ENVIRONMENTAL ENGINEERING LAB MANUAL

DEPARTMENT OF CIVIL ENGINEERING

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

2022-2023

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CERTIFICATE

This is to certify that this manual is a bonafide record of practical work in the **Environmental Engineering Lab** in **Second Semester of Third Year B. Tech (Civil) programme** during the academic year **2022-23**. The book is prepared by **Ms. Nanditha Mandava, Assistant Professor, Department of Civil Engineering.**

Signature of HOD Signature of Dean Academics Signature of Principal

PREFACE

This book entitled "Environmental Engineering Lab Manual" is intended for the use of sixth semester (i.e., III - II) B. Tech (civil) students of Marri Laxman Reddy Institute of Technology and Management, Dundigal, Hyderabad. The main objective of the Environmental Engineering Lab Manual is to teach the student basic Environmental Engineering fundamentals in various civil engineering applications. This book lays foundation of certain basic concepts and skills that can be repeatedly employed by the students in their future endeavours. The main aim of this book is to develop the habit of scientific reasoning and providing answers to all the doubts that arise during the course of conducting experiments. The book was written as per the new syllabus prescribed by the JNTUH university in a simple language. Some of the additional experiments apart from the syllabus also included in the book. These experiments will help the students to expertise in the analysis and reporting the water quality for drinking purpose. Hence, we hope this book serve for better understanding by the student community with all details of experiments

By,
Ms. Nanditha Mandava
Asst Professor, Department of civil engineering

ACKNOWLEDGEMENT

It was really a good experience, working at Environmental Engineering Lab. First, I would like to thank Dr. V. varalakshmi, Professor, Department of Civil Engineering, Marri Laxman Reddy Institute of technology & Management for giving the technical support in preparing the document.

I express my sincere thanks to Mr. K. Murali, Head of the Department of Civil Engineering, Marri Laxman Reddy Institute of technology & Management, for his concern towards me and gave me opportunity to prepare Concrete Technology laboratory manual.

I am deeply indebted and gratefully acknowledge the constant support and valuable patronage of Dr.Ravi Prasad, Dean Academics, Marri Laxman Reddy Institute of technology & Management. I am unboundedly grateful to him for timely corrections and scholarly guidance.

I express my hearty thanks to Dr. K. Venkateswara Reddy, Principal, Marri Laxman Reddy Institute of technology & Management, for giving me this wonderful opportunity for preparing the Concrete Technology laboratory manual.

At last, but not the least I would like to thank the entire Civil Department faculties those who had inspired and helped me to achieve my goal.

By,
Ms. Nanditha Mandava

Asst Professor, Department of civil engineering

GENERAL INSTRUCTIONS

1. Students are instructed to come to Environmental Engineering laboratory on time. Late comers are not entertained in the lab.

2. Students should be punctual to the lab. If not, conducted experiments will not be repeated.

3. Students are expected to come prepared at home with the experiments which are going to performed.

4. Students are instructed to display their identity cards and apron before entering into the lab.

5. Students are instructed not to bring mobile phones to the lab.

6. The equipment's and other accessories used in Environmental Engineering lab should be handled with care and responsibility.

7. Any damage to the equipment's during the lab session is student's responsibility and penalty or fine will be collected from the student.

8. Students should update the records and lab observation books session wise. Before leaving the lab, the student should get his lab observation book signed by the faculty.

9. Students should submit the lab records 2/3 days in advance to the concerned faculty members in the staffroom for their correction and return.

10. Students should not move around the lab during the lab session.

11. If any emergency arises, the student should take the permission from faculty member concerned in written format.

12. The faculty members may suspend any student from the lab session on disciplinary grounds.

SAFETY PRECAUTIONS

1. While working in the laboratory suitable precautions should be observed to prevent accidents.

2. Always follow the experimental instructions strictly.

3. Use the first aid box in case of any accident/mishap.

4. Never work in the laboratory unless a demonstrator or teaching assistant in present.

5. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

INSTITUTION VISION AND MISSION

VISION

To establish as an ideal academic institution in the service of the nation, the world and the humanity by graduating talented engineers to be ethically strong, globally competent by conducting high quality research, developing breakthrough technologies, and disseminating and preserving technical knowledge.

OUR MISSION

To fulfil the promised vision through the following strategic characteristics and aspirations:

- Contemporary and rigorous educational experiences that develop the engineers and managers.
- An atmosphere that facilitates personal commitment to the educational success of students in an environment that values diversity and community.
- Prudent and accountable resource management.
- Undergraduate programs that integrate global awareness, communication skills and team building.
- Leadership and service to meet society's needs.
- Education and research partnerships with colleges, universities, and industries to graduate.
- Education and training that prepares students for interdisciplinary engineering research and advanced problem-solving abilities.
- Highly successful alumni who contribute to the profession in the global society.

DEPARTMENT VISION, MISSION, PROGRAMME EDUCATIONAL OBJECTIVES AND SPECIFIC OUTCOMES

VISION

The Civil Engineering department strives to impart quality education by extracting the innovative skills of students and to face the challenges in latest technological advancements and to serve the society.

MISSION

Provide quality education and to motivate students towards professionalism

Address the advanced technologies in research and industrial issues

PROGRAMME EDUCATIONAL OBJECTIVES

The Programme Educational Objectives (PEOs) that are formulated for the civil engineering programme are listed below;

PEO-I solving civil engineering problems in different circumstances PEO-II Pursue higher education and research for professional development.

PEO-III Inculcate qualities of leadership for technology innovation and entrepreneurship.

PROGRAM SPECIFIC OUUTCOMES

PSO1. UNDERSTANDING: Graduates will have an ability to describe, analyze, and solve problems using mathematics and systematic problem-solving techniques.

PSO2. ANALYTICAL SKILLS: Graduates will have an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

PSO3. BROADNESS: Graduates will have a broad education necessary to understand the impact of engineering solutions in a global, economic, and societal context.

PROGRAMME OUT COMES

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE STRUCTURE, OBJECTIVES & OUTCOMES

COURSE STRUCTURE

Concrete Technology lab will have a continuous evaluation during 6th semester for 30 sessional marks and 70 end semester examination marks.

Out of the 30 marks for internal evaluation, day-to-day work in the laboratory shall be evaluated for 15 marks and internal practical examination shall be evaluated for 15 marks conducted by the laboratory teacher concerned.

The end semester examination shall be conducted with an external examiner and internal examiner. The external examiner shall be appointed by the principal / Chief Controller of examinations

COURSE OBJECTIVE

1. Perform the experiments to determine water and waste water quality
2. Understand the water &waste water sampling, their quality standards
3. Estimate quality of water, waste water, Industrial water

COURSE OUTCOME

CO	Course outcome
CE 326.1	Analyse the physical parameters of water for drinking
CE 326.2	Analyse the major elements of water for drinking
CE 326.3	Analyse the minor elements of water for drinking
CE 326.4	Analyse the waste water for different purposes of recycle
CE 326.5	Analyse the biological parameters of water for drinking

COURSE ARTICULATION MATRIX (CO - PO / PSO MAPPING):

Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2	PSO 3
CE 326.1	3	3	2	3	1	1	1	0	0	0	0	3	3	2	2
CE 326.2	3	3	2	3	1	1	1	0	0	0	0	3	3	2	2
CE 326.3	3	3	2	3	1	1	1	0	0	0	0	3	3	2	2
CE 326.4	3	3	2	3	1	1	1	0	0	0	0	3	3	2	2
CE 326.5	3	3	2	3	1	1	1	0	0	0	0	3	3	2	2
Total	15	15	10	15	5	5	5	0	0	0	0	15	15	10	10
Average	3	3	2	3	1	1	1	0	0	0	0	3	3	2	2

List of Experiments

1. Determination of pH
2. Determination of Electrical Conductivity
3. Determination of Total Solids (Organic and inorganic)
4. Determination of Acidity
5. Determination of Alkalinity
6. Determination of Hardness (Total, Calcium and Magnesium Hardness)
7. Determination of Chlorides
8. Determination of optimum coagulant Dosage
9. Determination of Dissolved Oxygen (Winkler Method)
10. Determination of COD
11. Determination of BOD/DO
12. Determination of Residual Chlorine
13. Total count No.
14. Noise level measurement

EXPERIMENTS LEARNING OUTCOMES

1. Determination of pH and Turbidity

Learning Objectives:
To learn about:

• pH of water • use of pH stripes • use of pH meter • significance of pH in Environmental Engineering practice	• Turbidity of water • Measurement of turbidity • Use of Nephelo turbidity meter • Significance of turbidity measurement in EE practice

Outcomes
By the end of this experiment, students should be able to know:

- The pH of any water sample by using pH stripes and use of pH meter
- The turbidity of any water sample byusing Nephelo turbidity meter
- The character of water sample and whether it is useful for the drinking purposes or not According to BIS.
- Knowledge of the turbidity variation in raw water supplies.
- The optimum dosage of coagulants to treat the domestic and industrial wastes

2. Determination of Conductivity and Total dissolved solids

Learning Objectives:
To learn about:

• Electrical Conductivity • Dissolved salts/solids • Salinity • Estimation of TDS • Relation between EC & TDS	• Total Dissolved Solids • Determination of TDS • Use of Filter paper, Desiccator • Significance of TDS

Outcomes

By the end of this experiment, students should be able to know:

- Construct simple electrical circuits to test the conductivity of liquids and solids
- Predict if a material is a good conductor and test their hypothesis
- Rank/group materials according to their conductivity.
- Assess the source of pollution. Salinity and TDS can be estimated very quickly from conductivity.
- In coastal regions, the extent of intrusion of sea water into ground water
- The suitability of water and waste water for disposal on land and suitable for irrigation depending on soils and climatic characteristics.

- Useful to determine whether the water is suitable for drinking purpose, agriculture and industrial processes.

3. Determination of Acidity & Alkalinity

Learning Objectives:

To learn about:

• Acidity of water	• Alkalinity of water
• Causes for acidity of water • Neutralizing acidity • Determination of Acidity • Mineral Acidity • CO_2 Acidity	• Causes for alkalinity • Neutralizing alkalinity • Determination of alkalinity • Significance of alkalinity in EE practice

Outcomes

By the end of this experiment, students should be able to know:

- The character of water sample and whether it is useful for the drinking purposes or not According to BIS.
- Waters having acidity more that cannot be used in R.C.C. works and aquatic life.
- Water contains which type of acidity.
- Wastewater subjected to biological treatment or direct discharge into water courses or sewers.
- Imparts taste to water.
- Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduces crop yields.

4. Determination of Chlorides

Learning Objectives:

To learn about:

• Chlorides in water • Significance of chlorides	• Testing of chlorides • Removal of chlorides

Outcomes

By the end of this experiment, students should be able to know:

- The character of water sample and whether it is useful for the drinking purposes or not According to BIS.
- The selection of water supplies for human use.
- Determining the type of desalting apparatus to be used.
- Control pumping of ground water from locations where intrusion of sea water is a problem.

5. Determination of Iron

Learning Objectives:

To learn about:

• Iron in drinking water • Effects of iron in water • Significance of iron	• Testing for iron • Removal of iron • Permissible limit

Outcomes

By the end of this experiment, students should be able to know:

- The character of water sample and whether it is useful for the drinking purposes or not According to BIS.
- Consumption of drinking water with a high concentration of iron can lead to liver diseases.
- Determining the suitability of water for domestic and industrial purpose.
- Determines the type of treatment unit used, as well as the amount of organic matter present in the water.

6. Determination of Dissolved Oxygen

Learning Objectives:

To learn about:

• Dissolved oxygen in water • Significance of DO in water	• Testing for DO • Significance of the test for DO

Outcomes

By the end of this experiment, students should be able to know:

- D.O. levels to assess quality of raw water and to keep a check on stream pollution.
- Evaluate organic pollution potential of a waste.
- The nature of biochemical reactions whether aerobic, anaerobic and anoxic

7. Determination of Nitrates

Learning Objectives:

To learn about:

• Nitrates in water • Reaction type	• Nitrites in water • Significance of the test for Nitrates

Outcomes

By the end of this experiment, students should be able to know:

- The character of water sample and whether it is useful for the drinking purposes or not According to BIS.
- Concentration of nitrate and form of nitrate.
- Reduction of nitrate is generally an anaerobic respiration.

8. Determination of Optimum Dose Of Coagulant

Learning Objectives:

To learn about:

• Removal of turbidity • Coagulation • Flocculation	• Coagulants • Sedimentation • Use of Jar test apparatus

Outcomes

By the end of this experiment, students should be able to know:

- Estimate optimum dosage of coagulant.
- Various types of natural coagulants.
- Water sample is useful for the drinking purposes or not.

9. Determination of Chlorine Demand.

Learning Objectives:

To learn about:

• Chlorination • Residual Chlorine	• Purpose of residual chlorine • Testing of residual chlorine

Outcomes

By the end of this experiment, students should be able to know:

- Control Chlorination of domestic and industrial waste waters.
- Disinfection practice to control addition of chlorine.
- The source of contamination or leakage points so as to supply wholesome water to the consumer.
- Active chlorine determined at each stage in the processing of drinking water and in the water mains in order to guarantee bacteriological impeccable water.
- Range of Active chlorine should be present in drinking water.

10. Determination of Total Phosphorous

Learning Objectives:

To learn about:

• Spectrophotometer • Polyphosphate	• Measurement of Total Phosphorous • organic phosphate

Outcomes
By the end of this experiment, students should be able to know:

- The operation of Spectrophotometer equipment.
- Standard calibration curve for Total Phosphorous.
- Concentration of Total Phosphorous in domestic and industrial waste waters.
- Control Phosphorous in domestic and industrial waste waters.

11. Determination of B.O.D

Learning Objectives:
To learn about:

• Biochemical Oxygen Demand • Significance of BOD	• Measurement of BOD • Removal of BOD

Outcomes
By the end of this experiment, students should be able to:

- Determine strength of domestic and industrial sewage.
- Studies to measure the self purification capacity of streams and serves regulatory authorities as a means of checking on the quality of effluents discharged to such waters.
- Useful in the design of treatment facilities.
- The choice of treatment method and size of certain units, particularly trickling filters and activated sludge units.
- Evaluate the efficiency of various treatment units.
- Estimate population equivalent of any industrial wastes for purification industrial wastes in municipal sewage treatment plant.
- Parameter to give an idea of the bio-degradability of any sample and self purification capacity of rivers and streams.

