A LAB TEXT BOOK ON

Environmental Studies

By

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PREFACE

Environmental studies is multidisciplinary branch consists of chemical sciences, physical sciences, biological sciences and various engineering branches. So, it is very important that students of Environmental Science perform lab experiments to fully understand that the theories they study in lecture and in their textbook are developed from the critical evaluation of experimental data. The laboratory can also help the student to develop interest in the study of the Environmental Science by clearly illustrating the principles and concepts involved. Finally, laboratory experimentation teaches students the opportunity to develop techniques and other manipulative skills that students of Environmental Science must master for application in career and daily life.

The faculty of the Environmental Science/Chemistry at AIT clearly understands the importance of laboratory work in the study of Environmental Science and committed to educate the student in lab skill and hopes that they will take full advantage of this opportunity. This Environmental Science lab manual provides the students clear, comprehensive and upto date information about the various practical of Environmental Science.

This Environmental Science lab manual is designed to meet the need of GGSIP University B.Tech 2nd semester students

In addition, students are encouraged to complete the report as soon after laboratory as possible, as this is much more efficient than waiting until the night

Before it is due. In conclusion, we view this manual as one of continual modification and improvement. We encourage you to discuss ideas for improvements or suggestions with author. Finally, we hope you find this laboratory manual helpful in your study of chemistry.

Dr. A.K.Jain

Dr. Era Upadhyay & Mr Anupam Adhikary

Acknowledgement

First we bow down at the feet of "**Almighty God"** and pray for peace in world and let noble thoughts come to me from the universe and by the eternal blessing of omniscient almighty as to enable persist always in me the strong belief of devotion and determination that anything incomprehensible on the holy earth is comprehensible through team work with the pleasure each moment, we spent working on this lab manual.

It gives us deep pleasure to express our sincere gratitude to Prof. M.P.Singh Director Ansal Institute of Technology, Gurgaon for his valuable guidance for preparing this manual.

We would like to pay our sincere gratitude to Prof. H.S Sexana, Dy. Director Ansal Institute of Technology, Gurgaon for providing us all the facility and support for this work. We are also highly thankful to Dr. Atul Kumar, Head Applied Science and Humanities for his valuable suggestions.

Last, But not least we wish to thank all those, whose names have not figured alone but have helped us directly and indirectly during the course of this work.

Dr. A.K.Jain,
Dr. Era Upadhyay & Mr Anupam Adhikary

Subject code - ETCH-154
Subject title - Environmental Studies Lab

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LIST OF EXPERIEMNTS

1. Determination of Alkalinity in the water sample
2. Determination of dissolved oxygen (DO) in the water sample.
3. Determination of Biological Oxygen Demand (BOD) in the water sample.
4. Determination of chemical oxygen demand (COD) in the water sample.
5. Determination of pH, Conductivity and turbidity in some drinking water sample and preparation of report.
6. Determination of residual chlorine in the water sample.
7. Determination of pH and conductivity of soil/ sludge samples.
8. Determination of moisture content of soil sample.
9. Determination of Total dissolved solids in water / effluent sample.
10. Preparation of Urea-Formaldehyde polymer.
11. To determine a) λ max of the solution of $KMnO_4$ b) Verify Beer's law and find out the concentration of unknown solution by spectrophotometer.
12. To determine the concentration of iron in water sample
13. To determine the concentration of particulate matter in the ambient air using High volume Sampler.

Table of content

GENERAL RULES FOR THE SAFE WORKING OF STUDENTS IN THE LABORATORY.

Laboratory Safety

1. **State-approved safety goggles must be worn in the laboratory at all times.** This is required by state health regulation. Failure to observe this requirement will result in your removal from the laboratory. The cost is approximately Rs100 (and trivial in comparison to your eyesight). Safety glasses, etc. are not acceptable. If you already have goggles, you will not be allowed in the laboratory and, consequently, will miss the experiment.
2. **The use of contact lenses in the laboratory is absolutely prohibited.** In the case of a splash or other emergency, they may interfere with the flushing of the eye, you may not be in a position to remove them, and those administering first aid may not know that you are wearing them or might not be able to remove them easily.
3. **You must dress appropriately for the laboratory.** Lab coats are required to be worn. Bare feet, sandals, or other open-toed shoes are not permitted in the laboratory. Shorts and short skirts are likewise not permitted; legs must be covered to below the knees. *Headphones are not allowed in the laboratory.* Failure to observe these requirements will result in your removal from the laboratory. Cotton clothing (including denim) is particularly susceptible to being eaten by acid solution. The laboratory is not a good place to wear your favorite clothes**. Long hair should be tied back.**

4. Learn the location and operation of the safety showers, emergency eyewashes and fire extinguishers in the laboratory. In the case of spill onto a person or clothing, the immediate action should be to flush with water and lots of it. Do not hesitate to yell for help. Report accidents to your instructor. He/she has been certified to

administer first aid. If you are not familiar with the operation of the fire extinguishers, ask your instructor to explain them to you.

5. The fire extinguishers should only be used for real emergencies since the chemicals they contain can cause considerable damage. In any emergency that requires the assistance of the fire department, aid car, or police, sends someone to the stockroom for assistance. Should clothing catch on fire, remain as calm as possible. Walk (do not run) to the safety shower and pull the ring to douse yourself with water. Alternatively, you may drop to the floor and roll to extinguish the flames.
6. Become familiar with all of the exits from the laboratory. A repeating siren and flashing of the FIRE indicator is the building evacuation signal. If this alarm goes off while you are in the lab, turn off any open flames, grab your valuables, and leave the building as quickly as possible.
7. **Never attempt any unauthorized or unassigned experiments**. Follow the experimental procedures explicitly, checking and double-checking the identity of all reagents before you use them. There are potentially hazardous combinations of chemicals present in the laboratory. If you have an idea for further investigation, discuss it with your instructor.
8. **Clean up spills immediately**. The next person to come along has no way of knowing if the clear liquid or white powder on the lab bench is innocuous or hazardous. Neutralize acid spills with sodium bicarbonate (baking soda) before cleaning them up. Spills of sulfuric acid solutions are particularly hazardous since only the water will evaporate, thereby making the solution more concentrated upon standing.
9. **Never return unused reagents to their storage container**. If you take more than you need, dispose of the excess in the appropriate manner. Use the reagents sparingly—they are expensive and time-consuming to prepare. When taking reagents, transfer the amount you need to a clean beaker or other suitable container for taking the material back to your desk. Never insert a pipette or any

other object into a liquid reagent container. Finally, check and double-check the identity of all materials before using them.

10. **Do not pick up hot objects**. Be sure your apparatus is cool before picking it up. Do not point the open end of a test tube or other vessel containing a reaction mixture toward yourself or anyone else. If the procedure calls for you to observe the odor of the contents of a vessel, hold it upright in front of you, gently fan some of the vapors toward your nose and sniff cautiously. Most chemical vapors are at least irritating, and many are quite toxic. Please do not taste any chemicals.
11. **Do not eat, drink or smoke in the laboratory**.
12. **Playing of radios, tapes, CDs is not permitted.** This includes small portable devices used with earphones or headsets.
13. Keep coats, backpacks and other non-essential materials away from areas where people are working.
14. Dispose of all broken glassware and other sharp objects in the cardboard glass disposal boxes. Custodial personnel will stop collecting trash after they find broken glass in the trashcans.
15. Wash hands often when working in lab, and always wash thoroughly before leaving.
16. Use the hood for evaporation of anything other than water. The vapors from your procedure alone may not present a problem but those from all the students in the lab could combine to create a hazard.
17. **Do not leave a Bunsen burner or other heated apparatus unattended.** The person working next to you may not know what is involved with your setup and may be working with a flammable material. Turn off open flames if you must leave your area. Make sure the gas taps are completely off whenever the Bunsen burner is not lit.
18. Waste Disposal Dispose of chemical reagents and other materials properly. The proper disposal of chemical wastes is essential to the health and safety of Institute faculty, staff, students and the surrounding community.

