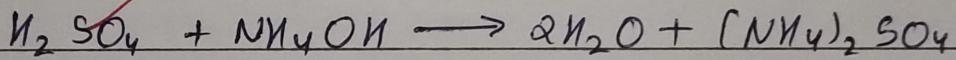
Apparatus:

Burette, Pipette, Conical flask, beakers, etc.

Chemicals:

N/50 H_2SO_4 , methyl orange

Theory: Ammonia is found as ammonium hydroxide in soln. and reacts with sulfuric acid according to following rxn:-



Procedure: ① Rinse and fill the burette with N/50 H_2SO_4 .

② Pipette out 10 ml of the unknown sample in titration flask.

③ Add 2 drops of methyl orange indicator and mix well.

④ Run the acid solution into the flask till the color changes from yellow to red.

⑤ Repeat to get three concordant readings.

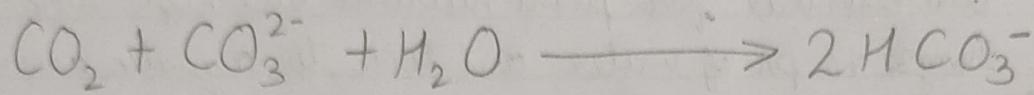
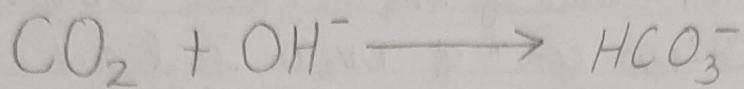
Result: The strength of ammonia in water is 329.8 ppm or mg/L

Precautions: ① The rxn. mixture should be stirred very gently while titration.

② Some amount of indicator should be added while taking different readings

- Implications :
- ① Ammonia is present in Natural water as NH_4^+
 - ② Presence of NH_3 in water changes the pH of water.
 - ③ Low conc. of NH_3 in soil and water is natural and essential for plant nutrient but high conc. of NH_3 changes the pH of water and toxic to aquatic animals.
 - ④ NH_3 can be utilized by bacteria reduction of dissolved oxygen in water.
 - ⑤ The acceptable limit of NH_3 in freshwater is 0.25 - 0.4 ppm.
 - ⑥ It acts like a nitrogen fertilizer in the soil.

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Observation :

Volume of water sample taken for each titration \rightarrow 20 ml

Normality of NaOH used $\rightarrow \frac{N}{100}$

S.No.	Volume of soln. taken in flask (ml)	Burette Reading		Volume of titrant used (ml)
		Initial Reading (ml)	Final Reading (ml)	
1	20	0	4.0	4.0
2	20	4.0	7.5	3.5
3	20	7.5	11.0	3.5

\therefore Concordant Reading \rightarrow 3.5 ml

Calculations :

Water sample

NaOH

Experiment - 05

Aim:

To determine the amount of free CO_2 in the given sample of water.

Apparatus:

Burette, Pipette, Conical flask, Beakers, etc...

Chemicals:

N/100 Na_2CO_3 or (N/100 NaOH), Phenolphthalein.

Theory:

Free CO_2 is determined by titrating the sample water with N/100 NaOH or N/100 Na_2CO_3 solution using phenolphthalein as an indicator. CO_2 reacts with NaOH or Na_2CO_3 to form HCO_3^- .

The end point is appearance of pink colour.

FREE CARBON DIOXIDE:

Varying amounts of CO_2 are present in water. CO_2 can be picked up from the atmosphere or it is generated at the bottom of the lake due to decay of organic matter. Rivers receiving acid waters may also show high CO_2 content. CO_2 content of water sample contributes to corrosion and imparts unacceptable taste to water. Thus the determination of free CO_2 is important.

Procedure:

1. Rinse and fill the burette with N/100 NaOH solution

$$N_1 V_1 = N_2 V_2$$

$$N_1 \times 20 = \frac{1}{100} \times 3.5$$

$$N_1 = \frac{1}{2000} \times 3.5$$

$$N_1 = 0.00175$$

Strength of $\text{CO}_2 \Rightarrow N_1 \times 22 \times 1000$

$$\Rightarrow \underline{\underline{38.5 \text{ mg/L}}}$$

2. Pipette out 20 ml of water sample in conical flask & add a few drops of Phenolphthalein.
3. Titrate the solution with N/100 NaOH from the burette, till the flask pink color persists for at least 30 seconds.
4. Note the readings and repeat to get three concordant readings.

Result:

~~10.915~~ The amount of free CO_2 present in water sample is 38.5 ppm.