12. Determination of C.O.D

Learning Objectives:
To learn about:

• Chemical oxygen demand • significance	• measurement of COD • removal of COD

Outcomes
By the end of this experiment, students should be able to know:

- The analysis of industrial wastes.
- Determination and control losses to sewer systems.
- Operation of treatment facilities.
- Assess strength of wastes which contain toxins and biologically resistant organic substances.

13. Presumptive coli form test

Learning Objectives:
To learn about:

• bacteriological examination of water • pathogens variation in count • Most Probable Number	• E. coli. • bacteriological examination of milk

Outcomes
By the end of this experiment, students should be able to know:

- Determination of coliforms in food products.
- Concentration of carbohydrates.
- Bacterial variation in count.

14. Determination of Sulphates

Learning Objectives:
To learn about:

• sulpahtes of water • spectrophotometer mesaurement	• Causes for sulphates • Significance of alkalinity in EE practice

Outcomes
By the end of this experiment, students should be able to know:

- The character of water sample and whether it is useful for the drinking purposes or not According to BIS.
- Wastewater subjected to biological treatment or direct discharge into water courses or sewers.

15. Determination of Flourides

Learning Objectives:
To learn about:

• Flouride concentration • significance	• measurement of flouride • removal of flouride

Outcomes
By the end of this experiment, students should be able to know:

- Determination of fluoride level in water
- Operation of treatment facilities.

16. Determination of Colour

Learning Objectives:

To learn about:

• Chemical oxygen demand	• measurement of COD
• significance	• removal of COD

Outcomes

By the end of this experiment, students should be able to know:

- To perform colour tests on a given set of water samples
- Assess the presence of metals, organic acids, microbiological matter and/or industrial wastes.

ACCORNYMS AND ABBREVATIONS

BIS	Bureau Of Indian Standards
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EC	Electrical Conductivity
EPA	Environmental Protection Agency
floc	Flocculation
JTU	Jackson Turbidity Unit
M	Molality
mg/l	Milligrams Per Liter
mL	Milli Liter
N	Normality
NOM	Natural Organic Matter
NTU	Nephelometric Turbidity Unit
pH	Hydrogen Ion Activity; Acidity/Alkalinity Continuum
ppm	Parts Per Million
rpm	Rotations per minute
UV	Ultra Violet
TDS:	Total Dissolved Solids
TSS:	Total Suspended Solids
TOC	Total Organic Content
µS/cm	Micro Siemens per centimeter

MEASUREMENT CONVERSIONS

Length or Distance

1 foot = 0.30 metres
1 m = 3.28 feet
1 inch = 25.4 mm
1 inch = 2.54 cm
1 cm = 0.39 inches
1 cm = 10 mm
1 mm = 0.1 cm
1 mm = 1,000 µm
1 µm = 0.001 mm

Volume

1 gallon = 3.78 L
1 L = 0.26 gallons
1 L = 33.8 fluid oz (US)
1 L = 1,000 mL
1 mL = 0.001 L

Weight

1 kg = 1,000 g
1 g = 0.001 kg
1 g = 1,000 mg
1 mg = 0.001 g
1 mg = 1,000µg
1 µg = 0.001mg

Concentration

1 ppm = 1 mg/L = 1/1 million = 0.000001

1 ppb =1µg/L = 1/1billion = 0.000000001

To convert ppb to ppm divide by 1,000

To convert ppm to ppb multiply by 1,000

To convert µg/L to mg/L divide by 1,000

To convert mg/L to µg/L multiply by 1,000

INTRODUCTION

AIM

To study the sampling and preservation methods in water and waste water characterization and to learn the significance of characterization of water and waste water

SAMPLING PROGRAMME AND PROCEDURES

The collection of a representative sample is the most important function of an environmentalist. The interpretation of results and recommendation for prevention and corrective treatment are all based on the analysis report. Scrupulous care in the collection of samples is therefore necessary to ensure that the sample is representative of the body of water under examination and to avoid spoilage and accidental contamination of the sample during collection and transport.

METHODS OF SAMPLING

Three types of samples are often collected depending on situations

a. Grab Samples

Grab samples are samples collected at a designated place at a particular time. They represent the composition at the time and space. When a source is known to vary in time, as in the case of waste effluents, grab samples collected at various time intervals and analysed separately can be of greater value.

b. Composite samples

Composite samples are a mixture of grab samples collected at one sampling point at different times. Individual samples are collected in wide mouth bottles every hour and mixed in volume proportional to the flow. The composite values are useful for observing average values.

c. Integrated samples

Integrated samples are a mixture of grab samples collected from different points simultaneously and mixed in equal volumes. Individual samples are collected from both banks of a river and at varying depths to represent available situations.

SAMPLING AND PRESERVATION REQUIREMENTS

1. PHYSICAL AND CHEMICAL REQUIREMENTS

For general physical and chenica1 examination, the sample should be collected in a chemically clean bottle made of good quality glass fitted with a ground glass stopper or a chemically inert polyethylene container. The volume of sample to be collected would depend on the selection of tests; however, for general examination 3.0 litre sample would be sufficient, The following precautions must be taken while collecting the sample

i. The sampling location is representative of the water body
ii. The place is devoid of floating material

Where ever possible the sample should be collected 15cm, below the surface or as the situation warrants

No physical activity is permitted upstream of sampling point Shorter the time between collection and examination, the reliable will be the analytical results. For certain constituents and physical values, immediate analysis in the field is required, because, the composition of water may change before it arrives at the laboratory.

The maximum limits of storage are:

Unpolluted water: 72 hours

Slightly polluted. : 48 hours

Grossly polluted: 1 2hours

Some determinations are more likely to be affected by storage than others. Temperature may change, pH may change significantly, and dissolved gases may be evolved and lost (O2, CO2. and H2S)

Frequency of sampling:
Frequency depends on objectives. Yet, collection of samples of both raw and treated waters should be carried out as frequently as possible and at least once in every three months. Some waters undergo more pronounced seasonal variation and therefore require more frequent testing. Samples from treatment units should be collected and analyses frequently, at least one from each unit daily.

2. BIOLOGICAL REQUIREMENTS

In general the samples for biological examination are collected in wide mouth, clean glass bottles of 2.0 litre capacity. They are never filled completely. This method is employed when total microscopic count is the aim. In some specific cases the concentrate of a sample may be collected through plankton nets made of bolting silk cloth, or the. sample filtered through Sedge wick Rafter funnels.

In general the sample must be examined microscopically within one hour of collections. If the facilities do not permit an immediate examination, it should be preserved after collection by addition of 2 ml neutralized (pH 7.0) formaline to each 100 ml of the sample.

There is no practice about the frequency of sampling but the examination should be made regularly, or else as the situation demands. Benthos study is complex, Collection through cages placed at proper preselected sites for a defined period of time is recommended.

TABLE 1: Summary of special sampling and handling requirements

S.No	Parameter	Container	Preservation	Maximum Storage	
				Recommended	Regulatory
1	Acidity	PG	Refrigerate	24h	14d
2	Alkalinity	PG	Refrigerate	24h	14d
3	BOD	PG	Refrigerate	6h	48h
4	COD	PG	Analyse as soon as possible	7d	28d
5	Chloride	PG	-	-	28d
6	Residual Chlorine	PG	Analyse as soon as possible	0.25h	-
7	Color	PG	Refrigerate	48h	48h
8	Specific conductance	PG	Refrigerate	28d	28d
9	Fluoride	PG	-	28d	28d
10	Nitrate	PG	Analyse as soon as possible	48h	48h
11	pH	PG	Analyse as soon as possible	0.25h	0.25h
12	Turbidity	PG	Analyse same day	24h	48h

SIGNIFICANCE OF CHARACTERISATION OF VARIOUS PARAMETERS

Natural waters are never completely pure. During their precipitation and passage over or through ground they require a wide variety of dissolved and suspended impurities. The

concentrations of these impurities are seldom large in ordinary chemical sense but they modify the chemical behaviour of water or its usefulness.

The waste waters generally have values far higher than in waters.

Some of these impurities are toxic, some may affect health, and some affect the portability while others indicate pollution.

A list of such impurities is given below:

TABLE 2: Water quality parameters and drinking water standards

S.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.	Aluminium	mg/l	**0.03**	**0.2**
33.	Boron	mg/l	**1**	**5**

Table 3: Different Analytical Water Quality Parameters Used For Testing Of Quality Of Water And Their Source Of Occurrence And Potential Health Effects With USEPA Guidelines

S.NO	PARAMETER	SOURCE OF OCCURENCE	POTENTIAL HEALTH EFFECT
1	Turbidity	Soil runoff	Higher level of turbidity are associated with disease causing bacteria
2	Color	Due to presence of dissolved salts	
3	Odor	Due to biological degradation	Bad odor unpleasant
4	Electrical conductivity		Conductivity due to ionizable ions. High conductivity increases corrosive nature of water
5	pH	pH is changed due to different dissolved gases and solids.	Affects mucus membrane bitter taste corrosion
6	Dissolved Oxygen	Presence due to dissolved oxygen	D. O. corrode water lines, boilers and heat exchangers, at low level marine animals cannot survive
7	Total hardness	Presence of calcium (Ca_2^+) and magnesium (Mg_2^+) ions in a water supply**.** It is expressed. Hardness minerals exist to some degree in every water supply.	Poor lathering with soap; deterioration of the quality of clothes; scale forming
8	Total Alkalinity	Due to dissolved gases (CO_2)	Embrittlement of boiler steel. Boiled rice turns yellowish
9	TDS	Presence all dissolved salts	Undesirable taste; gastro-intestinal irritation; corrosion or incrustation
10	Calcium	Precipitate soaps, anionic	Interference in dyeing, textile, paper industry etc.
11	Magnesium	surfactants, anionic emulsifiers,	
12	Ammonia	Due to dissolved gases and degradation of organics	Corrosion of Cu and Zn alloys by formation of complex ions.

13	Barium	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	Increase in blood pressure
14	Biochemical Oxygen Demand (BOD)	Organic material contamination in water	High BOD decreases level of dissolved oxygen.
15	Carbonate	Due to dissolution of CO2	Product imbalance Unsatisfactory Production Short product life
16	Chloride	Water additive used to control microbes, disinfect.	Eye/nose irritation; stomach discomfort. Increase corrosive character of water.
17	Nitrate	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits	Effect on Infants below the age of six months Symptoms include shortness of breath and blue-baby syndrome.
18	Phosphate		stimulate microbial growth, Rancidity Mold growth
19	Sodium	Natural component of water	
20	Sulphate	Due to dissolved Ca/Mg/Fe sulphates	Taste affected; gastro-intestinal irritation. Calcium sulphate scale.

Table 4: Water Quality Parameters And Drinking Water Standards

S.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**

HARDNESS

The study of hardness is important from the point of view of industrial utilization of water especially in boilers, where scales are formed. Hardness in municipal supplies increases the consumption of soap, fuel, tea leaves etc. in the household and renders it unsuitable for use in air-conditioning.

TURBIDITY

It is a measure of degree of opaqueness of water and interference presented by suspended matter to the passage of light. The turbidity is due to clay, silt, finely divided organic matter and microscopic organisms. Turbidity tests are important from aesthetic consideration and from the point of economics of treatment. The most important health significance of turbidity is that may, harbour pathogenic organisms.

pH

Determinations of pH, alkalinity and its forms, along with acidity are of interest in coagulation, softening and corrosion control

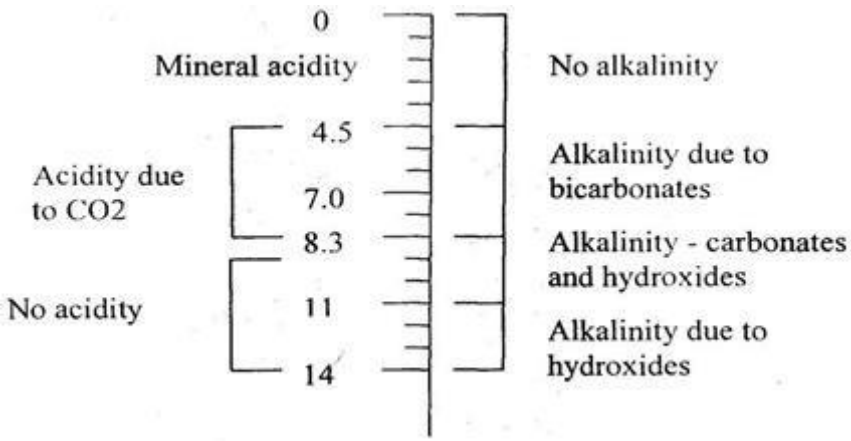


Fig 1.0: pH Scale

RESIDUE OR SOLID MATTER

The test for residue is of very great importance in sewage treatment processes to indicate the physical state of the principal constituents. The ratio of the weight of suspended solids to turbidity often referred as coefficient of fineness. The solids present in dissolved form are related to the electrical conductivity. The fixed solids indicate the mineral level while volatile solids are related to organic matter.

CHLORIDE

Concentration of chlorides in municipal sewage is often significantly (15-50 mg/L) higher than those in its water supply. For this reason, a change in its concentration may be indicative of sewage pollution, in waters of low chloride concentration. Chlorides occur in an all natural waters in widely varying amounts. Mountain streams are normally low in chloride values. Chloride gain access to water either because of

EXPERIMENT 1

DETERMINATION OF pH

AIM

To determine the pH value of water.