19. Chemical wastes must be managed and discarded in the most responsible and environmentally sound method available.

Miscellaneous Policies and Procedures

Homework and Lab Report Due Dates. Lab reports are due one week from the date of performance, at the beginning of the lab period. Only a verifiable illness (Doctor's note) or prior permission of the instructor counts as excused absences. Unexcused lab reports will receive a grade of zero.

Lab Partners. For those experiments where students are to work in pairs, lab partners will be assigned randomly as announced by the instructor at the beginning of the lab period. You may not exchange lab partners. Both lab partners must be present for the entire experiment.

Copying. All lab reports are to be your own. Lab partners are to independently produce their lab reports. It is very easy for the grader to spot identical work among two or more students. In the event of copying, all students involved will receive a grade of zero; therefore do not give a copy of your lab report to another student.

Make-Up Labs. There will be no make-up labs.

Experiment No……1…… **Date……..**

Objective: To Determine the Alkalinity of a given Water Sample.

Apparatus Required: Burette, Pipette, Conical Flask, and Beakers.

Chemicals Required: N/10 HCl, Phenolphthalein and Methyl Orange.

Theory:

Alkalinity in water is due to the presence of different ions in water. Determination of alkalinity in water is based on titration of water sample against a standard acid using selective indicators. The indicators used are phenolphthalein and methyl orange. The following reactions take place –

i) $OH^- + H^+ \rightarrow H_2O$

ii) $CO_3^{2-} + H^+ \rightarrow HCO_3^-$

iii) $HCO_3^- + H^+ \rightarrow H_2CO_3$

The volume of the acid used up to phenolphthalein end point corresponds to the reaction i) and ii), i.e., complete neutralization of OH^- ions and CO_3^{2-} ions up to HCO_3^- stage. The volume of the acid used up to methyl orange end point corresponds to the reaction i), ii), iii), i.e., complete neutralization of OH^-, CO_3^{2-} and HCO_3^- ions.

Thus from the volume of respective titration the strengths of various ions can be determined. By measuring phenolphthalein alkalinity and methyl orange alkalinity, it is possible to calculate the magnitude of various forms of alkalinity present in water sample, e.g.,

(i) Alkalinity due to HCO_3^- only

(ii) Alkalinity due to CO_3^{2-} only

(iii) Alkalinity due to CO_3^{2-} and HCO_3^-

(iv) Alkalinity due to CO_3^{2-} and OH^-

(v) Alkalinity due to OH^- only.

Case (I): When phenolphthalein alkalinity = 0, means OH^- and CO_3^{2-} both ions are absent. Whatever alkalinity is present is due to HCO_3^- ions and can be detected using methyl orange as indicator.

Case (II): When P = M / 2, this means that only CO_3^{2-} ions are present. Neutralization reaches up to HCO_3^- stage-using phenolphthalein as indicator. Same amount of acid will be further used to neutralize HCO_3^- to H_2O and CO_2. M or 2P will determine the strength of CO32-.

Case (III): When P < M / 2, this means that in addition to CO_3^{2-} ions, HCO_3^- ions are also present.

Alkalinity due to CO_3^{2-} = 2P

Alkalinity due to HCO_3^- = (M - 2P)

Case (IV): When P > M / 2, this means that in addition to CO_3^{2-} ions, OH^- ions are also present.

Let $[OH^-]$ = x and $[CO_3^{2-}]$ = 2y,

Then P = x+y ---(i) and M = x + 2y ---(ii), so subtracting (i) from (ii), we get

(M-P) = y ---(iii)

Putting the value of y from (iii) in (i), we get

P = x + M-P

Or, $[OH^-]$= x = 2P-M ---(iv) and $[CO_3^{2-}]$ = 2y = 2 (M-P)

Case (v) : When P = M, this means that only $[OH^-]$ ions are present, so $[OH^-]$= P=M

Significance:

Highly alkaline waters are usually unpalatable and upper limits with respect to phenolphthalein alkalinity and total alkalinity are required to be specified. Alkaline waters used in boilers for steam generation may lead to precipitation of sludges, deposition of scale and cause caustic embitterment. A knowledge of the kinds of alkalinity present in water and their magnitudes is important in calculating the amounts of lime $[Ca(OH)_2]$ and soda $[Na_2(CO)_3]$ needed for water softening.Use of different fertilizers in agriculture is dictated by alkalinity of water.

Procedure:

a) Pipette out 20 ml of water sample into a conical flask. Add 1-2 drops of phenolphthalein.
b) Rinse and fill the burette with N / 10 HCl.
c) Titrate the water sample in conical flask with N / 10 HCl till the pink color just disappears.
d) Note down the reading and repeat to get three concordant readings.
e) Again take 20 ml of the water sample in conical flask and add 2-3 drops of methyl orange indicator to it.

f) Titrate it using N/ 10 HCl till just a red color is obtained.

g) Record the observation and repeat to get three concordant readings.

Observations:

Using Phenolphthalein:

Normality of the acid used = N/10

S. No.	Volume of the solution taken in the titration flask (ml)	Burette Readings		Volume of the titrant used (Final-Initial Reading) (ml) V_1
		Initial Reading	Final Reading	
1. 2. 3.				

Note : If no color develops on addition of phenolphthalein to the water sample, it means that phenolphthalein alkalinity is zero and hence do not titrate the sample for phenolphthalein alkalinity.

Using Methyl Orange

Normality of the acid used = N/10

S. No.	Volume of the solution taken in the titration flask (ml)	Burette Readings		Volume of the titrant used (Final-Initial Reading) (ml) Vi
		Initial Reading	Final Reading	
1. 2. 3.				

Calculations :

1. Phenolphthalein alkalinity in terms of $CaCO_3$ Equiv. :

(Acid) (Water Sample)

$N_1V_1 = N_2V_2$

$1/10 \times V_1 = N_2 \times 20$

$N_2 = 1/10 \times V_1/ 20 = V_1/ 200$

Strength in terms of $CaCO_3$ equiv. = N_2 x Eq. wt. of $CaCO_3$

$(V_1/ 200) \times 50$ g/L = *X* g/L

Phenolphthalein alkalinity (P) = *X* x 1000 mg/L = *X* x 1000 ppm.

2. Methyl orange Alkalinity in terms of $CaCO_3$ Equiv. :

(Acid) (Water Sample)

$N_1 V_i = N_2 V_2$

$1/10 \times Vi = N_2 \times 20$

$N_2 = 1/10 \times V_i / 20 = V_1 / 200$

Strength in terms of $CaCO_3$ equiv. = N_2 x Eq. wt. of $CaCO_3$

$(V_1/ 200) \times 50$ g/L = y g/L

Methyl orange alkalinity or total alkalinity of water sample = y x 1000 mg/L

Result:

Phenolphthalein alkalinity = ……. ppm. of $CaCO_3$

Methyl orange alkalinity = …… ppm. of $CaCO_3$

Alkalinity in terms of individual ions: 1……

2……

3……

Questions:

1. Write the structural formula of methyl orange. In which forms does it exist in acidic and alkaline medium
2. Explain the use of two different indicators in the above experiment on the basis of pH change during the titration.
3. Explain the action of phenolphthalein as an acid base indicator.
4. Why the alkalinity is calculated in terms of $CaCO_3$ equivalent?
5. Why Phenolphthalein cannot be used for titrating a weak base like HCO_3^-?

6. How much alkalinity is permissible for drinking water?

Experiment No…2…….. **Date:…….**

Objective: To Find out the amount of dissolved oxygen in the given sample of water.

Apparatus required: Burette, pipette, conical flask with stopper, measuring cylinders.

Chemical required: $Na_2S_2O_3$ (N/40), $MnSO_4$ solution, KI, Starch, conc. H_2SO_4.