Precautions:

1. The reaction mixture should be stirred very gently during titration.
2. Some amount of indicator should be added while taking different readings.

Implications: ① Free CO_2 in neutral water is determined by titration with Na_2CO_3 or NaON to form NaHCO_3 , completion of the even? indicates the development of pink colour of phenolphthalein

- ② Ag CO_2 reacts with water forming H_2CO_3 .
- ③ H_2CO_3 may loose protons to form HCO_3^- & CO_3^{2-} .
- ④ In case; the proton dissociated to the Water, decreasing pH.
- ⑤ About 3% of CO_2 that people have put into atmosphere has diffused into the ocean through the direct chemical exchange.
- ⑥ Dissolved CO_2 is present in water in the form of a dissolved gas.
- ⑦ Surface waters normally contains less than 10 ppm free CO_2 while some ground water may easily exceed that conc. :)

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Experiment - 06

Aim: Determination of pH in some drinking water sample

Apparatus: pH meter, electrode, thermometer, buffer solⁿ, beaker, stirrer.

Theory: One of the frequently used tests in water chemistry is to determine the pH of water. The water supplied for drinking purposes has to undergo many processes such as neutralization, precipitation, coagulation, etc. The pH range lies in the range of 4.4 to 8.5.

For determining the pH of a solution different method are employed. The most widely used method is by using pH meter. The value of the pH, the logarithm of the reciprocal of the H⁺ ions concentration in solution, is determined by measuring the difference in potential b/w two electrodes immersed in solⁿ.

Procedure: 1) Calibration → Calibrate the electrode as per following procedure →

- a) Connect the pH meter to power supply. Switch on the instrument.
- b) Take a standard buffer solution of pH 7 in 100 ml beaker. Note the temp. of buffer solution.
- c) Set the temp. control of pH meter to temp. of buffer solution.
- d) Remove the electrode from storage solⁿ, wash it with distilled water & blot dry with soft tissue paper.
- e) Connect the combination electrode to input socket & dip the electrode in pH 7 buffer solution.
- f) Set the function selector switch to pH position and adjust

Observation :

Drinking Water Sample

S.No.	Sample	pH
1.	Home Water (drinking)	6.51
2.	Tap Water	7.2

with "calibrate" control till the digital display show pH 7.

g) Now move the function switch to "stand by" position.

h) Remove the electrode from the buffer sol., and wash it with distilled water. Dry with tissue paper.

i) distilled H₂O → For storage, after cleaning, the electrode is suspended in distilled water and the system is protected against evaporation. The drying out of the electrode should be avoided.

j) Dip the electrode in the buffer solution having pH.

k) Set the "temp." to the temp. of the sol.

l) Set the function selector switch to pH position and adjust with "slope correction" control till the digital show pH

pH Measurement

a) Connect the electrode to the input socket after washing it with distilled water.

b) Dip the combined electrode in the solution under test.

c) Set the temperature knob to the temp. of the sol.

d) Set the "function selector knob" to pH position.

e) Note the pH of the solution.

f) Repeat the same procedure for other water sample.

Result : The pH of the given water sample is 6.51 of home water (drinking) & 7.2 of tap water.

Precaution : 1) Immediately after testing, the electrodes should be washed off with a stream of distilled water.

- 2) Correctly measure the temperature of the buffer sol.
- 3) Measure the pH accurately.
- 4) Switch on the pH meter correctly.

Implications: 1). Knowing "pH" value is a very important parameter for analysis of water/water waste treatment, its suitability for domestic uses and for irrigation. Certain chemical & biological processes work only at a particular pH of 6.5 to 8.5 has no direct adverse effect on health.

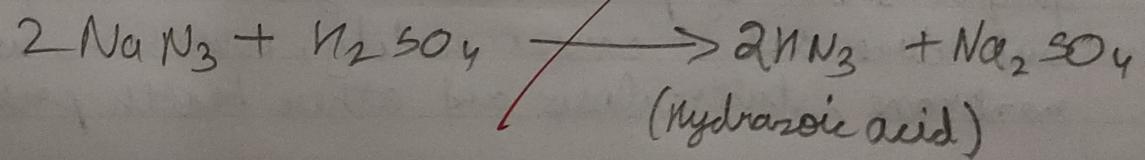
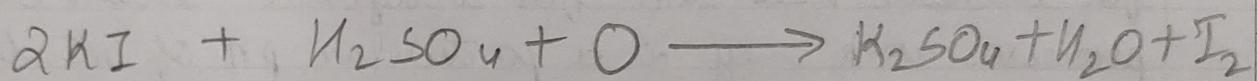
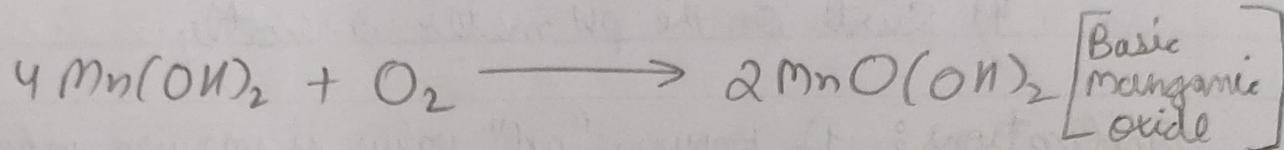
However, lower value will produce sour taste and higher value above 8.5 a bitter taste. Higher value of pH encourage the scale formation of trihalomethanes which are causing cancer in human beings. The water for domestic consumption should have pH between 6.5 to 8.5.