APPARATUS

1. pH meter with combined electrode
2. beakers

CHEMICALS REQUIRED

Buffer tablet of pH values 4.01,7.0 and 9.2

REAGENTS PREPARATION

i. Buffer Solution of pH 4.0

1. Take 100 mL standard measuring flask and place a funnel over it.
2. Using the forceps carefully transfer one buffer tablet of pH 4.0 to the funnel.
3. Add little amount of distilled water, crush the tablet and dissolved it.
4. Make up the volume to 100 mL using distilled water.

ii. Buffer Solution of pH 7.0

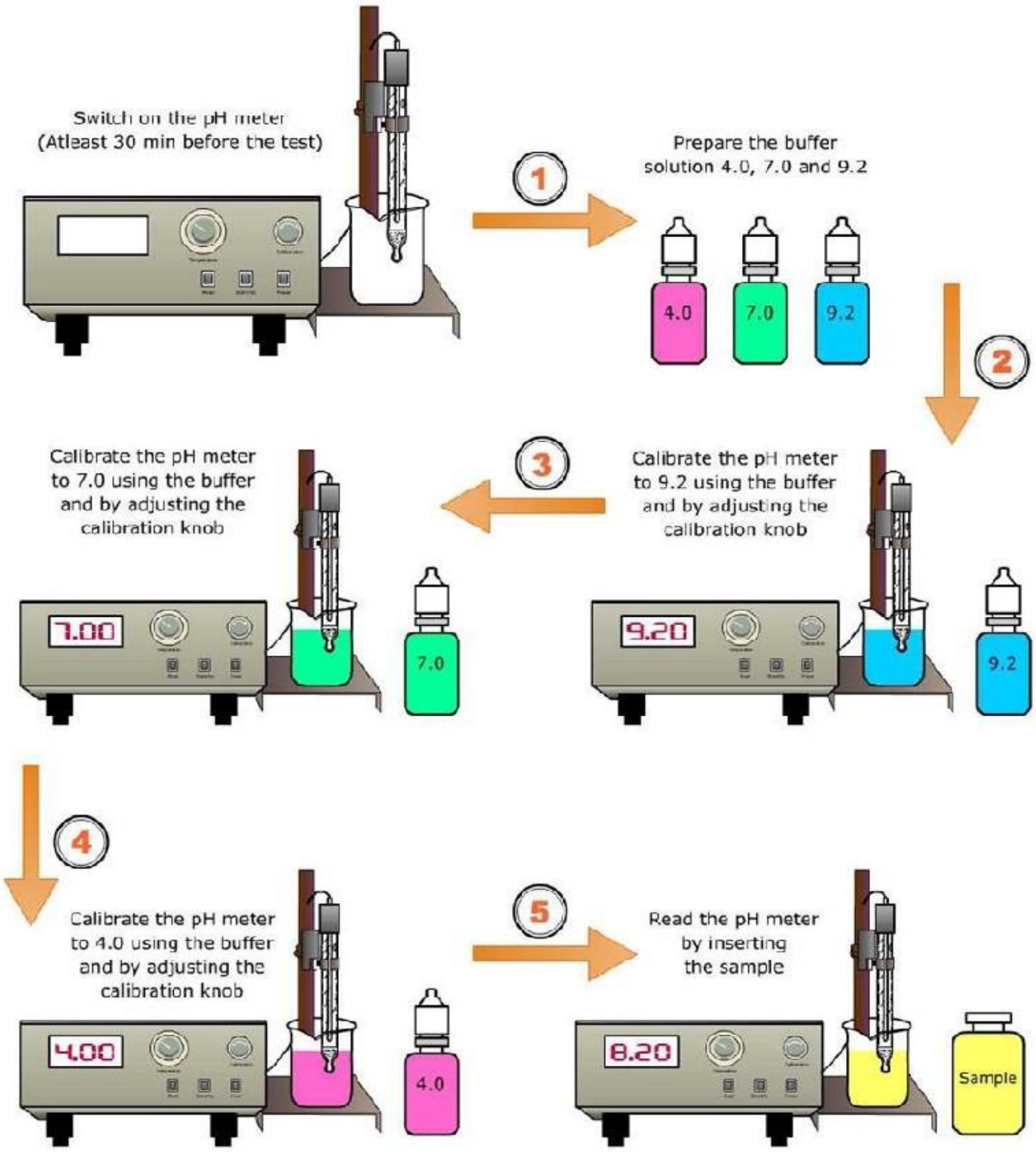
1. Take 100 mL standard measuring flask and place a funnel over it.
2. Using the forceps carefully transfer one buffer tablet of pH 7.0 to the funnel.
3. Add little amount of distilled water, crush the tablet and dissolved it.
4. Make up the volume to 100 mL using distilled water.

iii. Buffer Solution of pH 9.2

1. Take 100 mL standard measuring flask and place a funnel over it.
2. Using the forceps carefully transfer one Buffer tablet of pH 9.2 to the funnel.
3. Add little amount of distilled water, crush the tablet and dissolved it.
4. Make up the volume to 100 mL using distilled water.

PROCEDURE

1. Switch the pH meter 30min before the test.
2. Prepare the buffer solution 4.0, 7.0 and 9.2.
3. Calibrate the pH meter to 9.2 using the buffer and by adjusting the calibration knob.
4. Calibrate the pH meter to 7.0 using the buffer and by adjusting the calibration knob.
5. Calibrate the pH meter to 4.0 using the buffer and by adjusting the calibration knob.
6. Read the pH meter by inserting the sample.



CALIBRATING THE INSTRUMENT

Using the buffer solutions calibrate the instrument.

Step 1 In a 100ml beaker take pH 9.2 buffer solution and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 9.2, using the calibration knob adjust the reading to 9.2. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 2 In a 100ml beaker take pH 7.0 buffer solution and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 7.0, using the calibration knob adjust the reading to 7.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 3 In a 100ml beaker take pH 4.0 buffer solution and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 4.0, using the calibration knob adjust the reading to 4.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.
Now the instrument is calibrated.

TESTING OF SAMPLE

1. In a clean dry 100 mL beaker take the water sample and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well.
2. Now place the electrode in the beaker containing the water sample and check for the reading in the pH meter. Wait until you get a stable reading.

Take the electrode from the water sample, wash it with distilled water and then wipe gently with soft tissue.

ENVIRONMENTAL SIGNIFICANCE

1. pH (6.5 to 8.5) has no direct effect on health
2. However, a lower value below 4 will produce sour taste
3. Higher value above 8.5 a bitter taste.
4. Higher values of pH have scale formation in water heating operators and also reduce the germicidal potential of chlorine.
5. High pH induces the formation of trihalomethanes which are causing cancer in human beings.
6. pH below 6.5 starts corrosion in pipes, thereby releasing toxic metals such as zinc, lead, cadmium & copper etc.,
7. According to BIS water for domestic consumption should have pH between 6.5 to 8.5
8. A pH less than 7 is acidic
9. A pH of 7 is neutral
10. A pH greater than 7 is basic

CALCULATIONS

The pH value is obtained directly from the instrument.

S.NO	Sample Name	Observed P^H Value
1		
2		
3		
4		
5		

RESULT AND REPORT

The pH of given water sample-1 is = _____

The pH of given water sample-2 is = _____

The pH of given water sample-3 is = _____

The pH of given water sample-4 is = _____

The pH of given water sample-5 is = _____

INTERPRETATION OF RESULTS

The sample- 1 water contains_____nature and will produce _____effect. It requires_____treatment.

The sample- 2 water contains_____nature and will produce _____effect. It requires_____treatment.

The sample- 3 water contains_____nature and will produce _____effect. It requires_____treatment.

The sample- 4 water contains_____nature and will produce _____effect. It requires_____treatment.

The sample- 5 water contains_____nature and will produce _____effect. It requires_____treatment.

VIVA

1. pH is defined as

a. Logarithm of Hydrogen ions
b. Negative logarithm of Hydrogen ions
c. Hydrogen ion concentration
d. OH ion concentration

2. pH of neutral water is

a. less than7
b. more than 7
c. 7.0
d. 0.0 3.

3. For pure water at 25°C, the product of H+ and OH– ions is

a) 10–7
b) 10–14
c) 10
d) 10 7

4. The acceptable value of pH of potable water is

a) 7.0 to 8.5
b) 6.5 to 9.5
c) 6 to 8.5
d) 6.5 to 10

5. Acidity of water means

a) pH of water in acidic range
b) base neutralizing capacity of water
c) pH of water in alkaline range
d) acid neutralizing capacity of water

6. The alum is most effective as a coagulant in the pH range of

a) 6.5 to 8.5
b) 6 to 9.0
c) 6.5 to 9.5
d) 7.0 to 7.5 6

7. For the aerobic decomposition of organic matter the pH should not go below

a) 5.0
b) 6.0
c) 7.0
d) 9.0

8. Following indicator is used for pH determination of water between 4 to 11 pH

a) Phenolphthalein
b) Methyl orange
c) Universal Indicator
d) Bromthymol Indicator

9. 9. The measurement of pH made by determining the e.m.f of the .

a) cell constant

b) solution
c) electrode cell
d) calomel electrode

10. The turbidity is measured based on the

a) Light absorbing properties

b) Light Scattering properties

c) Particle Size

d) Particle mass

11. In a Nephelo turbidity meter the light detectors are at

a) 180°

b) 360°

c) 90° d) 270°

12. What is the unit of turbidity?

a) TU

b) MTU

c) NTU

d) IU

13. What is the light source for the Nephelo turbidity meter?

a) Tungsten filament lamp

b) Deuterium lamp

c) Hallow Cathode lamp

d) Sodium vapour lamp

14. The standard unit of turbidity is considered as that produced by

a) 2ppm of silica in distilled water

b) 1ppm of silica in distilled water

c) 4ppm of silica in distilled water

d) 9ppm of silica in distilled water

15. The material used in the standard solution for nephelometer is .

a) Silica

b) Clay

c) Formazine

d) Barium Chloride

16. Mixture of hydrazine sulphate and hexamethylenetetramine solution is allowed to stand for
a) 24 hours

b) 12 hours

c) Minimum 6 hours

d) No specific time

17. What are three of the factors (suspended and colloidal solids) that cause an increase in turbidity?

a) Sediments

b) phytoplankton

c)finely divided organic and inorganic matter

d)all of the above

18. If you intake to much turbidity, you can get

a) Malaria

b) Cholera

c) Digestive Diseas

d)all of the above

KEY 1 b 2 c 3 b 4 a 5c 6a 7 a 8 c 9c 10b 11c 12c 13a 14b 15c 16a 17d 18d

EXPERIMENT 2

DETERMINATION OF ELECTRICAL CONDUCTIVITY

AIM

To determine the conductivity of given water sample.

APPARATUS REQUIRED

1. Conductivity Meter with Electrode
2. ATC probe
3. Standard flask
4. Measuring jar
5. Beaker 250 ml
6. Funnel
7. Tissue Paper

CHEMICALS REQUIRED

Potassium Chloride

CHEMICALS REQUIRED

Potassium Chloride

PREPARATION OF REAGENTS

i. Potassium Chloride Solution (0.1N)

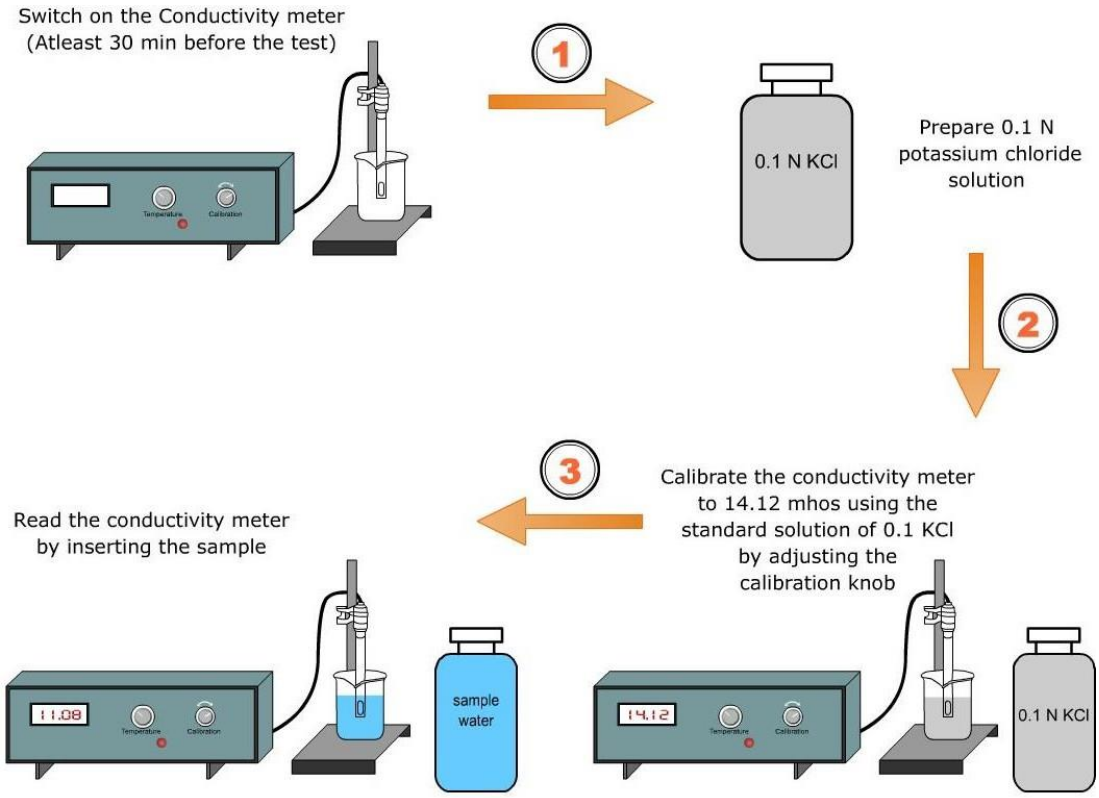
1. Switch on the Electronic balance, keep the weighing pan, set the reading to zero.
2. Measure 50 mL of distilled water and transfer it to the beaker.
3. Weigh 0.7456g of Potassium chloride.
4. Transfer the 0.7456g of potassium chloride to the beaker contains distilled water and mix it by the glass rod until it dissolves thoroughly.
5. Transfer the contents to the 100ml standard flask.
6. Make up the volume to 100ml, by adding distilled water and shake the contents well. This solution is used to calibrate the conductivity meter.

PROCEDURE

Calibration of Conductivity Meter

calibrate the instrument at the same temperature as the solution is being measured. Calibration of Conductivity Meter Take 0.1N Potassium Chloride in a beaker. Switch on the magnetic stirrer and place the beaker on the stirrer. Insert the magnetic bead in the beaker. Place the electrode inside the solution. Select the calibration button and using up and down key adjusts the conductivity of the 0.1N potassium chloride solution to 14.12 milli Siemens / cm at 30^{o}c.Now the meter is ready for the measurement of samples.

PROCEDURE CHART



Testing Of Water Sample

1. Rinse the electrode thoroughly with de ionized water and carefully wipe with a tissue paper.
2. Measure 200 mL of water sample and transfer it to a beaker and place it on the magnetic stirrer.
3. Dip the electrode into the sample solution taken in a beaker and wait for a steady reading. Make sure that the instrument is giving stable reading.
4. Note down the reading in the display directly, which is expressed in milli Siemens.