Principle: Oxygen itself is not a pollutant but its deficiency is an indicator of several types of pollution in water determination of dissolved oxygen (D.O.) is important for Industrial purposes. Dissolved Oxygen is needed for living organism to maintain their biological process. In presence of good amount of dissolved oxygen, aerobic bacteria lead to oxidation of organic compounds present in water. This kind of oxidation is called aerobic oxidation. But if the dissolved oxygen is less than 5ppm, anaerobic oxidation of organic compounds present in water takes place by anaerobic bacteria. If the water is polluted with large amount of organic matter, a large amount of dissolved oxygen is rapidly consumed in the biological aerobic oxidation. Which in turn decreases the population of aquatic life. D.O. is also important in precipitation and dissolution of inorganic substances in water. Dissolved oxygen is an important factor in corrosion.

Oxygen is poorly soluble in water. The solubility of oxygen decreases with increase in conc. Of the salt under a pressure of one atmosphere, the solubility is less in saline water.

Dissolved oxygen is usually determined by Winkler's method. It is based on the fact that dissolved oxygen oxidized potassium iodide (KI) to iodine. The liberated iodine is titrated against standard sodium thio sulphate solution using starch indicator. Since dissolved oxygen in water is in molecular state. It as such cannot oxidize KI. Hence Manganese Hydroxide is used as an oxygen carrier to bring about the reaction between KI and Oxygen. Manganese hydroxide, in turn, is obtained by the action of NaOH on $MnSO_4$.

$$MnSO_4 + 2NaOH \longrightarrow Mn(OH)_2 + Na_2SO_4$$

$$2Mn(OH)_2 + O_2 \rightarrow 2MnO(OH)_2$$

$$MnO(OH)_2 + H_2SO_4 \rightarrow MnSO_4 + 2H_2O + [O]$$

$$2KI + H_2SO_4 + [O] \rightarrow K_2SO_4 + H_2O + I_2$$

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

Starch + I_2 ⟶ Blue colored complex.

The Nitrites present in water interfere with the titration as these can also liberate I_2 from KI.

$$2HNO_2 + H_2SO_4 + 2KI \rightarrow 2NO + K_2SO_4 + 2H_2O + I_2.$$

Thus to destroy nitrite, sodium azide is used.

$$2NaN_3 + H_2SO_4 \rightarrow 2HN_3 + Na_2SO_4.$$

$$HNO_2 + HN_3 \rightarrow NO_2 + N_2 + H_2O$$

Procedure:

1. Take 250 ml of sample water in a bottle avoiding as far as possible contact with air in a stoppered bottle.
2. Add about 1ml of $MnSO_4$ solution to it . Also add 2ml of alkaline iodide-azide solution to it.
3. Stopper the bottle and shake thoroughly. Allow the brown precipitates of MnO $(OH)_2$ formed, to settle down.
4. When some portion of the liquid below the stopper is clear, add 2 ml of Conc. H_2SO_4. Stopper and mix till the precipitate is completely dissolved. The characteristic brown colour of iodine is produced.
5. Transfer 50ml of the above solution is a conical flask. Titrate the liberated I_2 with standardized sodium thiosulphate solution until a pale yellow colour appeared. Now add 2 ml of freshly prepared starch solution (1%) , the solution will turn blue.
6. Continue titration till the blue colour disappears.
7. Repeat to get another reading.

End Point: Disappearance of blue colour.

Observation:

Volume of the water sample taken for titration = 50 ml.

Observation Table:

S.No.	Volume of sample taken (ml)	Burette reading		Volume of hypo solution used
		Initial	Final	

1 2 3				

Calculation:

Volume of Hypo solution used in each titration =…….ml.

N_1V_1 = N_2V_2

(Water sample) (Hypo Solution)

Normality of sample water (N_1) = N_2V_2/V_1

The strength of oxygen = Normality X Equivalent weight

= (N_1 X 8) gm/L

= (N_1 X 8) X 1000 mg/L (ppm)

Result: The amount of dissolved oxygen in water = …….ppm

Precautions:

1. No bubbles should be their in the sample bottle because, if present, the oxygen of air present inside the bubble will also take part in the reaction and this will lead to high value of dissolved oxygen.
2. Avoid air contact while introducing the reagents in the bottle.
3. Addition of sulfuric acid should be done slowly and by shaking the flask

Questions:

1. What is dissolved oxygen?
2. Discuss the factors, which affect the solubility of oxygen in water.
3. What are the disadvantages of boiler corrosion?
4. With the help of an example explain why the determination of D.O. is important for industrial purposes?
5. Differentiate between Iodometric and Iodimetric titrations.
6. What is Starch?
7. Why starch solution is added near the end point?

8. What is the role of MnSO4 in D.O. determination?

Significance of Dissolved Oxygen

1. It is essential for survival of aquatic life.
2. If water does not contain sufficient Dissolved Oxygen, the degradation of pollutants will occur through anaerobic oxidation giving foul smelling product.
3. The D.O. content predicts the purity and the ability of the stream to purify itself through biochemical process.
4. Higher amount of D.O. in water is harmful for boilers since it causes corrosion of boiler.

Experiment No……3….. **Date:…….**

Objective: To determine Biological Oxygen Demand (BOD) of a given sample of water.

Requirements: Burette, pipette, conical flasks, beakers, $MgSO_4$ solution, $CaCl_2$ solution, $FeCl_3$ solution, Phosphate buffer solution, BOD bottles, Na_2S2O_3**.**

Principle:

Microorganisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, manure, sewage, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste. When this happens, most of the available dissolved oxygen is consumed by aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live.

Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste. If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.

Nitrates and phosphates in a body of water can contribute to high BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level. The temperature of the water can also contribute to high BOD levels. For example, warmer water usually will have a higher BOD level than colder water. As water temperature increases, the rate of photosynthesis by algae and other plant life in the water also increases. When this happens, plants grow faster and also die faster. When the plants die, they fall to the bottom where they are decomposed by bacteria. The bacteria require

oxygen for this process so the BOD is high at this location. Therefore, increased water temperatures will speed up bacterial decomposition and result in higher BOD levels.

When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive.

Procedure

The BOD test takes **5 days to complete** and is performed using a dissolved oxygen test kit. The BOD level is determined by comparing the DO level of a water sample taken immediately with the DO level of a water sample that has been incubated in a dark location for 5 days. The difference between the two DO levels represents the amount of oxygen required for the decomposition of any organic material in the sample and is a good approximation of the BOD level.

1. Take 2 samples of water
2. Record the DO level (ppm) of one immediately using the method described in the dissolved oxygen test.
3. Place the second water sample in an incubator in complete darkness at 20 °C for **5 days**. If you don't have an incubator, wrap the water sample bottle in aluminum foil or black electrical tape and store in a dark place at room temperature (20 °C or 68 °F).
4. After 5 days, take another dissolved oxygen reading (ppm) using the dissolved oxygen test kit.
5. Subtract the Day 5 reading from the Day 1 reading to determine the BOD level. Record your final BOD results in *ppm*.

What to Expect

BOD Level *(in ppm)*	**Water Quality**
1 - 2	**Very Good** There will not be much organic waste present in the water supply.
3 - 5	**Fair: Moderately Clean**
6 - 9	**Poor: Somewhat Polluted** Usually indicates organic matter is present and bacteria are decomposing this waste.
100 or greater	**Very Poor: Very Polluted**

	Contains organic waste.

NOTE: Generally, when BOD levels are high, there is a decline in DO levels. This is because the demand for oxygen by the bacteria is high and they are taking that oxygen from the oxygen dissolved in the water. If there is no organic waste present in the water, there won't be as many bacteria present to decompose it and thus the BOD will tend to be lower and the DO level will tend to be higher.

At high BOD levels, organisms such as macro invertebrates that are more tolerant of lower dissolved oxygen (i.e. leeches and sludge worms) may appear and become numerous. Organisms that need higher oxygen levels (i.e. caddisfly larvae and mayfly nymphs) will NOT survive.