- 2) Corrosion of water mains is the main problem associated with acidic water. Acidic waters cannot be used for consumption purpose also. If pH is less, algae will die, fish cannot reproduce and it causes acidity, corrosion, irritation of mucous membrane, tuberculosis and other health problems in humans.

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Experiment - 07

Aim: Determination of dissolved oxygen in given sample of water

Apparatus: Burette, Pipette, Conical flask, Beakers, etc.

Chemicals: $\text{Na}_2\text{S}_2\text{O}_3$ (N/100), MnSO_4 solution, KI, starch, conc. H_2SO_4

Theory: Oxygen itself is not a pollutant in water but its deficiency is an indicator of several types of water pollution

DO is determined by Winkler's method of Iodometric titration. The DO in water oxidizes KI. This I₂ is titrated against a standard hypo solution. However, DO in water is in molecular state & is not capable of reacting with KI. ∴ an oxygen carrier such as Mn(OH)_2 is used.

The method involves a conc. soln. of MnSO_4 , NaOH , & Potassium iodide-azide reagent, the liberated I₂ is then titrated against $\text{Na}_2\text{S}_2\text{O}_3$ using starch.

The nitrate present, interfere with titration as these can also liberate I₂ from KI.

Thus to destroy nitrite, sodium azide is used.

Procedure: ① A known amount of water ($\approx 250 \text{ mL}$) is taken in a stopped bottle avoiding contact with air.

② Add 1mL of MnSO_4 to it. And also add 1mL of Alkaline

Observation

S.No.	Vol. of solution taken (ml)	Burette Reading		Vol. of titration used (ml)
		Initial (ml)	Final (ml)	
1	25	0	1.8	1.8
2	25	1.8	3.5	1.7
3	25	3.5	5.2	1.7

Concordant Reading = 1.7 ml

Calculation

$$N_1 V_1 = N_2 V_2$$

$$\frac{1}{100} \times 1.7 = N_2 \times 1000$$

$$N_2 = \frac{1.7}{2500} \Rightarrow 0.00068$$

$$\text{Strength} = N_2 \times 8 \times 1000, \text{ mg/L}$$

$$= \underline{\underline{5.44}} \text{ mg/L}$$

iodide-azide soln.

- ③ stopper the bottle & shake thoroughly. All the precipitate to form settle.
- ④ when some portion of the liquid is clear, add 1 ml of conc. H_2SO_4 until precipitate are completely dissolved & brown color of I_2 is produced.
- ⑤ pipette out 25 ml in a 100 mL conical flask, titrate I_2 with given $\text{Na}_2\text{S}_2\text{O}_3$ until sample becomes pale yellow.
- ⑥ Add 2 drops of starch & continue till blue color disappears.

Result: The amount of dissolved O_2 in water = ~~5.44 mg/L or ppm~~

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Precautions: ① Water should be taken in stopper bottle without trapping air.
 ② MnSO_4 & alkaline iodide-azide are added to water sample.
 ③ Whole of precipitate of MnO(OH)_2 should be dissolved in H_2SO_4 .