TOTAL DISSOLVED SOLIDS

Total Dissolved Solids (TDS) 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:

$$\text{TDS (mg/l)} = \text{cell constant} \times \text{EC } (\mu S/cm)$$

CALCULATIONS

The EC value is obtained directly from the instrument.

S.NO	Sample Name	Observed EC Value
1		
2		
3		
4		
5		

RESULT AND REPORT

The EC of given water sample-1 is = _____

The EC of given water sample-2 is = _____

The EC of given water sample-3 is = _____

The EC of given water sample-4 is = _____

The EC of given water sample-5 is = _____

VIVA

1. The unit of conductance is
   a) mho b) ohm c) ampere d) watts
2. The conductivity of standard 0.01M KCl solution is
   a) 1412 µmhos/ cm b) 1412 mmhos/ cm2
   c) 1412 µmhos/ mm d) 1412 mmhos/ mm2
3. Using a conductivity meter we can measure of the solution.
   a) Specific conductance b) Equivalent conductance
   c) Specific resistance d) Concentration
4. The Conductivity is the maximum for water.
   a) Distilled b) Deionized c) Ground d) Sea
5. The conductivity of potable water varies from
   a) 2501 to 5000 µmhos /cm b) 50 to 1500 µmhos /cm
   c) 1501 to 2000 µmhos /cm d) 2001 to 2500 µmhos /cm
6. The measurement of conductivity may lead to the estimation of .
   a) Total solids b) Total dissolved solids c) Colloidal solids d) Suspended solids
7. Freshly made distilled water has a conductivity of
   a) 2.0 to 3.0 µmhos /cm b) 0.5 to 2.0 µmhos /cm
   c) 2.5 to 4.5 µmhos /cm d) 4.5 to 5.0 µmhos /cm
8. The dissolved solids that impose BOD are .
   a) Volatile solids b) Non volatile solids c) Inorganic solids d) Total solids
9. As per IS Code the acceptable TDS value is
   a) 250 ppm b) 500 ppm c) 750 ppm d) 900 ppm
10. The Total dissolved solids (TDS) can be reduced by the following method
   a) Distillation b) Reverse osmosis
   c) Ion exchange d) All of the above
11. According to The United States Geological Survey, water having less than 1000 ml/litre of total dissolved solids is
   a) Fresh water b) Slightly saline
   c) Moderately saline d) Brine water
12. The pore size of the filter paper used for filtration is
   a) 2.0Rm or smaller b) 2.0Rm or bigger
   c) 2.0Rm d) 20.0Rm
13. The type of crucible used for the experiment is made of .
   a) Porcelain b) Clay c) Silver d) Iron
14. Total Suspended Solids are mostly responsible for
   a) Turbidity. b) Colour c) Odour d)taste
15 The chemical substance used in the desiccators is .
   a) Calcium Chloride b) Calcium Carbonate
   c) Sodium Chloride d) Sodium Hydroxide
16 Always the Total Suspended Solids value will be
   a) Less than TDS b) Greater than TDS
   c) Less than Total Solids d) Greater than Total Solids
17 The concentration of dissolved solids in water can be determined by
   a) specific conductance b) specific resistance
   c)polarization d)all of the above
18. The Settleable suspended solids with diameter 0.15 to 0.2mm are generally
   a) Inorganic b) Organic c) Algae d) Fungi
19. The conductivity of a sample depends on Temperature.
   a) Temperature b) soluble salts c) both a &b d) none
20. the minimum drinking limit of TDS is
a) 500 b) 1000 c) 250 d) not defined

KEY 1 a 2 a 3 a 4 d 5b 6b 7 b 8 a 9 b 10d 11b 12a 13a 14a 15a 16c 17a 18a 19c 20a

EXPERIMENT 3
DETERMINATION OF TOTAL SOLIDS (ORGANIC AND INORGANIC)

AIM
The aim of the experiments is to determination of suspended, volatile, fixed and settle able solids in wastewater.

APPARATUS
1. Porcelain evaporating dishes of 150–200 ml capacity
2. Steam bath
3. Drying oven
4. Desiccators
5. Analytical balance or monopan balance
6. Filter paper (preferably of glass fibre)
7. Electric muffle furnace
8. Imhoff cone

PRINCIPLE
Total solids‟ is the term applied to the material left in the vessel after evaporation of a sample of water/waste water and its subsequent drying in an oven at a definite temperature. Fixed solids is the residue remaining after ignition for 1 hour at 550°C. The solid portion that is volatilised during ignition is called volatile solids. It will be mostly organic matter. Waters that are low in organic matter and total mineral content and are intended for human consumption may be examined under 103–105°C or 179–181°C. But water containing considerable organic matter or those with pH over 9.0 should be dried at 179–181°C. In any case, the report should indicate the drying temperature. The sample is filtered and the filtrate evaporate in a weighed dish on a steam bath, the residue left after evaporation is dried to constant weight in an oven at either 103–105°C or 179–181°C. The increase in weight over that of the empty dish represents total dissolved solids and includes all materials, liquid or solid, in solution or otherwise, which passes through the filter and not volatilised during the drying process. The difference between the total solids and the total dissolved solids will give the total suspended solids. The dishes with the residue retained after completion of the tests for total solids and total dissolved solids are subjected to heat for 1 hour in a muffle furnace held at 550°C. The increase in weight over that of the ignited empty vessel represents *fixed solids* in each instance. The difference between the total dissolved/total suspended solids and the corresponding fixed solids will give *volatile solids* in each instance. All the quantities should be expressed in mg/L. Settleable matter in surface and saline waters as well as domestic and industrial wastes may be determined and reported on a volume basis as millilitre per litre.

PROCEDURE
Total solids
1. Ignite the clean evaporating dishes in the muffle furnace for 30 minutes at 550°C and cool in a desiccator.
2. Note down the empty weight of the dish (W1).
3. Pour a measured portion (10 ml) of the well-mixed sample into the dish and evaporate the contents by placing the dish on a steam bath.
4. Transfer the dish to an oven maintained at either 103–105°C or 179–181°C and dry it for 1 hour.
5. Allow the dish to cool briefly in air before placing it, while still warm in a desiccators to complete cooling in a dry atmosphere.

6. Weigh the dish as soon as it has completely cooled (W2).
7. Weight of residue = (W2 – W1) mg.
8. W2 and W1 should be expressed in mg.

Total fixed solids

1. Keep the same dish used for determining total residue in a muffle furnace for 15minutes at 550°C.
2. Allow the dish to partially cool in air until most of the heat has dissipated, then transfer to a desiccators for final cooling in a dry atmosphere.
3. Weigh the dish as soon as it has cooled (W3).
4. Weight of total fixed residue = (W3 – W1) mg.
5. W3 and W1 should be expressed in mg

Total dissolved solids

1. Filter a measured portion of the mixed sample (10 ml) through a filter paper and collect the filtrate in a previously prepared and weighed evaporating dish.
2. Repeat the steps 3 to 6 outlined in total solids procedure.
3. Weight of dissolved solids = (W5 – W4) mg.
4. W4 = Weight of empty evaporating dish in mg.
5. W5 = Weight of empty evaporating dish in mg + Residue left after evaporating the filtrate in mg.

Total suspended solids = Total solids – Total dissolved solids.

Total volatile solids = Total solids – Total fixed solids.

ENVIRONMENTAL SIGNIFICANCE OF EC AND TDS

Water containing TDS concentrations below 1000 mg/litre is usually acceptable to consumers, although acceptability may vary according to circumstances. However, the presence of high levels of TDS in water may be objectionable to consumers owing to the resulting taste and to excessive scaling in water pipes, heaters, boilers, and household appliances. Water with extremely low concentrations of TDS may also be unacceptable to consumers because of its flat, insipid taste; it is also often corrosive to water-supply systems.

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

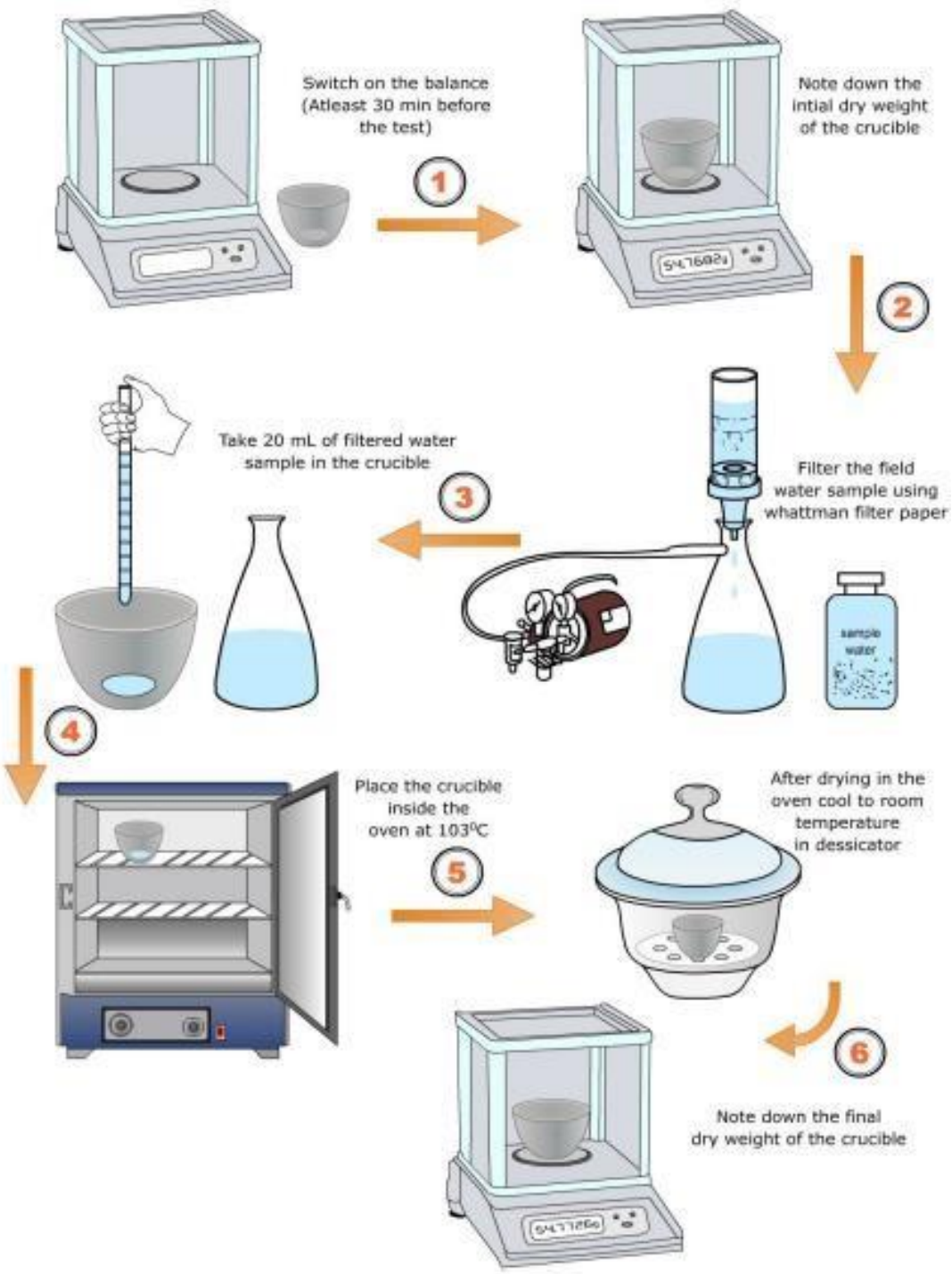
conductivity generally ranges between 10 and 1 000 µS/cm in most rivers or lakes that have outflows. Classification of water based on conductivity

Conductivity (µS/cm)	**Classification**
<600	Freshwater
600-6 000	Moderately saline
>6 000	Saline

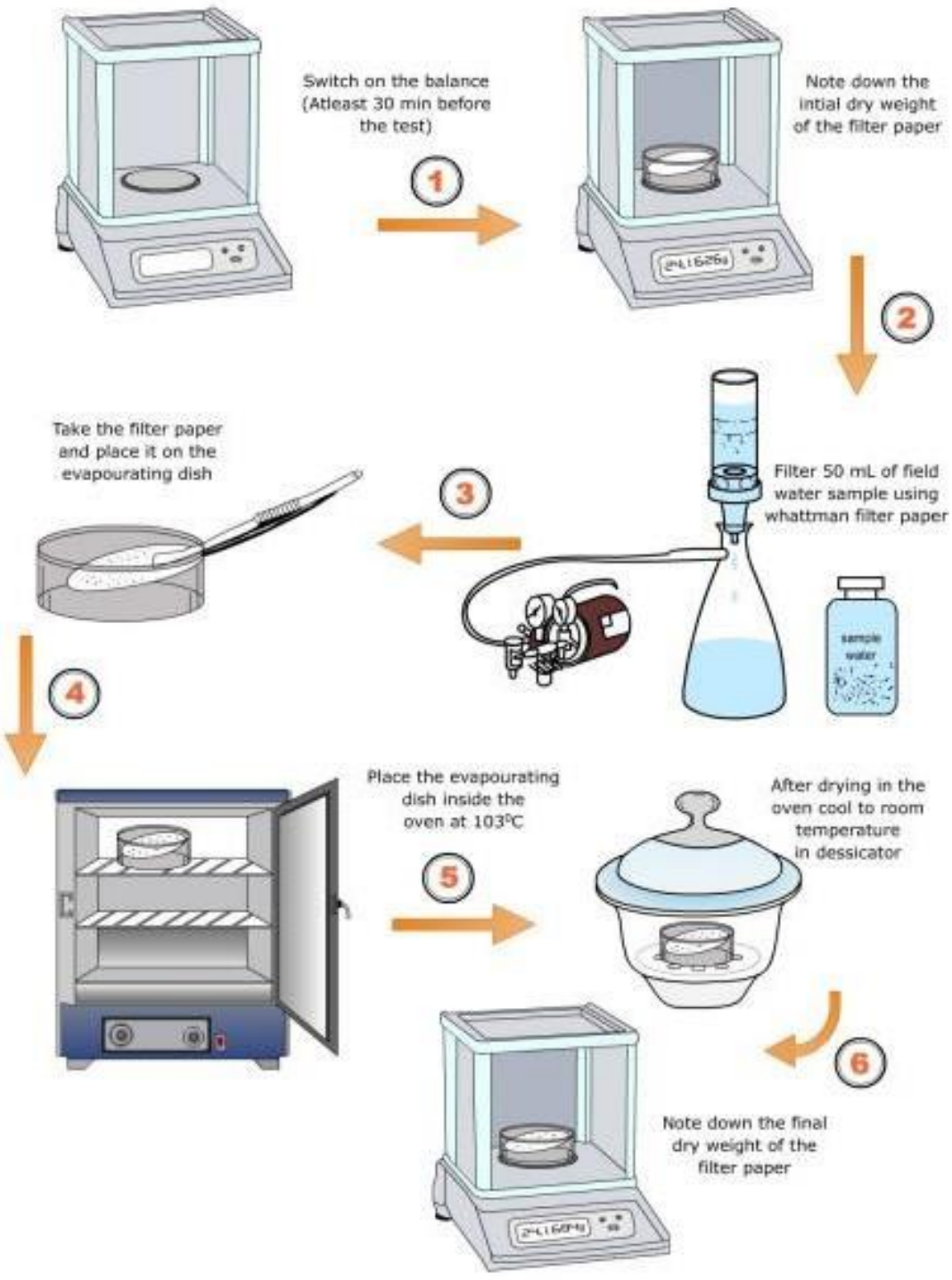
Classification of water based on conductivity