Observation:

i) Determination of DO in bottle No-1

S.No.	Volume of the solution taken in the titration flask (ml)	Burette Readings		Volume of the titrant used (final –initial reading) (ml)
		Initial Reading	Final Reading	
1. 2. 3.				

ii) Determination of DO in bottle No-2 (after incubation for 5 days)

S.No.	Volume of the solution taken in the titration flask (ml)	Burette Readings		Volume of the titrant used (final –initial reading) (ml)
		Initial Reading	Final Reading	
1. 2. 3.				

Volume of sample taken for each titration = 100ml

Normality of $Na_2S_2O_3$ used = N/100

Calculations:

Volume of the sample before dilution = 5 ml

Volume of the sample after dilution = 300 ml

i) DO in bottle No-1

$N_1V_1 = N_2V_2$

$1/100 \times V_1 = N_2 \times 100$

$N_2 = V_1/10000$

Strength of dissolved oxygen = N_2 x Eq. Wt

$(D_1) = V_1/10000 \times 0.8$ g/L

$= 0.8$ V1 ppm

ii) DO in bottle No-2

Similarly find D.O. in Bottle No-2

Let it be D_2

iii) OD = $D_1 - D_2$ x Volume of sample after dilution / Volume of sample before dilution

Result: BOD of the given water sample =……ppm

Questions:

1. What is BOD?
2. What do you mean by BOD_5 test?
3. How is dilution water prepared?
4. What is the significance of BOD determination?

Significance of BOD

1.

Experiment No……4….. **Date:…….**

Objective: To find out the chemical oxygen demand (COD) of a water sample using $K_2Cr_2O_7$.

Apparatus required: Burette, pipette, conical flask, beakers, round bottom flask, condenser, water bath.

Chemicals required: $K_2Cr_2O_7$, Mohr's salt solution, ferroin indicator, sample water, $HgSO_4$, silver sulphate reagent

Theory: The chemical oxygen demand is defined as the amount of oxygen used while oxidizing the organic matter content of a sample with a strong chemical oxidant under acidic conditions.

A known amount of $K_2Cr_2O_7$ is added to the measured amount of the sample and mixture is boiled with conc. H_2SO_4 .The organic matter gets completely oxidized to produce CO_2 and H_2O.

$$C_xH_yO_z + \left(x + \frac{y}{4} - \frac{z}{2}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

The excess of $K_2Cr_2O_7$ remained after the reaction is titrated against standard Mohr's salt solution using ferroin as indicator .The dichromate consumed is calculated which gives the oxygen required for the oxidation of organic matter .It is an important and quickly measured parameter for steam and industrial waste water analysis and water treatment plants.

Indicator: Ferroin

End point: Blue to wine red or (colourless to red).

Procedure:

1. Take 50ml of the sample in a round bottom flask and at 1 gram of $HgSO_4$ and some broken porcelain pieces.

2. Immerse the flask in cold water and slowly add 75ml silver sulphate-sulphuric acid reagent with continuous shaking through the open end of condenser attached.
3. Now add 25ml of $K_2Cr_2O_7$ to this solution and mix the contents of the flask.
4. Attached the reflux condenser and reflux for 1hour over a water bath.
5. Wash the condenser with distilled water into the flask. Cool and dilute to about 300ml by distilled water.
6. Take about 50ml of the sample in a conical flask add 2-3 drops of ferroin as indicator and titrate against standard Mohr's salt solution till the end point. Record the volume of Mohr's salt solution as Xml.
7. Perform a blank titration using distilled water in place of sample solution exactly following the same steps. Record the volume of Mohr's salt solution used as Yml.

Observations:

Volume of the sample taken for the titration. = 50 ml

Observation Table:

a) For Sample Water

S.No.	Volume of sample taken in the titration flask (ml)	Burette reading		Volume of titrant used
		Initial	Final	
1 2 3				

b) For distilled water:

S.No.	Volume of	Burette reading	Volume of titrant

	sample taken in the titration flask (ml)	Initial	Final	used
1 2 3				

Volume of $K_2Cr_2O_7$ used To oxidize the organic matter = Volume of Mohr's salt solution equivalent to = [Y-X] ml

Present in water sample $K_2Cr_2O_7$ used.

N_1V_1 = N_2V_2

(Sample) (Mohr's salt Solution)

$N_1 \times 50 = \frac{1}{4}(Y-X)$

$$N_1 = \frac{1}{4\times 50}(Y-X)$$

Therefore COD = N_1 x equivalent wt. of oxygen = N_1 x 8 x 100 mg/L

Result: The COD of the given sample is …….mg/L

Precautions:

1. The addition of Ag_2SO_4- H_2SO_4 to the sample should be done slowly with shaking and cooling during mixing
2. It should always be added through the open end of the condenser.
3. Smaller volume of the sample should be taken in the flask, if it has high COD

Questions:

1. Define COD?
2. What is the role of $HgSO_4$ in the reaction?
3. What is the structure of ferroin?
4. What is septic and stale sewage?
5. Differentiate between BOD and COD?

Experiment No. :…5…… **Date:……**

Objective: Determine the pH and Conductivity and turbidity of given water samples.

Apparatus Required: pH meter with electrode, beakers, Conductometer with conductivity cell. Turbidity meter

Chemical Required: Water samples from different sources, Buffer solution, standard KCl solution (.001M).

Principle:: pH of a solution is defined as the negative power to which $[H]^+$ concentration of a solution is raised to express the H^+ concentration or H^+ activity of the solution.

For dilute solution $[H]^+ = 10^{-pH}$

Taking logarithms we get $-\log [H]^+ = pH$

pH value of a solution may be defined as the negative log of $[H]^+$.

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since chemicals in the water can affect pH, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/basic ness of the water. Water with a pH of five is ten times more acidic than water having a pH of six.

The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical

constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For example, in addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. In the case of heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble.

Conductivity:

Conductivity is a measurement of the ability of an aqueous solution to carry an electrical current. An ion is an atom of an element that has gained or lost an electron which will create a negative or positive state. For example, sodium chloride (table salt) consists of sodium ions (Na+) and chloride ions (Cl-) held together in a crystal. In water it breaks apart into an aqueous solution of sodium and chloride ions. This solution will conduct an electrical current. An equation which shows this is:

$$Na\ (atom)^{+}\ Cl\ (atom)\ Na^{+}\ Cl^{-}\ (ionic\ crystal)$$

$$Na^{+}Cl^{-}\ (in\ a\ water\ solution) = Na^{+}\ (ion) + Cl^{-}\ (ion)$$

There are several factors that determine the degree to which water will carry an electrical current. These include:

1) The concentration or number of ions;

2) Mobility of the ion;

3) Oxidation state (valence) and;

4) Temperature of the water.

Conductivity is a measurement used to determine a number of applications related to water quality. These are as follows:

1) Determining mineralization: this is commonly called total dissolved solids. Total dissolved solids information is used to determine the overall ionic effect in a water source. The number of available ions in the water often affects certain physiological effects on plants and animals.

2) Noting variation or changes in natural water and wastewaters quickly;

3) Estimating the sample size necessary for other chemical analyses; and

4) Determining amounts of chemical reagents or treatment chemicals to be added to a water sample.

Elevated dissolved solids can cause "mineral tastes" in drinking water. Corrosion or encrustation of metallic surfaces by waters high in dissolved solids causes problems with industrial equipment and boilers as well as domestic plumbing, hot water heaters, toilet flushing mechanisms, faucets, and washing machines and dishwashers.

Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species. Excessive dissolved solids limit agricultural uses of water for livestock watering and high dissolved solids can be a problem in water used for irrigation.

Turbidity:

Turbidity is a measure of the degree to which the water looses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. Turbidity is considered as a good measure of the quality of water.

The WHO establishes that the turbidity of drinking water shouldn't be more than 5 NTU, and should ideally be below 1 NTU.