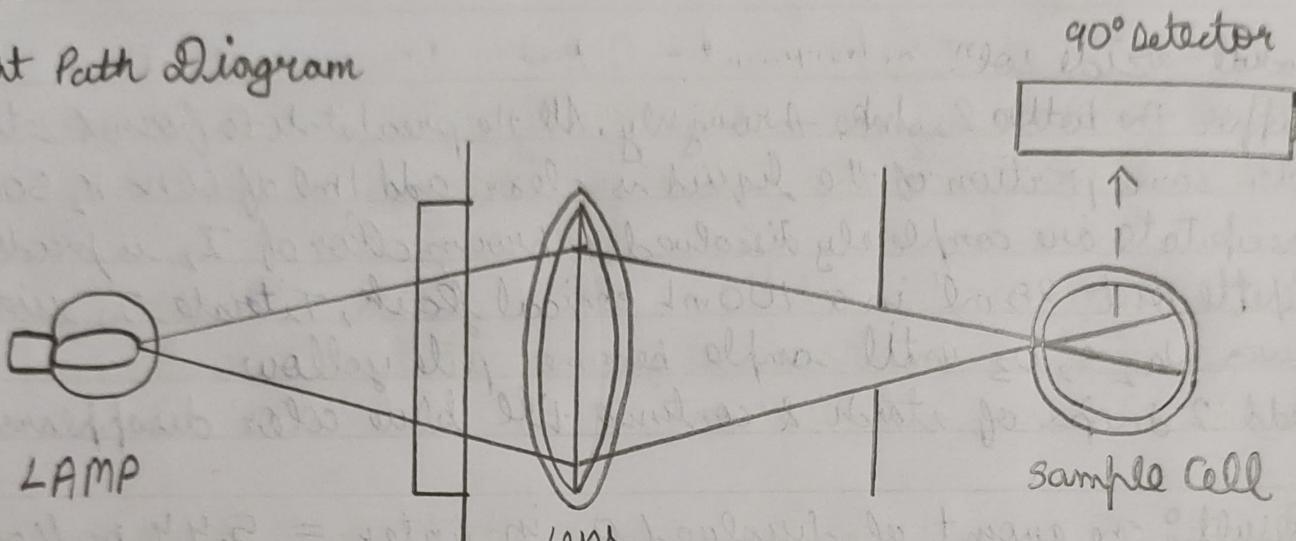
Implications: ① Amt. of O_2 is measured of biological activity of water

② O_2 is responsible for corrosion

③ Solubility of O_2 decreases with increase in temp. & conc.

TURBIDITY METER

Light Path Diagram



When light is passed through the sample cell, the 90° detector receives the light scattered by particles in the sample.

Observation :

S.No	sample	Turbidity
1	Water sample 1	94 NTU
2	Water sample 2	71 NTU

Experiment - 08

Aim: To determine the turbidity of given water sample

Apparatus: Turbidity meter, cuvettes (30 mm dia) 1 set

Chemicals: Hydrazine sulphate, Hexamethylene tetramine, water sample

Theory: Clarity of water is important in producing products destined for human consumptions in many manufacturing users, beverage products, etc. Drawing of surface water supply commonly rely on coagulation, & settling and filtration to ensure an acceptable product.

Turbidity is caused by suspended matter such as clay, silt, finely divided organic & inorganic matter soluble. It is an expression of optical property that uses light scattering properties of suspension in sample.

The digital Turbidity Meter is very accurate & stable instrument for measurement up to 100 NTU.

Reagent Preparation

Stock Turbidity Suspension

1. Solution - 1 : Dissolve 1.000g hydrazine sulphate,
2. Solution - 2 : Dissolve 10.00 g hexamethylenetetramine.
3. In 100ml volumetric flask, mix 5ml solution-1 & 5 ml of solution 2
4. Prepare solution & suspension weekly.

Procedure: ① Switch on the instrument & keep it on for some time.
② Select appropriate range depending upon turbidity of sample

Teacher's Signature _____

- ③ Set ZERO of instruments with turbidity free water using a blank solution.
- ④ 0-100 NTU range uses 100 NTU solⁿ for higher range use 400 NTU solⁿ.
- ⑤ Take measurement & set display to value of standard suspension.
- ⑥ Put the given sample solution in cuvet & measure its turbidity.

Interference ① Turbidity can be determined for any water sample that is free of debris and opacity setting.

- ② dirty glassware, the presence of air bubbles disturb surface visibility.
- ③ "TRUE COLOUR", i.e. water color due to dissolved substances.
- ④ This effect usually is not significant in case of treated water.

Result: Turbidity of sample 1 is 95 NTU & sample 2 is 71 NTU.

Precaution: ① Sample test tube must be thoroughly cleaned both inside & outside.

- ② Do not touch the test tube where the light strikes.

Implications ① Suspended sediments that cause turbidity can block light to aquatic plants, organism.

- ② It carry contaminated and pathogens such as lead, mercury & bacteria.
- ③ It is important in industrial process.
- ④ It promotes growth of pathogen leading to waterborne disease.
- ⑤ It can be used as quality control measures to monitor the efficiency of treatments.
- ⑥ Water treatment plants constantly measures turbidity level so that it can't exceed safety levels.

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