TDS (ppm)	**Classification**
>250	Excellent
250-500	Good
500-1500	Permissible

PROCEDURE CHART (TOTAL DISSOLVED SOLIDS)



PROCEDURE CHART (TOTAL SUSPENDED SOLIDS)



CALCULATIONS

Conductivity calculations

S. No	Sample name	Conductivity in µS/cm
1		
2		
3		
4		
5		

TDS calculations

S.No	Sample name	Conductivity µS/cm	TDS = Conductivity × EC Cell Constant (ppm)
1			
2			
3			
4			
5			

RESULT AND REPORT

The Conductivity of given water sample-1 is =_____µS/cm

The Conductivity of given water sample-2 is =_____µS/cm

The Conductivity of given water sample-3 is =_____µS/cm

The Conductivity of given water sample-4 is =_____µS/cm

The Conductivity of given water sample-5 is =_____µS/cm

The TDS of given water sample-1 is =_____ppm

The TDS of given water sample-2 is = _____ppm

The TDS of given water sample-3 is = _____ppm

The TDS of given water sample-4 is = _____ppm

The TDS of given water sample-5 is = _____ppm

INTERPRETATION OF RESULTS

The sample- 1 water will produce_____effect. It requires_____treatment.

The sample- 2 water will produce_____effect. It requires_____treatment.

The sample- 3 water will produce_____effect. It requires_____treatment.

The sample- 4 water will produce_____effect. It requires_____treatment.

The sample- 5 water will produce_____effect. It requires_____treatment.

VIVA

1. What is the aim of the Electrical conductivity experiment?
2. List out the apparatus required to conduct the EC experiment?
3. Name the chemical which is required for the EC experiment?
4. The water which is required to rinse the electrode is……
5. Units of Electrical Conductivity……
6. Relation between the EC and the TDS?
7. The abbreviation of TDS.
8. The units of TDS are……
9. What is the aim of the TDS experiment?
10. Name the various apparatus required to conduct the TDS experiment?
11. Total solids = …….
12. Total suspended solids = …….
13. TDS = …….
14. Water containing TDS concentration below..... is usually acceptable.
15. High levels of TDS in water is..... By the consumers.
16. High levels of TDS cause excessive scaling in …….
17. Water with extremely low TDS is..... by the consumers.
18. Conductivity ranges between ……. in most rivers or lakes that have outflows.
19. If the conductivity is less than 600 then the water is called as…….
20. The conductivity lies in between 600 – 6000 is called as……

EXPERIMENT 4

DETERMINATION OF ACIDITY

AIM

To determine the acidity of given water sample with the stipulations.

INTRODUCTION

1. Acidity is a measure of the capacity of water to neutralize bases.
2. Acidity is the sum of all titrable acid present in the water sample.
3. Strong mineral acids, weak acids such as carbonic acid, acetic acid present in the water sample contributes to acidity of the water.
4. Usually dissolved carbon dioxide (CO2) is the major acidic component present in the unpolluted surface waters.
5. The volume of standard alkali required to titrate a specific volume of the sample to pH 8.3 is called phenolphthalein acidity (Total Acidity).
6. The volume of standard alkali required to titrate a specific volume of the water sample (wastewater and highly polluted water) to pH 3.7 is called methyl orange acidity (Mineral Acidity).

ENVIRONMENTAL SIGNIFICANCE

Acidity interferes in the treatment of water. Carbon dioxide is of important considerations in determining whether removal by aeration or simple neutralization with lime /lime soda ash or NaOH will be chosen as the water treatment method. The size of the equipment, chemical requirements, storage spaces and cost of the treatment all depends on the carbon dioxide present. Aquatic life is affected by high water acidity. The organisms present are prone to death with low pH of water. Water containing mineral acidity is not fit for drinking purposes. Industrial wastewaters containing high mineral acidity is must be neutralized before they are subjected to biological treatment or direct discharge to water sources.

PRINCIPLE

1. Hydrogen ions present in a sample as a result of dissociation or hydrolysis of solutes reacts with additions of standard alkali (NaOH).
2. Acidity thus depends on end point of the indicator used.
3. colour change of phenolphthalein indicator is close to pH 8.3 at 25ºC corresponds to stoichiometric neutralization of carbonic acid to bicarbonate

MATERIALS REQUIRED

APPARATUS REQUIRED

1. Burette with Burette stand
2. porcelain tile
3. 500 mL conical flask
4. Pipette with elongated tips
5. Pipette bulb
6. Conical flask
7. Measuring cylinders
8. Wash Bottle and Beakers

CHEMICALS REQUIRED

1. Sodium Hydroxide
2. Phenolphthalein

3. Methyl Orange
4. Ethyl alcohol
5. Distilled Water

PROCEDURE

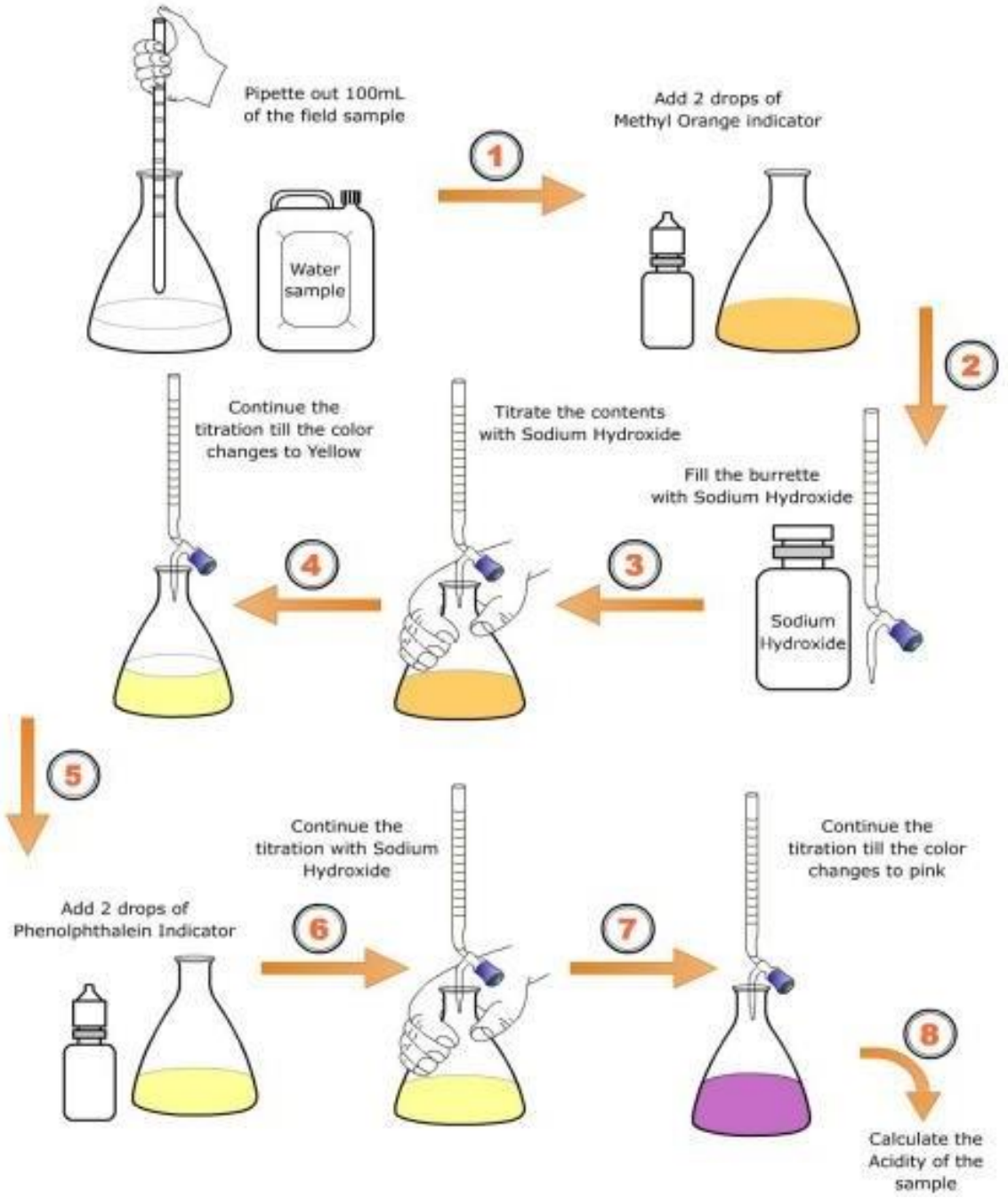
PREPARATION OF REAGENTS

1. Sodium Hydroxide (0.02 N)
2. Take 1000 mL standard measuring flask and fill 3/4th of it with distilled water.
3. Accurately measure 20 mL of 1N sulphuric acid solution using a pipette and transfer to 1000 mL standard flask containing the distilled water.
4. Make up to 1000 mL using distilled water. Phenolphthalein Indicator.
5. Weigh accurately 1 g of phenolphthalein and dissolve it in 95% ethyl alcohol.
6. Take 100 mL standard measuring flask and place a funnel over it.
7. Transfer it to the 100ml standard flask and make up to 100ml using 95% ethyl alcohol. Methyl Orange Indicator
8. Weigh accurately 1 g of methyl and dissolve it in distilled water.
9. Take 100 mL standard measuring flask and place a funnel over it.
10. Transfer it to the 100ml standard flask and make up to 100ml using distilled water.

TESTING OF SAMPLE

1. Rinse the burette with 0.02N sodium hydroxide and then discard the solution.
2. Fill the burette with 0.02N sodium hydroxide and adjust the burette.
3. Fix the burette to the stand.
4. A sample size is chosen as the titer value does not exceed 20mL of the titrant. For highly concentrated samples, dilute the sample. Usually, take 100 mL of a given sample in a conical flask using pipette.
5. Add few drops of methyl orange indicator in the conical flask.
6. The colour changes to orange. Now titrate the sample against the 0.02N sodium hydroxide solution until the orange colour faints.
7. Note down the volume (V1) consumed for titration 0.4mL.
8. This volume is used for calculating the mineral acidity.
9. To the same solution in the conical flask add few drops of phenolphthalein indicator.
10. Continue the titration, until the colour changes to faint pink colour.
11. Note down the total volume (V2) consumed for titration 2.3 ml
12. This volume is used for calculating the total acidity.
13. Repeat the titration for concordant values.

PROCEDURE CHART



CALCULATION

MINERAL ACIDITY

S.NO	VOL OF SAMPLE	BURETTE READING (ml)		VOL OF NaOH (ml)
		INTIAL	FINAL	

Burette Solution: Sodium Hydroxide
Pipette Solution: Sample
Indicator: Methyl Orange
End Point: Faint of Orange Colour
For the calculation of Mineral Acidity:

1. The Sodium Hydroxide is taken in the burette.
2. For the First titration the volume of water sample taken is 100 ml. The initial reading is 00, the final reading is 0.5 ml.
3. The volume of NaOH consumed to get the end point is 0.5ml.
4. For Second titration the volume of water sample taken is 100 ml. The initial reading is 00; the final reading is 0.4ml.
5. The volume of NaOH consumed to get the end point is 0.4 ml.
6. For third titration the volume of water sample taken is 100mL.The initial reading is 00, the final reading is 0.4 ml.
7. The volume of NaOH (V_1) consumed to get the end point is 0.4 ml.
8. For second and third titration the burette reading is same so we have achieved concordant values. We can go for the calculations.

TOTAL ACIDITY:

S.NO	VOL OF SAMPLE	BURETTE READING (ml)		VOL OF NaOH (ml)
		INTIAL	FINAL	

Burette Solution: Sodium Hydroxide
Pipette Solution: Sample
Indicator: Phenolphthalein
End Point: Faint Pink Color
For the calculation of Total Acidity

1. The Sodium Hydroxide is taken in the burette.
2. For the First titration the volume of water sample taken is 100 ml. The initial reading is 00, the final reading is 2.2 ml.
3. The volume of NaOH consumed to get the end point is 2.2 ml.
4. For Second titration the volume of water sample taken is 100 ml. The initial reading is 00, the final reading is 2.3 ml.
5. The volume of NaOH consumed to get the end point is 2.3 ml.
6. For third titration the volume of water sample taken is 100 ml. The initial reading is 00, the final reading is 2.3 ml.
7. The volume of NaOH (V2) consumed to get the end point is 2.3 ml.

For second and third titration the burette reading is same so we have achieved concordant values. We can go for the calculations.