Turbidity is measured in NTU: Nephelometric Turbidity Units. The instrument used for measuring it is called nephelometer or turbidimeter, whichmeasures the intensity of light scattered at 90 degrees as a beam of light passes through a water sample.

Procedure:

Determination of pH

1. Switch on the pH meter and connect the banana socket of pH electrode with the instrument and allow it to warm up for 15 to 20 minutes.
2. Insert the electrode in buffer solution of 4.00 pH and adjust the desired value by using CAL control.
3. Wash the electrode and carefully insert it into another buffer solution of 9.20 pH, adjust the value again by using the CAL knob.

4. Now insert the electrode in the water sample 1,2,3,4… respectively and note down the pH values for each of the sample.

Determination of Conductivity.

1. Connect the conductivity cell to the instrument and allow it to warm up for 15 minutes.
2. Wash the cell with distilled water and calibrate the instrument as described in the working manual.
3. Dip the cell in the water samples whose conductivity is to be measured.
4. Note down the conductivity of the water samples as displayed by the instrument.

Procedure:

1. Pipette water out of the top of the first sample and place it in a sample tube, making sure that no air bubbles are present in the sample. (Air bubbles will rinse while turbidity will sink.)
2. Carefully wipe the outside of the sample tube clean.
3. Place the sample tube in a calibrated turbidity meter and read the turbidity.
4. Repeat for the water from the other samples.

Observation:

S. No.	Sample No.	Observed pH value	Observed Conductivity value	Observed Turbidity
1.				
2.				
3.				
4.				

Result and Report: _____

_____

Precautions: _____

1. Handle the pH glass electrode very carefully and keep the pH meter always at stand by mode when not in use.
2. Wash the pH electrode and Conductivity cell with distilled water after every observation.
3. Do not disturb the CAL mode of the instruments during the experiment.

Questions:

1. What is the pH
2. Define conductivity of the solution.
3. What should be the range of drinking water pH?
4. What is turbidity?
5. What causes turbidity?
6. Which is the maximum allowed turbidity in drinking water?
7. What are the impacts of turbidity?
8. How do we measure turbidity?

Experiment No……6…… **Date:……**

Objective: To determine the total residual chlorine in water sample.

Apparatus Required: Burette, pipette, conical flask beakers

Chemical Required: Standard $Na_2S_2O_3$, Glacial acetic acid, KI (Solid), conc. HCl, starch indicator.

Theory: Living organism such as algae, fungi and bacteria are more abundant in surface drainage water, while in deep well waters, the bacterial count is often low. The process of killing diseases producing bacteria, microorganism etc. from water and making it fit for use is called disinfection. While doing the disinfection of water it is necessary to add sufficient quantity of disinfectants to kill the pathogen. Chlorine is widely used for disinfections of potable and municipal water supplied to remove bacteria, fungus and other pathogenic microorganism, and for deodorization, since it is a powerful oxidizing agent and is cheaply available. Chlorination is done with the help of bleaching powder or chlorine gas or chlorine dissolved in water in the form of concentrated solution or with chloramines. The sterilizing action of chlorine is supposed to be due to its reaction with water producing hypochlorous acid and nascent oxygen both of which have powerful germicidal properties.

$CaOCl_2 + H_2O \longrightarrow Ca(OH)_2 + Cl_2$

$Cl_2 + H_2O \longrightarrow HOCl + HCl$

$HOCl$ Hypochlorous acid $\longrightarrow HCl + (O)$ Nascent Oxygen

$HOCl$ + Germs $\longrightarrow$ Germs are killed

However, excess of free chlorine in drinking water is undesirable, as it is not only unpleasant for drinking but it also injurious for human metabolism. Hence, the amount of free chlorine in municipal water is estimated prior to the domestic supply.

The estimation of residual chlorine is based on oxidation of KI by residual chlorine (Iodometrically).

When the water sample containing residual chlorine (both free and combined) is treated with excess of KI, the free chlorine present in the water oxidizes the corresponding

amount of I_2 .The liberated I_2 is titrated against hypo solution using starch as indicator to estimate the amount of chlorine present in the water sample.

$Cl_2 + 2KI \longrightarrow 2KCl + I_2$

$HOCl + 2KI + HCl \longrightarrow 2KCl + I_2 + NH_3.$

$NHCl_2 + 2KI + 2HCl \longrightarrow 2KCl + 2I_2 + NH_3$

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

$I_2 + 2\ Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$

$I_2 + Starch \longrightarrow$ Deep Blue complex.

End Point: Disappearance of Blue colour.

Procedure:

1. Pipette out 50 ml of given water sample in conical flask and add 1g of KI (solid) and about 2 ml of glacial acetic acid.
2. Cover the flask and shake it well to mix the solution.
3. Using a wash bottle rinse the sides of the flask.
4. Titrate it with standard hypo solution from the burette till the solution becomes straw yellow.
5. Add 2 ml of the starch solution. The solution will turn blue.
6. Continue the titration with hypo solution till the blue colour disappears.
7. Note the final reading and repeat to get three concordant readings.

Observation Table -

S.No.	Volume of sample taken (ml)	Burette reading		Volume of hypo solution used
		Initial	Final	
1 2 3				

Calculation:

Volume of Hypo solution used in each titration =…….ml.

N_1V_1 = N_2V_2

(Water sample) (Hypo Solution)

Normality of sample water (N_1) = N_2V_2/V_1

Total Chlorine residuals = Normality (N_1) X Equivalent weight

= (N_1 X 35.5) gm/L

= (N_1 X 35.5) X 1000 mg/L (ppm)

Result: The amount of Residual Chlorine in water = …….ppm

Precautions

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 iodine.

Questions:

1. Why chlorine is added to water?
2. What are the disadvantages of excess of chlorine present in water.

3. What is the role of acetic acid added in step 1 in the procedure?
4. Name few other chemicals used for disinfections of water.

Experiment No……7….. **Date:…….**

Objective: Determination of pH and conductivity of soil/ sludge samples**.**

Requirements: Burette, pipette, Conical flasks, Beakers, Soil sample, water. pH Meter , Conductivity meter

Principle:

A saline soil contains sufficient soluble salts adversely affect crop growth & production. On visual inspection of fields, saline soils often show white patches, spotty crops stands, irregular crop growth stunted deep green plants and in some cases visible signs of salt injury, such as tip burn of leaves and chlorosis of leaves.
It is how ever necessary to know the amount of salt in the soil for further remedial measures. The amount of salt in a soil can be precisely determined only by complete chemical analysis. But a close estimate can be obtained relatively easily by measuring Electrical Conductivity of Soil: Water mixture. The more the salts, higher the electrical conductivity. The Electrical Conductivity of a soil solution is usually expressed in milli mohs/cm and that of irrigation water in milli mohs/cm at 25°C.
The pH value of soil is indicative of acidic/basic nature of soil. The pH value of a solution is the negative logarithm of the Hydrogen ion activity. When the exchangeable sodium percentage becomes high (exceeds 10 - 20% of exchange capacity) , the pH value of such soil sample is above 8.5 and soil show physical conditions of low permeability , sticky when wet and hard when dry , nutritional disorders etc which visually display in reduction of crop growth and water logged conditions.

Procedure:

Take 20gm of soil sample is shaken with 40ml of distilled water in a 250ml conical flask for 1hr.

pH Measurement

1. The suspension is steered at regular intervals for 30 minutes. Then pH is recorded. The suspension must be steered well just before the electrodes are immersed.
2. pH meter is calibrated with 2 buffers , one in the acidic side and the other alkaline or neutral range. The glass & calomel electrodes are inserted in suspension and pH measurement is made.

Conductivity:

1. The conductivity of the suspended liquid is determined with the help of conductivity meter. Measurements of Electrical Conductivity is determined on a saturation extract of soil or supernatant liquid of 1:2 soil water suspension.
2. Electrical conductivity is measured with the help of Electrical Conductivity Meter. The Conductivity Meter is to be calibrated and cell constant be determined with a Standard Solution of 0.7456 gm of dry potassium chloride of 1 liter of distilled water (at 25°C , this solution gives Electrical Conductivity of 1.41 milli mohs/cm)

Observation:

S.No.	pH	Conductivity (milli mohs/cm)
1. 2. 3.		

Result:

pH of the given soil sample = ……

Conductivity of the given soil sample = ……. milli mohs/cm

Questions:

1. What is pH?
2. What do you mean by Electrical Conductivity?

Experiment No. :……8…… **Date:……**

Objective: To determine the moisture content in a given soil sample

Requirements: China dish, balance of precision .001gm, hot air oven, desiccators, soil sample, pestle and mortar.

Principle: Water contained in soil is called soil moisture. The water is held within the soil pores. Soil water is the major component of the soil in relation to plant growth. If the moisture content of a soil is optimum for plant growth, plants can readily absorb soil water. Not all the water, held in soil, is available to plants. Much of water remains in the soil as a thin film. Soil water dissolves salts and makes up the soil solution, which is important as medium for supply of nutrients to growing plants.

The method is based on removing soil moisture by oven drying a soil sample until the weight remains constant. The moisture content is calculated from the sample weight before and after drying. Soil containing gypsum lose water of crystallization on heating therefore the moisture content determined by this method will be affected by approximately 0.1% for each 1% gypsum. If it is suspected the presence of gypsum in the soil then drying shouldn't be more than at 80^{o}C temperature for 16 hours.

Importance of Soil Water

- Soil water serves as a solvent and carrier of food nutrients for plant growth
- Yield of crop is more often determined by the amount of water available rather than the deficiency of other food nutrients
- Soil water acts as a nutrient itself
- Soil water regulates soil temperature
- Soil forming processes and weathering depend on water

- Microorganisms require water for their metabolic activities
- Soil water helps in chemical and biological activities of soil
- It is a principal constituent of the growing plant
- Water is essential for photosynthesis

Procedure:

1. Weigh accurately a dry crucible (China Dish) kept in the oven at 110^{o}C overnight and cooled in desiccators.
2. Take 10 to 20 grams of finely powdered soil sample in the same crucible.
3. Keep the sample in the oven at 105^{o}C to 110^{o}C for 16 hours.
4. Remove the sample from oven and cool in a desiccators.
5. Take the weight again.
6. Repeat the process of step 3 to 5 till a constant weight is found.

Observation Table:

Weight of the dry china dish = W_1

Observation Number	Weight of the sample before drying (W_2)	Weight of the sample after drying (W_3)	Difference in weight (W_2-W_3)
1.			
2.			
3.			
4			

Calculations:

The moisture content of the soil as the percentage of the dry soil weight is

MC% = $(W_2-W_3)/ (W_3-W_1)$ X 100

Result: The moisture present in the soil sample is ……%

Precautions:

1. The balance to be used in a particular test will depend on the size of the sample. The balance should be accurate to within 0.03% of the weight of the sample.
2. The soil sample should be finely powdered before use.
3. The sample may be crumbled to assist drying but care is necessary to avoid loss of any soil.
4. The soil sample used in determination of moisture content should be discarded and should not be used in any other test.

Significance of Soil Moisture

Compared to other components of the hydrologic cycle, the volume of soil moisture is small; nonetheless, it of fundamental importance to many hydrological, biological and biogeochemical processes. Soil moisture information is valuable to a wide range of government agencies and private companies concerned with weather and climate, runoff potential and flood control, soil erosion and slope failure, reservoir management, geotechnical engineering, and water quality. Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. As a result, soil moisture plays an important role in the development of weather patterns and the production of precipitation. Simulations with numerical weather prediction models have shown that improved characterization of surface soil moisture, vegetation, and temperature can lead to significant forecast improvements. Soil moisture also strongly affects the amount of precipitation that runs off into nearby streams and rivers. Large-scale dry or wet surface regions have been observed to impart positive feedback on subsequent precipitation patterns, such as in the extreme conditions over the central U.S. during the 1988 drought and the 1993 floods. Soil moisture information can be used for reservoir management, early warning of droughts, irrigation scheduling, and crop yield forecasting.

Experiment No…9…….. **Date:…….**

Objective: To find out the total dissolved solid in the given water sample

Requirements: China dish, hot air oven, balance and desiccator.

Principle:

Total Dissolved Solids (often abbreviated **TDS**) is an expression for the combined content of all inorganic and organic substances contained in a liquid which are present in a molecular, ionized or micro-granular (colloidal sol) suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a sieve size of two micrometers. Total dissolved solids are normally only discussed for freshwater systems, since salinity comprises some of the ions constituting the definition of TDS. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is generally considered not as a primary pollutant (e.g. it is not deemed to be associated with health effects), but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants.

Procedure:

1. Take a clean china dish and heat it at 180^0 C for one hour in an Oven.
2. Store the dish in a desiccator for 15 to 20 minutes.
3. Weigh the dish kept in desiccator immediately before use.(x)
4. Pippete out the properly filtered water/ sludge sample and pour it into the weighed china dish.
5. Evaporate to dryness in a hot air oven for 1 hour at 180^0C.
6. Cool in a desiccator to balance temperature and weigh.(

Observation Table:

Volume of the Sample taken (ml)	**Weigh of empty china dish (*x*) *gm***	**Weight after evaporation (*y*) *gm***	**Difference (*Y-X*)**

Calculation and Result:

Milligram of total dissolved solids/L = (*Y-X*) x 1000/ Sample Volume (ml)

Significance of TDS measurement

High TDS levels generally indicate hard water, which can cause scale buildup in pipes, valves, and filters, reducing performance and adding to system maintenance costs. These effects can be seen in aquariums, spas, swimming pools, and reverse osmosis water treatment systems. Typically, in these applications, total dissolved solids are tested frequently, and filtration membranes are checked in order to prevent adverse effects.

In the case of hydroponics and aquaculture, TDS is often monitored in order to create a water quality environment favorable for organism productivity. For freshwater oysters, trouts, and other high value seafood, highest productivity and economic returns are achieved by mimicking the TDS and pH levels of each species' native environment. For hydroponic uses, total dissolved solids is considered one of the best indices of nutrient availability for the aquatic plants being grown.

TDS or Total Dissolved Solids is a measure of the total ions in solution. EC is actually a measure of the ionic activity of a solution in term of its capacity to transmit current. In dilute solution, TDS and EC are reasonably comparable. The TDS of a water sample based on the measured EC value can be calculated using the following equation:

TDS (mg/l) = 0.5 x EC (dS/m or mmho/cm) or = 0.5 * 1000 x EC (mS/cm).

Questions:

1. What is TDS in water?
2. What is the importance of TDS?
3. The TDS value of bottled water is usually more than the Tap water. Explain?

Experiment No. ……10….. **Date:……**

Objective: To prepare Urea Formaldehyde resins.

Apparatus Required: Beaker, Measuring cylinder, Pipette, Glass rod, and Dropper

Chemicals required: (a) Urea Formaldehyde: Urea, Formaldehyde solution (40%), and Sulfuric acid (H_2SO_4)

Principle:

Polymers: The term polymer is derived from the Greek words 'poly' meaning many and 'mer' meaning part. Thus, a polymer means a substance with many parts. Every polymeric substance has a definite identifying unit of molecular structure, which is called a part or mer (monomer). A polymer is a large molecule made up of small, simple chemical units held together by covalent bonds. Some polymers are linear in the form of chains while others are branched or interlinked chains to form three-dimensional networks.

On the basis of reaction to stress and temperature polymers may be:

(i) Thermoplastics (Thermoplasts) which can be repeatedly given shapes by heat and pressure. Hence, once used for a particular form, they can again be formed into a different shape or form, e.g. polyethylene (PE), polystyrene (PS).