VIVA

1. Alkalinity of water is an indication of

a) Base neutralizing capacity b) Acid neutralizing capacity
b) Quantity of base present d) Quality of base present

2. Mixed indicator is a combination of

a) Bromcresol Blue and Methyl Orange b) Bromcresol Green and Methyl Red
c) Bromcresol Blue and Methyl Red d) Bromcresol Green and Methyl Orange

3. Alkalinity is present due to all except .

a) Bromates b) Phosphates c) Silicates d) Chlorides

4. Alkalinity is not caused by

a) Carbonates ions b) Bicarbonates ions c) Hydroxyl ions d) Chloride ions

5. The phenolphthalein alkalinity is present then the pH of that water will be More than

a) 8.3 b) 9.3 c) 7.3 d) 6.3

6. Alkalinity of natural water is mainly due to the presence of_____.

a) Bicarbonates b) Bromates c) Phosphates d) Silicates

7. The bicarbonate equivalence point normally occur at pH

a) 2.5 b) 3.5 c) 4.5 d) 5.5

8. What is ppm?

a) Parts per meter square b) Parts per meter c) Parts per million d) Parts per millimeter

9. The normality of the acid used in the titration is_____.

a) 0.2 N b)0.02 c)0.002 N d)2.0 N

10. A standard solution is a

a) Solution of accurately known strength b) Solution of accurately known pH
c) Coloured solution d) Colourless solution

11. Acidity is

a) Base neutralizing capacity b) Acid neutralizing capacity
c) Quantity of acid present d) Quality of acid present

12. Acidity can be electrometrically measured by

a) pH meter b) Conductivity meter c) Turbidity meter d) Spectrometer

13. The indicators used in the titration are

a) Methyl orange and phenolphthalein b) Methyl red and phenolphthalein
c) Methyl orange and Methyl red d) Bromocresol green and Methyl red

14. To prepare 100 mL of 0.02 N of NaOH from 1 N NaOH, dilute of NaOH.

a) 20 mL b) 2 mL c) 0.2 mL d) 0.02 mL

15. The major acidic component of surface water is

a) Dissolved oxygen b) Dissolved carbon dioxide
c) Dissolved sulphur dioxide d) Dissolved nitrous oxide

KEY

1 b	2 b	3 d	4d	5a	6a	7 c	8 c	9 b	10 a
11a	12a	13a	14b	15b					

EXPERIMENT 5

DETERMINATION OF ALKALINITY

AIM

To determine the alkalinity of given water sample.

INTRODUCTION

Alkalinity is primarily a way of measuring the acid neutralizing capacity of water. In other words, it's ability to maintain a relatively constant pH. The possibility to maintain constant pH is due to the hydroxyl, carbonate and bicarbonate ions present in water. The ability of natural water to act as a buffer is controlled in part by the amount of calcium and carbonate ions in solution. Carbonate ion and calcium ion both come from calcium carbonate or limestone. So water that comes in contact with limestone will contain high levels of both Ca++ and CO3 2- ions and have elevated hardness and alkalinity.

PRINCIPLE

1. The alkalinity of water can be determined by titration of the water sample with Sulphuric acid of known values of pH, volume and concentrations.
2. Based on stoichiometric of the reaction and number of moles of Sulphuric acid needed to reach the end point, the concentration of alkalinity in water is calculated.
3. When a water sample that has a pH of greater than 4.5 is titrated with acid to a pH 4.5 end point, all OH-, CO2-3 , and HCO3 will be neutralized.
4. For the pH more than 8.3, add phenolphthalein indicator, the colour changes to pink colour. This pink colour is due to presence of hydroxyl ions. If sulphuric acid is added to it, the pink colour disappears i.e. OH- ions are neutralized.
5. Then add mixed indicator, the presence of CO2- And HCO - Ions in the solution changes the colour to blue. While adding sulphuric acid, the color changes to red, this color change indicates that all the CO neutralized. This is the end point. 3 2-and HCO3 - ions has been

MATERIALS REQUIRED

APPARATUS REQUIRED

1. Burette with Burette stand and porcelain title
2. Pipettes with elongated tips
3. Pipette bulb
4. Conical flask (Erlenmeyer Flask)
5. 250 mL Measuring cylinders
6. Standard flask
7. Wash Bottle
8. Beakers

CHEMICALS REQUIRED

1. Standard sulphuric acid
2. Phenolphthalein
3. Mixed Indicator
4. Bromocresol Green
5. Methyl Red

6. Ethyl alcohol
7. Distilled Water

PROCEDURE

PREPARATION OF REAGENTS

For testing the given sample, first the reagents are required to be prepared. Sulphuric Acid Solution (0.02N)

Take approximately 500 mL of distilled water in a 1000 mL standard flask.

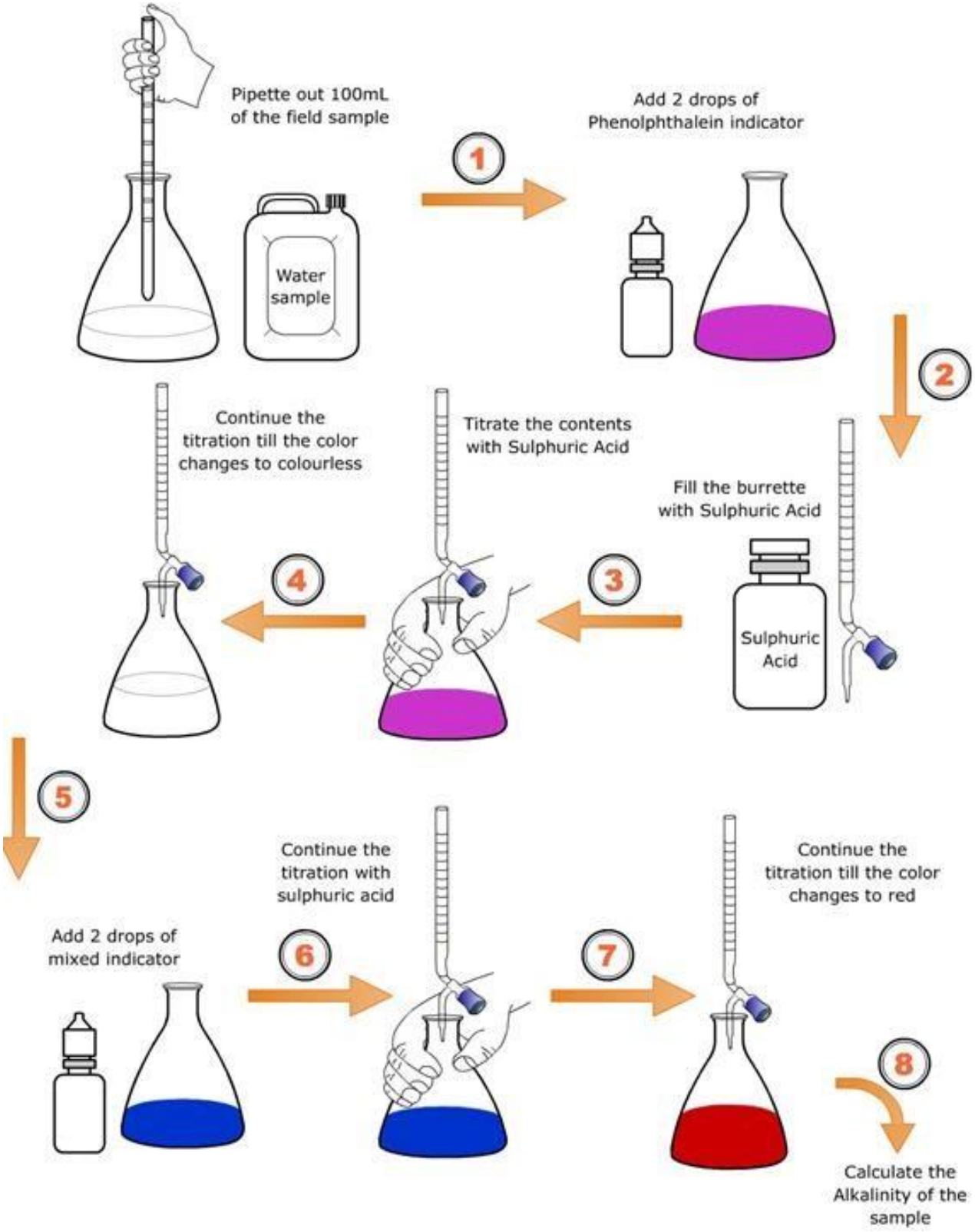
1. Pipette 20 ml of concentrated 0.1 Normality Sulphuric acid and add slowly along the sides of the standard flask.
2. Then make up the volume up to 1000 ml mark. Now the strength of this solution is 0.02 N. Phenolphthalein Indicator Preparation:
3. Weigh 1g of phenolphthalein and add to 100 ml of 95% ethyl alcohol or to 100 mL of distilled water. Use the readymade Phenolphthalein indicator available in the market. Mixed Indicator Preparation:
4. Dissolve 100 mg Bromocresol green and 20 mg of methyl red in 100 ml of 95% ethyl alcohol or use 100 mL of distilled water. Mixed indicator also readily available in the market. So it can be used as indicator in this experiment.

TESTING OF WATER SAMPLE

1. Rinse the burette with 0.02N Sulphuric acid and discard the solution.
2. Fill the burette with 0.02N sulphuric acid and adjust it to zero.
3. Fix the burette in the stand. Using a measuring cylinder exactly measure 100 mL of sample and pour it into a 250 mL of conical flask.
4. Add few drops of phenolphthalein indicator to the contents of conical flask. The colour of the solution will turn to pink. This colour change is due to alkalinity of hydroxyl ions in the water sample.
5. Titrate it against 0.02N sulphuric acid till the pink color disappears. This indicates that all the hydroxyl ions are removed from the water sample. Note down the titter value (V1). The value of titration is 0.5mL.
6. This value is used in calculating the phenolphthalein alkalinity.
7. To the same solution in the conical flask add few drops of mixed indicator. The colour of the solution turns to blue. This colour change is due to CO3 2- & HCO3 ions in water sample.
8. Continue the titration from the point where stopped for the phenolphthalein alkalinity. Titrate till the solution becomes red. The entire volume (V2) of sulphuric acid is noted down and it is accountable in calculating the total alkalinity. The value of titration is 8.3ml.

Repeat the titration for concordant values

PROCEDURE CHART



ENVIRONMENTAL SIGNIFICANCE

Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes. Higher alkalinity levels in surface waters will buffer acid rain and other acid wastes and prevent pH changes that are harmful to aquatic life. Large amount of alkalinity imparts

bitter taste in water. The principal objection of alkaline water is the reactions that can occur between alkalinity and certain cations in waters. The resultant precipitate can corrode pipes and other accessories of water distribution systems. Wastewaters containing excess caustic (hydroxide) alkalinity are not to be discharged into natural water bodies or sewers.

Alkalinity as carbonate and bicarbonate of saline water is very important in tertiary recovery processes for recovering petroleum. Alkaline water offers better wetting to the formation rock and improve oil release. As an additional benefit, ions that provide alkalinity absorb on rock surfaces occupying adsorption sites and decrease the loss of recovery chemical by adsorption.

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

World health organization suggested a guideline value for alkalinity:

- Low alkalinity < 50mg/lit as $CaCO_3$
- Medium alkalinity 50 - 250 mg/lit as $CaCO_3$
- High alkalinity > 250 mg/lit as $CaCO_3$

Once, the phenolphthalein and total alkalinities are determined, three types of alkalinities, i.e. hydroxide, carbonate and bicarbonate are easily calculated from the table given as under

Value of P and T	**Alkalinity due to**		
	OH^-	**CO_3^-**	**HCO_3^-**
P=0	0	0	T
P<1/2T	0	2P	T-2P
P=1/2T	0	2P	0
P>1/2T	2P-T	2(P-T)	0
P=T	T	0	0

1. To find the different values of Alkalinity due to Hydroxyl, Carbonate and Bicarbonate ions take P as Phenolphthalein Alkalinity and T as Total Alkalinity.
2. If P=0, The Alkalinity due to Hydroxyl and carbonate ions is 0. Alkalinity due to Bicarbonate ion is equal to the Total Alkalinity i.e. T = 83 mg/L.
3. If P < ½ , T then the Alkalinity due to Hydroxyl ion is 0. The Alkalinity due to carbonate ion is 2P. i.e. 2P = 10 mg/L. Alkalinity due to Bicarbonate ion is equal to the Total Alkalinity minus 2 times Phenolphthalein Alkalinity i.e. T-2P = 73 mg/L.
4. If P = ½ , T then the Alkalinity due to Hydroxyl ion is 0. The Alkalinity due to carbonate ion is 2P. i.e. 2P = 10 mg/L. Alkalinity due to Bicarbonate ion is equal to 0
5. If P > ½ , T then the Alkalinity due to Hydroxyl and carbonate ions is 2P-T. i.e. 2P-T = -73 mg/L. Alkalinity due to Bicarbonate ion is 0

6. If P=T, The Alkalinity due to Hydroxyl is equal to the Total Alkalinity i.e. T = 83 mg/L. Alkalinity due to carbonate and Bicarbonate ions is 0.
7. If P > ½, T then the Alkalinity due to Hydroxyl and carbonate ions is 2P–T. i.e. 2P-T = -73 mg/L. Alkalinity due to Bicarbonate ion is 0. If P = T, The Alkalinity due to Hydroxyl is equal to the Total Alkalinity. i.e. T = 83 mg/L. Alkalinity due to carbonate and Bicarbonate ions is 0.

CALCULATIONS

Table -1 sulphuric acid Vs sodium bicarbonate

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Vol of H_2SO_4 consumed
			Initial	Final	
1					
2					
3					

$$N_1V_1=N_2V_2$$

Where N_1 = normality of Na2CO3,
V_1 = volume of Na_2CO_3,
N_2 = normality of sulphuric acid,
V_2 = volume of sulphuric acid

Table -2 Phenolphthalein Alkalinity

S. No	Name of sample	Volume of Sample (mL)	Burette Reading (mL)		Volume of Sulphuric acid (H_2SO_4) (ml)
			Initial	Final	
1.		20			
2.		20			

Phenolphthalein Alkalinity (in mg/L as CaCO3) = $\frac{\text{Vol. of } H_2SO_4 \times \text{Normality of acid} \times 50{,}000}{\text{Vol. of sample taken}}$

Table - 3 Total Alkalinity

S. No	Name of sample	Volume of Sample (mL)	Burette Reading (mL)		Volume of Sulphuric acid (H_2SO_4) (ml)
			Initial	Final	
1.		20			
2.		20			

Total Alkalinity = $\frac{\text{volume of } H_2SO_4 \times \text{ Normality of acid} \times 50{,}000}{\text{Volume of sample taken}}$ ppm

RESULT AND REPORT

1. The phenolphthalein alkalinity present in a given water sample-1 is =_____ppm
2. The phenolphthalein alkalinity present in a given water sample-2 is =_____ppm
3. The Total alkalinity present in a given water sample-1 is =_____ppm
4. The Total alkalinity present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water will produce_____effect. It requires_____treatment.
2. The sample- 2 water will produce_____effect. It requires_____treatment.