(ii) Thermosets are the polymers which once subjected to heat and pressure to give a particular form, cannot be formed again like the thermoplastics, e.g. urea formaldehyde, phenol formaldehyde, nylon-6,6, etc.

(iii) Rubbers, when subjected to heat and pressure, behave at first like the thermoplastics and subsequently become highly elastic. Their elasticity may be arrested at an intermediate stage and this process is called curing (vulcanization)

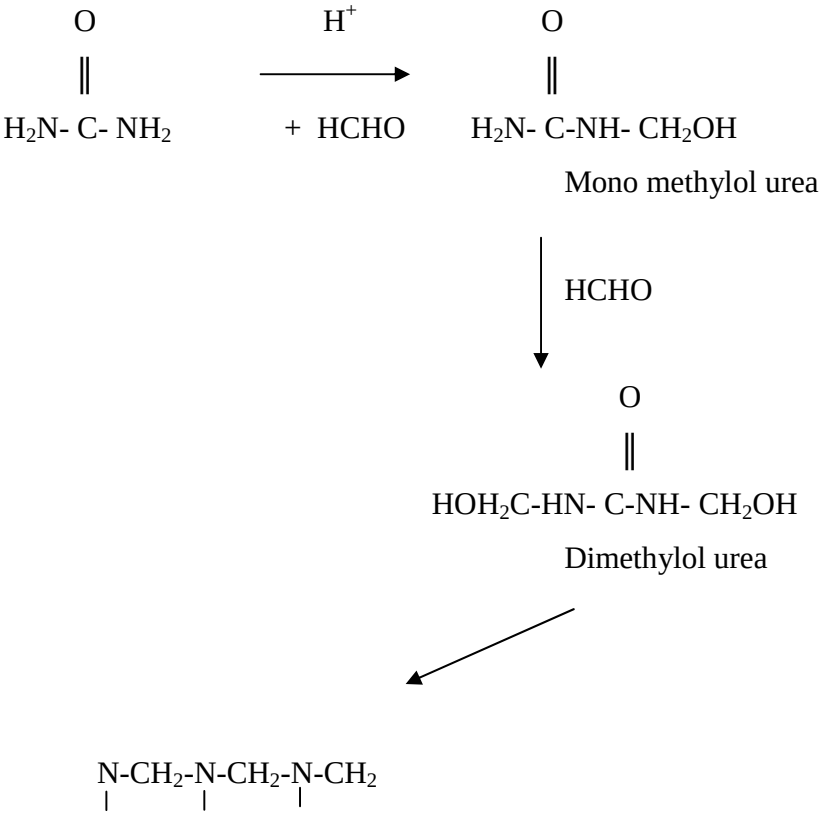
On the basis of method of production, polymers are classified as:

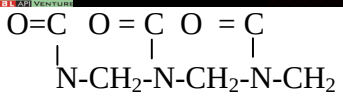
(i) Addition (chain reaction) polymers are produced by addition or chain reaction polymerization in which a simple, low molecular weight molecule (monomer), which possesses at least one double bond, is induced to break its double bond resulting in the free valences, which then link up with other similar molecules to give the polymer. In this polymerization, the monomer retains its identity in the polymer and also, no byproduct is formed, e.g. polyethylene:

$$n CH_2=CH_2 \longrightarrow -[CH_2-CH_2]_n-$$

(ii) Condensation polymers are produced by the method of condensation polymerization in which the monomer need not contain a double bond and the monomer does not retain its characteristic molecular formula in the polymer. Moreover a small molecule is essentially given out and hence the resulting molecule is condensed in the process, e.g.

Urea formaldehyde :





Cross Linked polymer

(Urea- Formaldehyde)

Procedure:

1. Take 1.5 gm of urea in a 100 ml beaker.
3. Add 3 ml of formaldehyde solution.
4. Stir the mixture till all the crystals of urea dissolve.
5. Now add 2 drops of Conc. H_2SO_4 when all of a sudden a white mass of urea formaldehyde resin appears.
6. Wash the resin several times with tap water to remove any trace of acid.
7. Collect the white resin and take the weight.

Result:

The measured weight of the resin formed is ----------gm.

Precautions:

1. Be very careful while adding Sulphuric acid in the mixture.
2. Keep the beaker away from the body during the reaction.
3. Avoid inhaling the fumes coming out from the reaction mixture

Questions:

1. What is polymer?
2. What arte natural polymer?
3. What are thermoplastic and thermoses polymers?
4. What are the applications of Urea formaldehyde resin?

Experiment No.: ……11… **Date:……**

Objective: Determine the concentration of $KMnO_4$ solution Spectrophotometrically

Apparatus Required: UV- Visible spectrophotometer, cuvette, test tubes, pipette

Chemical required: $KMnO_4$

Principle: When an electromagnetic radiation is passed through a sample, certain characteristic wavelengths are absorbed by the sample as a result the intensity of the transmitted light is decreased. The measurement of the decrease in intensity of the radiation is the basis of spectrophotometry**.**

According to the Beer Lambert's Law the intensity of the incident light is proportional to the length of thickness of the absorbing medium and the concentration of the solution,

$\log I_0/I = A = \varepsilon C l$ where ε is Molar absorption coefficient defined as the absorbance of a solution having unit concentration (C= 1M) placed in a cell of unit thickness (l = 1 cm).

A plot between absorbance and concentration is expected to be linear. Such a straight line plot, passing through the origin, shows that Beer-Lambert's law is obeyed. This plot is called calibration curve can also be employed in finding the concentration of a given solution.

The λ_{max} of $KMnO_4$ solution is calculated by plotting the graph in between the absorbance (A) and wavelength and the concentration of the $KMnO_4$ solution is calculated by plotting the graph in between the absorbance (A) and concentration of the solution.

The relationship between absorbance and transmittance is illustrated in the following diagram:

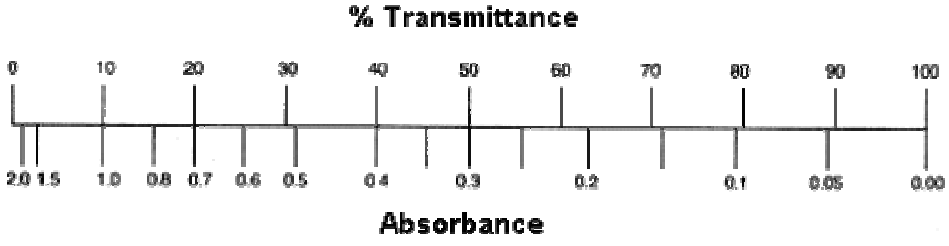


Fig. 1

Significance:

- UV / Visible spectrophotometers are used in the modern life science laboratory for the quantification of nucleic acids, the determination of protein concentrations and the calculation of enzyme activity in kinetics studies.
- The purity of DNA and RNA extractions from cells can be readily measured using spectrophotometry

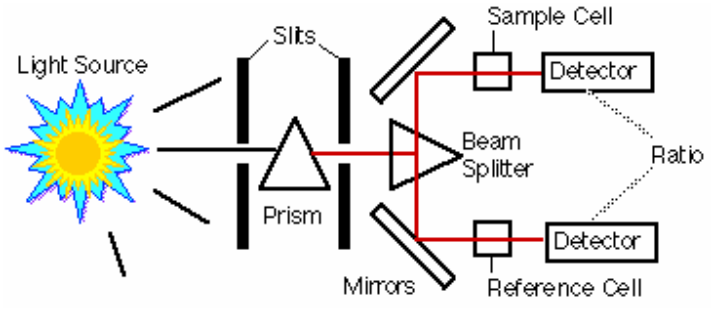


Fig: 2 Schematic of a Double Beam Spectrophotometer

Procedure:

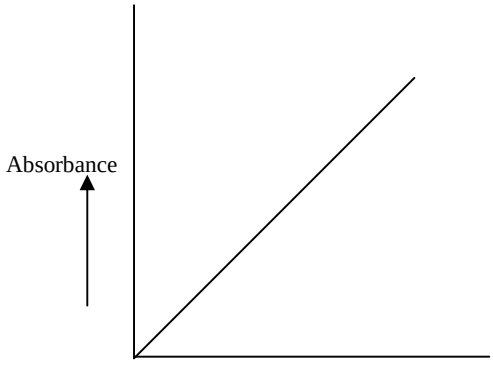
1. Switch ON the instrument and allow it to self calibrate.
2. Calibrate the instrument for blank solution as per the instrument Manual.
3. Prepare the solution of different concentrations from the given stock solution.
4. Find the value of λ_{max} of $KMnO_4$ solution as per the instrument manual.
5. Note down the value of absorbance for different concentration of $KMnO_4$ solution at λ_{max} value of $KMnO_4$ (say 0.5%, 1.0%, 1.5%, 2.0% etc.).
6. Plot the observed values of absorbance against concentration.
7. Find the concentration of given unknown $KMnO_4$ solution from the plotted graph.