VIVA

1. What are the chemicals which are required to conduct the Alkalinity experiment?
2. If we want to calculate the alkalinity of the given water sample then we need to titrate it with …….
3. The normality of the standard sulphuric acid used in the Alkalinity is ……
4. If residual chlorine is present in the water sample then we need to add ……
5. The normality of Sodium Thiosulphate solution is…….
6. If the pH of the water sample is above 8.3 then the indicator to be used is ……
7. After adding the phenolphthalein indicator, the given water sample turns into ……
8. The standard sulphuric acid is taken in the …….
9. After titrating the pink colour solution the end point is …….
10. Methyl orange indicator is added to the sample then it turns to ……
11. The end result of the alkalinity experiment is..... colour.
12. Alkalinity means …….
13. Alkalinity is important for ……
14. Higher alkalinity levels in the surface waters will buffer ……
15. Large amount of alkalinity imparts .....taste to the water.
16. As per the WHO suggestion the alkalinity less than 50mg/l as caco3 is …….
17. Medium alkalinity ranges between…….
18. High alkalinity is…….
19. What are the reagents required to conduct the acidity test? 2
20. The normality of NAOH solution in acidity test is …….

EXPERIMENT 6
DETERMINATION OF HARDNESS (TOTAL, CALCIUM AND MAGNESIUM HARDNESS)

AIM

To determine the amount of Total Hardness present in a given water sample by EDTA Titration method.

APPARATUS USED

1. Pipette
2. Conical flask
3. Burette
4. Beaker
5. Dropper

INTRODUCTION

Hardness is the degree of ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solutions. Hardness can be categorized into two types– permanent hardness and temporary hardness. Temporary hardness is caused due to the presence of bicarbonates of calcium and magnesium. Permanent hardness is non-carbonate hardness and is caused due to the presence of sulphates, chlorides and nitrates of calcium and magnesium.

The hardness of water is significant in determining the suitability of water for domestic and industrial uses. The comparative amount of calcium and magnesium hardness, carbonates and non-carbonates hardness present in water are the aspects while determining the most economical type of softening process. When hard water is heated, Ca^{2+} ions react with bicarbonate (HCO_3^-) ions to form insoluble calcium carbonate ($CaCO_3$) (Eq. 1(a)). This precipitate, known as scale, coats the vessels in which the water is heated, producing the mineral deposits on your cooking dishes. Equation 2(a) presents magnesium hardness.

$$Ca^{2+}(aq) + 2HCO_3(aq) \rightarrow CaCO_3\,(s) + H_20 + CO_2 \quad \text{(Eq. 1(a))}$$

$$Mg^{2+}(aq) + 2OH^-\,(aq) \rightarrow MgOH_2\,(s) \quad \text{(Eq. 2a)}$$

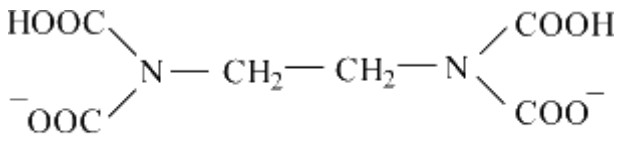
Carbonate hardness (mg/L) = Alkalinity (2a)
When alkalinity > Total hardness: Carbonate hardness (mg/L) = Total hardness (2b)

The amount of hardness in excess of this is called "Non-carbonate hardness (NCH)". These are associated with sulphate chloride, and nitrate ions. It is calculated using Eq (2c)

$$\text{NCH (mg/L)} = \text{Total hardness} - \text{Carbonate hardness} \quad \text{(Eq. 2c)}$$

The ions involved in water hardness, i.e. $Ca^{2+}(aq)$ and $Mg^{2+}(aq)$, can be determined by titration with a chelating agent, Ethylene Diamine Tetra Acetic acid (EDTA), usually in the form of disodium salt (H_2Y^{2-}).

The titration reaction is: $Ca^{2+}(aq) + H_2Y^{2-}(aq) \rightarrow CaY^{2-}(aq) + 2H^+(aq)$



EDTA (anionic form)

Eriochrome Black T is often used as indicator for the above titration. At pH 10, Ca^{2+}(aq) ion first complexes with the indicator as $CaIn^{+}$(aq) which is wine red. As the stronger ligand EDTA is added, the $CaIn^{+}$(aq) complex is replaced by the CaY^{2-}(aq) complex which is blue. The end point of titration is indicated by a sharp colour change from wine red to blue. Titration using Eriochrome Black T as indicator states total hardness due to Ca^{2+}(aq) and Mg^{2+}(aq) ions. Hardness due to Ca^{2+}(aq) ion is determined by a discrete titration at a higher pH, by adding NaOH solution to precipitate $Mg(OH)_2$(s), by means of hydroxy naphthol blue as indicator.

PROCEDURE

1. Open the simulation of hardness of water, go through the given Description and Solutions used and click on NEXT button shown at the bottom right corner.
2. Place the funnel in the burette to add 200ml test sample.
3. Open the lid and pour EDTA solution on to the burette upto zero mark.
4. Remove the funnel.
5. Squeeze the pipette bulb to take the $CaCO_3$ solution up into the pipette.
6. release liquid into the beaker.
7. Note the addition of 10ml 0.01M Calcium carbonate solution to conical flask.
8. add ammonia buffer solution through pipette to the conical flask.
9. add 5-6 drops of E. B.T indicator to the conical flask.
10. Observe the colour change of solution to wine red
11. Titrate ETDA solution into the conical flask till the colour changes to blue.
12. Calculate $CaCO_3$ equivalent to 1ml of ETDA using the formula.
13. Repeat the same procedure for the 100ml of water sample. Calculate the total hardness of water using the formula.

CALCULATIONS

S. No	Volume of calcium carbonate solution ($CaCO_3$) in ml	Burette Reading (ml)		Volume of EDTA (ml) (Final value – Initial value)
		Initial	Final	
1				
2				

$$CaCO_3 \text{ equivalent to 1 ml of EDTA} = \frac{volume\ of\ \text{CaCO3}}{volume\ of\ EDTA}$$

S. No	Volume of taken sample in ml C	Burette Reading (ml)		Volume of EDTA (ml) (Final value – Initial value) A	$CaCO_3$ equivalent to 1 ml of EDTA B
		Initial	Final		
1					
2					

$$\text{Total Hardness} = \frac{A\ X B\ X\ 1000}{C}$$

Where,

A = Volume of EDTA for sample titration

B = $CaCO_3$ equivalent to 1 ml of EDTA

C = Volume of sample taken for titration

VIVA

1.The limit of chlorides in drinking water as per IS code is

a)200 ppm b)225 ppm c)250 ppm d)500 ppm

2. Silver nitrate is stored in a brown bottle

a) to avoid decomposition by sun light b)because it is dark in colour

c) because the solution is colourless d)to avoid heat

3. The colour of Silver Chromate is

a) Milky White b)Opale Yellow c)Colourless d)Brick Red

4. When both hardness and chloride content are very high above 500 mg/L, then the water will be

a) Non salty in nature b)Fit for drinking

c)Salty in nature d)Soft water

5. Presence of chloride can corrode _.

a) GI pipes b)Rubber tubes c)PVC pipes d)Glass pipes

6. The chloride concentration in sewage is

a) More concentrated than the municipal watersupplied

b) Equal concentration to the municipal watersupplied

c) Less concentrated than the municipal watersupplied

d) Only in trace

7. Chloride consumed by human beings

a) Pass through the fecal matter as it is

b)Gets changed into other forms

c) Gets disappeared in the body

d)Stored in bones

8. Chloride gives salty taste to water particularly when present as .

a) Sodium chloride b)Magnesium chloride

c) Potassium chloride d)Zinc chloride

9. The point at which a clear visual change is observed after the reaction between titrant and titrates is called

a) End point b)Equivalence point c)Equal point d)Double equivalence point

10. Most common ion in the water is

a) Fluoride b)Nitrate c)Chloride d)Sulphate

KEY 1c 2 a 3 bd 4 c 5a 6a 7 a 8 a 9 a 10 c

EXPERIMENT 7

DETERMINATION OF CHLORIDES

AIM

To determine the amount of chloride present in the given sample

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 ion according to1 mole of $AgNO_3$ reacts with 1 mole of chloride. The titrant concentration is generally 0.02 M. Silver chloride is precipitated quantitatively, before red silver chromate 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).

APPARATUS REQUIRED

1. Burette with stand
2. Pipette
3. Conical flask measuring jar etc.,

CHEMICALS REQUIRED

1. Sodium Chloride
2. Silver nitrate
3. Potassium Chromate

REAGENTS PREPARATION

1. **Standard silver nitrate solution 0.0141 N:**
   Dissolve 2.395 g $AgNO_3$ in distilled water and dilute to 1 litre. Standardise against 0.0141 N NaCl. Store in a brown bottle

2. **Standard sodium chloride 0.0141N:**
   Dissolve 824.1 mg NaCl (dried at 140°C) in chloride free water and dilute to 1 litre.

3. **Potassium Chromate Solution (K2CrO4)**
   Dissolve 1 gm of potassium chromate in 20m1 of distilled water.

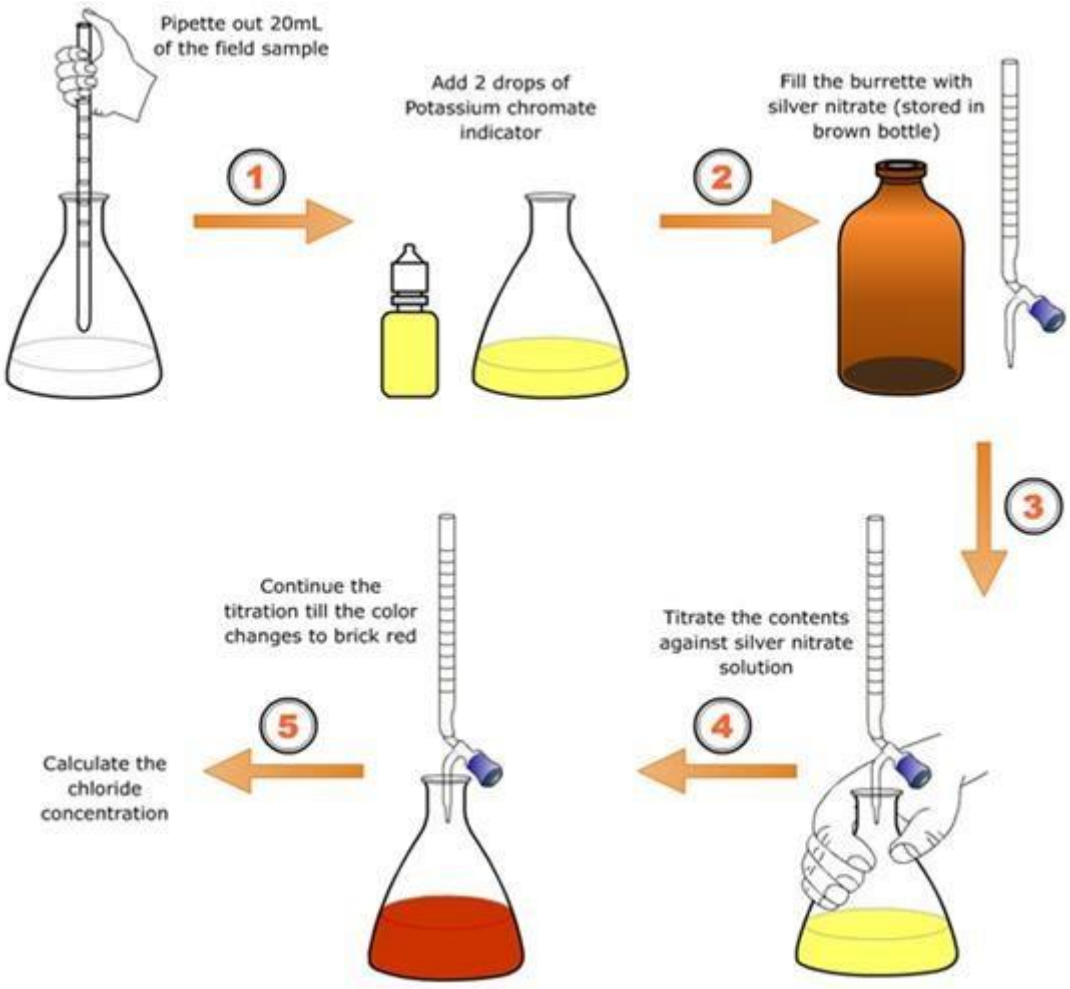
PROCEDURE

Standardization of Silver Nitrate Solution

1. Pipette 20 ml of sodium chloride solution in to the conical flask.
2. Add one or two drops of potassium chromate solution.
3. Titrate against Silver Nitrate solution until the appearance of reddish brown colour
4. Re peat the titration for concordant values.

Silver Nitrate Vs Sample -

1. Pipette 20 ml of sample in the conical flask.
2. Add one or two drops of potassium chromate solution
3. Titrate against silver Nitrate solution until the appearance of reddish brown colour.
4. Repeat the titration for concordant values.



ENVIRONMENTAL SIGNIFICANCE

Chloride associated with sodium exerts salty taste, when its concentration is more than 250 mg/1. There is no known evidence that chloride- constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/L in supplies intended for public use. In many areas of world where water supplies are scarce, sources containing as much as 2000mg/L are used for domestic purposes without the development of adverse effect once the human system becomes adapted to the water.

It can also corrode concrete by extracting calcium in the form of calcide. Magnesium chloride in water generates hydrochloric acid after heating which is also highly corrosive and create problems in boilers.

The high concentrations of chloride ions mostly results in an unpleasant salty taste of water and it also aides the corrosion of plumbing system. Very high chloride content of water may also produce laxative effect. An upper limit of 250 mg/L has been set for the chloride ions. An increase in the normal chloride content of your water may indicate possible pollution from human sewage, animal manure or industrial wastes. As all aware the sea water is full of sodium chloride, the chloride levels will be much higher compared to the fresh water sources.