Observation:

Determination of concentration of given $KMnO_4$ solution

Sr. No.	Concentration (C)	Absorbance (A)
1		
2		

3		
4		
5		
6		
Unknown		



Graph in between absorbance and Concentration

Result:

Concentration of given $KMnO_4$ = _____ mg/l

Precautions:

1.Always use the dilute solution.

2. Cuvette should be cleaned properly and must be wiped with tissue paper.

3.Do not leave any finger marks on the cuvette.

Questions:

1. What is the purpose of this experiment? What is the relation between concentration and absorbance? Explain.
2. Mention the role of potassium permanganate in the water treatment.
3. What is the light source for visible region and UV region of the spectrum?
4. What are the advantages of using Quartz or silica cells over Glass and plastic when measuring absorption of ultraviolet wavelengths by a solution?
5. Why is it important to determine λmax before determine the concentration of the

unknown?

Experiment No……12….. **Date:…….**

Objective: To determine the concentration of iron in water sample by spectrophotometric method.

Requirements: Spectrophotometer. Stock solution of Fe^{3+} ions, conc. HCl, Potassium thiocyanate.

Principle: The colorimetric determination of iron using KCNS as colour developing agent is based on the formation of a red coloured complex between Fe3+ and CNS^- ions

$$Fe^{3+} + 3CNS \leftrightarrow [Fe(CNS)]^{2+}$$

(Red)

In the determination of iron in the water sample, a series of standard solutions having iron is treated with KCNS to get iron-thiocyanate complex. The absorbance of all the standard solution prepared is noted at λmax 480 nm because iron-thiocyanate complex shows maximum absorbance at this wavelength. Now the absorbance for the unknown solution is also determined. A graph is plotted against the absorbance (OD) against the concentrations of the known solutions. From the graph the concentration of the unknown solution can be found out.

Procedure:

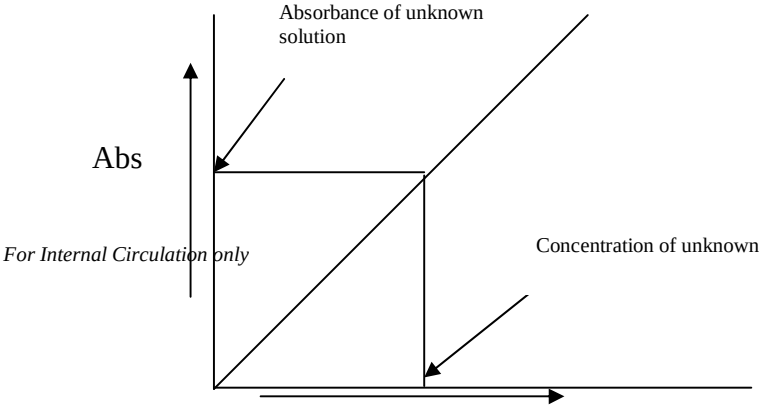
1. Set the Spectrophotometer and adjust the wavelength to 480 nm.
2. Prepare the stock solution of Fe^{3+} ions by dissolving 2.0g of ferric ammonium sulphate in 50 ml of distilled water and 10 ml. of conc. HC1. HCl is added to suppress the hydrolysis of ferric ammonium sulphate.
3. Take the stock solution in the burette and prepare 5 solutions of different known concentrations by diluting the above stock solution in five different flasks.

4. Transfer 1 ml solution of standard stock solution to 50 ml measuring flask and add 10 ml of thiocyanate solution. Dilute the solution to 50 ml.
5. Repeat the process (step 4) with the solutions of other concentrations prepared above and also with the unknown sample.
6. Prepare the blank solution by dissolving 10 ml of thiocyanate solution in distilled water and making the volume to 50 ml.
7. Keep the solution at rest for 5 minutes.
8. Note down the absorbance of all the solution against blank solution, spectrophotometrically at 480 nm.
9. Prepare a calibration curve by plotting absorbance against concentration.
10. From the calibration curve, the concentration of the unknown solution corresponding to its absorbance can be found.

Observation:

S.No.	Concentration	Absorbance
1. 2. 3. 4. 5. 6. Unknown		

Calibration Curve:



Result:

The amount of Fe(III) in water was found to be =……g/L.

Questions:

1. What is spectrophotometry?
2. Discuss Lambert's and Beer's law of absorbance.
3. What is colorimetry?
4. What is absorbance, transmittanc/?, extinction coefficient.
5. How you can verify Beer's law?
6. How you can find out the conc. of the given unknown solution spectro. photometrically?
7. What is the significance of spectrophotometry.
8. What is the structure of orthophenanthroline complex with iron (II).

List of Content of Notebook

Objective:

Materials:

Procedure:

Data:

Other Measurements:

Formulas:

Calculations/Results:

Simplified/Rounded Calculations:

Conclusion:

Partners name :

References:

WATER QUALITY PARAMETERS AND DRINKING WATER STANDARDS

SL. NO.	PARAMETERS	UNITS	DRINKING WATER IS: 10500 - 1991	
			DESIRABLE	MAXIMUM
1.	Colour	Hazen units	5	25
2.	Odour	-	Unobjectionable	-
3.	Taste	-	Agreeable	-
4.	Turbidity	NTU	5	10
5.	pH value	-	6.5 to 8.5	No relaxation
6.	Total hardness (as $CaCO_3$)	mg/l	300	600
7.	Iron	mg/l	0.3	1.0
8.	Chlorides	mg/l	250	1000
9.	Residual, free Chlorine	mg/l	0.2	-
10.	Dissolved Solids	mg/l	500	2000
11.	Calcium	mg/l	75	200
12.	Copper	mg/l	0.05	1.5
13.	Manganese	mg/l	0.1	0.3
14.	Sulphate	mg/l	200	400
15.	Nitrate	mg/l	50	No relaxation
16.	Fluoride	mg/l	1.0	1.5
17.	Phenolic compounds	mg/l	0.001	0.002
18.	Mercury	mg/l	0.001	No relaxation
19.	Cadmium	mg/l	0.01	No relaxation
20.	Selenium	mg/l	0.01	No relaxation

21.	Arsenic	mg/l	0.05	No relaxation
22.	Cyanide	mg/l	0.05	No relaxation
23.	Lead	mg/l	0.05	No relaxation
24.	Zinc	mg/l	5	15
25.	Anionic detergents	mg/l	0.2	1.0
26.	Chromium	mg/l	0.05	No relaxation
27.	Polynuclear aromatic Hydrocarbons	mg/l	-	-
28.	Mineral oil	mg/l	0.01	0.03
29.	Pesticides	mg/l	Absent	0.001
30.	Radioactive materials (a) Alpha emitters (b) Beta emitters	 Bq/l Pci/l	 - -	 0.1 0.037
31.	Alkalinity	mg/l	200	600
32.	Aluminlum	mg/l	0.03	0.2
33.	Boron	mg/l	1	5