CALCULATIONS

SILVER NITRATE VS SODIUM CHLORIDE

S.No	Name of sample	Volume of water sample	Burette reading (ml)		$AgNO_3$ consumed
			Initial	Final	
1					
2					
3					

$$N_1V_1=N_2V_2$$

Where N_1 = Normality of NaCl,
V_1 = Volume of NaCl,
N_2 = Normality of silver nitrate
V_2 = Volume of silver nitrate

SILVER NITRATE VS SAMPLE

S. No	Name of sample	Volume of water sample	Burette reading (ml)		$AgNO_3$ consumed
			Initial	Final	
1					
2					

$$\text{Chlorides} = \frac{\text{Volume of } AgNO_3 \times \text{Normality } AgNO_3 \times 35.45 \times 1000}{\text{Volume of sample taken}}$$

RESULT AND REPORT

The phenolphthalein alkalinity present in a given water sample-1 is =_____ppm

The phenolphthalein alkalinity present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

The sample- 1 water will produce_____effect. It requires _____ treatment.

The sample- 2 water will produce_____effect. It requires _____ treatment.

VIVA

1. The limit of chlorides in drinking water as per IS code is
   a) 200 ppm b) 225 ppm c) 250 ppm d) 500 ppm

2. Silver nitrate is stored in a brown bottle
   a) To avoid decomposition by sun light b) Because it is dark in colour
   c) Because the solution is colourless d) To avoid heat

3. The colour of Silver Chromate is
   a) Milky White b) Opale Yellow c) Colourless d) Brick Red

4. When both hardness and chloride content are very high above 500 mg/L, then the water will be
   a) Non salty in nature b) Fit for drinking c) Salty in nature d) Soft water

5. Presence of chloride can corrode_____.
   a) GI pipes b) Rubber tubes c) PVC pipes d) Glass pipes

6. The chloride concentration in sewage is
   a) More concentrated than the municipal water supplied
   b) Equal concentration to the municipal water supplied
   c) Less concentrated than the municipal water supplied
   d) Only in trace

7. Chloride consumed by human beings
   a) Pass through the fecal matter as it is b) Gets changed into other forms
   c) Gets disappeared in the body d) Stored in bones

8. Chloride gives salty taste to water particularly when present as_____.
   a) Sodium chloride b) Magnesium chloride
   c) Potassium chloride d) Zinc chloride

9. The point at which a clear visual change is observed after the reaction between titrant and titrates is called
   a) End point b) Equivalence point c) Equal point d) Double equivalence point

10. Most common ion in the water is
   a) Fluoride b) Nitrate c) Chloride d) Sulphate

KEY

1c 2 a 3 bd 4 c 5a 6a 7 a 8 a 9 a 10 c

EXPERIMENT 8
DETERMINATION OF OPTIMUM COAGULANT DOSAGE

AIM

To determine the optimum dosage of coagulant required for a given sample of waste water.

PRINCIPLE

Coagulants are used in water treatment plants (i) to remove natural suspended and colloidal matter, (ii) to remove material which do not settle in plain sedimentation, and (iii) to assist in filtration. Alum [$Al_2(SO_4)_3$. $18H_2O$] is the most widely used coagulant. When alum solution is added to water, the molecules dissociate to yield $SO_2^{-4}$and Al_3^{+}. The +ve species combine with negatively charged colloidal to neutralize part of the charge on the colloidal particle. Thus, agglomeration takes place. Coagulation is a quite complex phenomenon and the coagulant should be distributed uniformly throughout the solution. A flash mix accomplishes this. Jar test is simple device used to determine this optimum coagulant dose required. The jar test, device consists of a number of stirrers (4 to 6) provided with paddles. The paddles can be rotated with varying speed with the help of a motor and regulator. Samples will be taken in jars or beakers and varying dose of coagulant will be added simultaneously to all the jars. The paddles will be rotated at 100 rpm for 1 minute and at 40 rpm for 20 to 30 minutes, corresponding to the flash mixing and slow mixing in the flocculator of the treatment plant. After 30 minutes settling, supernatant will be taken carefully from all the jars to measure turbidity. The dose, which gives the least turbidity, is taken as the optimum coagulant dose.

APPARATUS REQUIRED

1. Laboratory flocculator with stirring paddles or jar apparatus
2. Glass Jars

CHEMICALS REQUIRED

Alum (Aluminum Sulfate) OR Ferric Chloride OR Ferrous Sulfate

REAGENTS PREPARATION

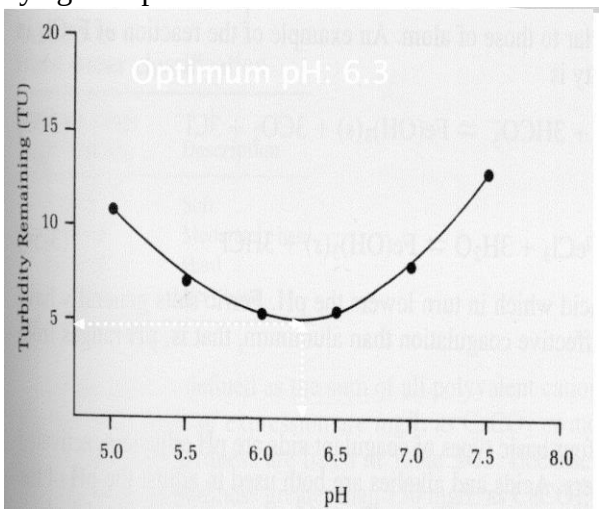
Alum Solutions Dissolve 1.0 gram of Alum in 1 lit of distilled water so that each ml. of Alum solution contains one milligram of Alum.

PROCEDURE

Determination of optimum pH

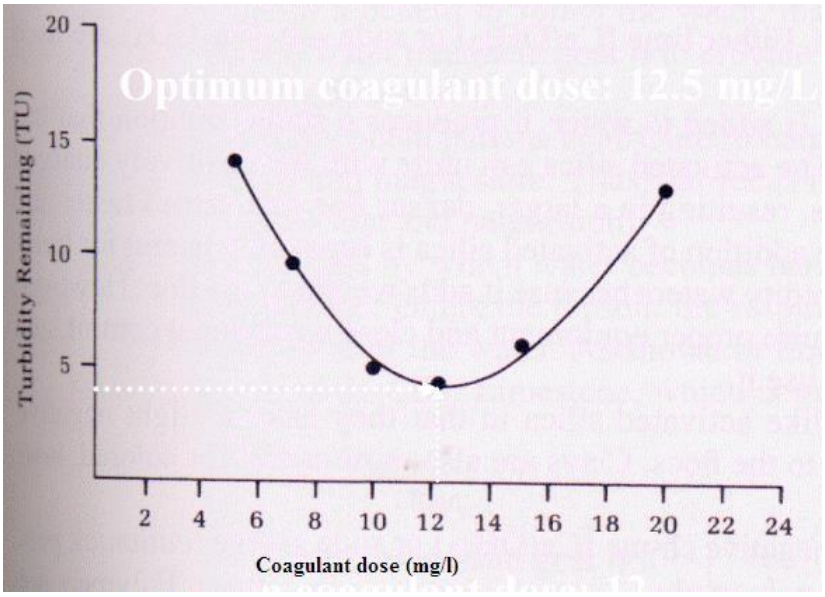
1. Fill the jars with raw water sample (500 or 1000 mL) – usually 6 jars
2. Adjust pH of the jars while mixing using H_2SO_4 or NaOH/lime (pH: 5.0; 5.5; 6.0; 6.5; 7.0; 7.5)
3. Add same dose of the selected coagulant (alum or iron) to each jar (Coagulant dose: 5 or 10 mg/L)
4. Rapid mix each jar at 100 to 150 rpm for 1 minute. The rapid mix helps to disperse the coagulant throughout each container
5. Reduce the stirring speed to 25 to 30 rpm and continue mixing forθ 15 to 20 mins. This slower mixing speed helps promote floc formation by enhancing particle collisions which lead to larger flocs
6. Turn off the mixers and allow flocs to settle for 30 to 45 mins
7. Measure the final residual turbidity in each jar

8. Plot residual turbidity against pH.



Determination of optimum coagulant dose

1. Fill the jars with raw water sample (500 or 1000 mL) – usually 6 jars
2. Adjust pH of all jars at optimum (6.3 found from first test) while mixing using H_2SO_4 or NaOH/lime
3. Add different doses of the selected coagulant (alum or iron) to each jar (Coagulant dose: 5; 7; 10; 12; 15; 20 mg/L)
4. Rapid mix each jar at 100 to 150 rpm for 1 minute. The rapid mix helps to disperse the coagulant throughout each container
5. Reduce the stirring speed to 25 to 30 rpm and continue mixing for 15 to 20 mins. This slower mixing speed helps promote *flocculation* formation by enhancing particle collisions which lead to larger *flocculation*
6. Turn off the mixers and allow flows to settle for 30 to 45 mins.
7. Measure the final residual turbidity in each jarθ Plot residual turbidity against coagulant dose.



ENVIRONMENTAL SIGNIFICANCE

Coagulation in combination with flocculation and sedimentation is a process that is commonly used in water treatment to remove undesirable contaminants. Coagulation, the first step of the process, involves the addition of a coagulant to destabilize suspended and colloidal particles, adsorb natural organic matter (NOM) to particles, and to create *flocculation* of particles that enmesh other particles. Flocculation is the process by which larger particles are produced

through *flocculation* aggregation to an appropriate size for removal. Sedimentation is the process that is used to then remove the *flocculation* of appropriate size. All of these processes work together with the goal of maximizing removal under given water conditions. Parameters that affect the removal efficiency include the type of coagulant used, mixing intensity used to disperse the coagulant, and flocculation mixing intensity
The optimum value of coagulant generally lies between 8 to 10 for normal water from rivers.

OBSERVATIONS

Sample No	Dosage of coagulant	Turbidity	pH
1			
2			
3			
4			
5			
6			

RESULT

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

1. The optimum value of coagulant dosage present in a given water sample-1 is =_____ppm.

2. The optimum value of coagulant dosage present in a given water sample-2 is =_____ppm.

INTERPRETATION OF RESULTS

1. The sample- 1 requires _____treatment.

2. The sample- 2 requires _____treatment.

VIVA

1. The Size and shape of the particle can be altered by the addition of certain chemicals in water.
   a. Coagulants b. Crystallization c. Both d. None

2 Which of the following chemical is sometime added in the process of coagulation and flocculation?
   a) Aluminum sulphate b) Aluminum oxide
   c) Calcium chloride d) None of these

3. The detemtion period in coagulation tanks is usally kept as
   a)1 -2 minutes b)30-45minutes c)2 - 6 hours d)2-6 days

4. The amount of coagulant needed for coagulation of water increase with
   i)increase in turbidity of water ii) decrease in turbidity of water
   iii)increase in temperature of water iv) decrease in temperature of water
   a) (i) &(ii) b) (i) &(iv) c) (ii) &(iii) d) (ii) &(iv)

5. The alumn, when added as coagulant in water
   a) doesnot require alkalinity in water for flocculation
   b) does not affect pH value of water
   c) increase pH value of water
   d) decrease pH value of water

6. Alumn as a coagulant is found to be most effective when pH range of water is
   a)2-4 b)4-6 c)6-8 d)8-10

7. HCl is also..... and create problems in boilers.
8. The high concentrations of chlorides ions mostly result in an unpleasant ..... taste to the water.
10. High concentrations aides the .....of plumbing system.
11. The sodium chloride levels in sea water is ..... than that in the fresh water.
12. The formula for the con of chlorides …….
13. Measuring jar is used to ……
14. Conical flask is used to ……
15. Most common ion in water is_____.
16. The colour of silver chromate is …….
17. Brick red is the ..... Of the experiment

KEY

1 a 2 a 3 c 4 b 5d 6c

EXPERIMENT 9

DETERMINATION OF DISSOLVED OXYGEN (WINKLER METHOD)

AIM

To find out the dissolved oxygen in a given water sample

PRINCIPLE

Dissolved Oxygen can be measured either by Titrimetric or electrometric method.

(1) Titrimetric Method: Titrimetric method is based on the oxidizing property of DO while the electrometric method (using membrane electrodes) is based on the rate of diffusion of molecular oxygen across a membrane. It is most accurate method to determine DO. There are different titrimetric methods based on the nature of sample to be tested.

(a) Winkler Method
(b) Azide Modification
(c) Alum Flocculation
Modification
(d) Permanganate Modification

SPECIAL APPARATUS

1. Burette
2. Burette stand
3. 300 ml glass stoppered BOD bottles
4. 500 ml conical flask
5. Pipettes with elongated tips
6. Pipette bulb
7. 250 ml graduated cylinders
8. Wash bottle

CHEMICALS REQUIRED

1. Manganous sulphate solution
2. Alkaline iodide-Azide solution
3. Sulfuric acid
4. Concentrated
5. Starch indicator solution
6. Sodium thiosulphate
7. Distilled or deionized water
8. Potassium Hydroxide
9. Potassium Iodide
10. Sodium Azide

REAGENTS PREPARATION

Manganous Sulphate

Dissolve 480 g $MnSO_4.4H_2O$, 400 g $MnSO_2.2H_2O$ or 364 g $MnSO_4.H_2O$ in distilled water, filter and dilute to 1 litre.

Alkali iodide-azide reagent.

Dissolve 500 g NaOH or 700 g KOH and 135 g NaI or 150 g KI in distilled water and dilute to 1 litre. Add 10 g sodium azide (NaN_3) dissolved in 40 mL distilled water. The reagent should not give colour with starch when diluted and acidified.

Starch indicator:

Add cold water suspension of 5 g soluble starch to approximately 800 mL boiling water with stirring. Dilute to 1 litre, allow to boil for a few minutes and let settle overnight. Use supernatant liquor.

Stock sodium thiosulphate, 0.1N:

Dissolve 24.82g $Na_2S_2O_3.5H_2O$ in distilled water. Preserve by adding 0.4g solid NaOH or 1.5mL of 6N NaOH and dilute to 1000mL.

Standard sodium thiosulphate, 0.025N:

Dissolve 6.205 g sodium thiosulphate ($Na_2S_2O_3.5H_2O$) in freshly boiled and cooled distilled water and dilute to 1 litre. Preserve by adding 5 mL chloroform or 0.4 g NaOH/L or 4 g borax and 5 to 10 mg HgI_2/L. Standardise this with 0.025 N potassium dichromate solution which is prepared by dissolving 1.226 g potassium dichromate in distilled water and diluted to 1 litre.

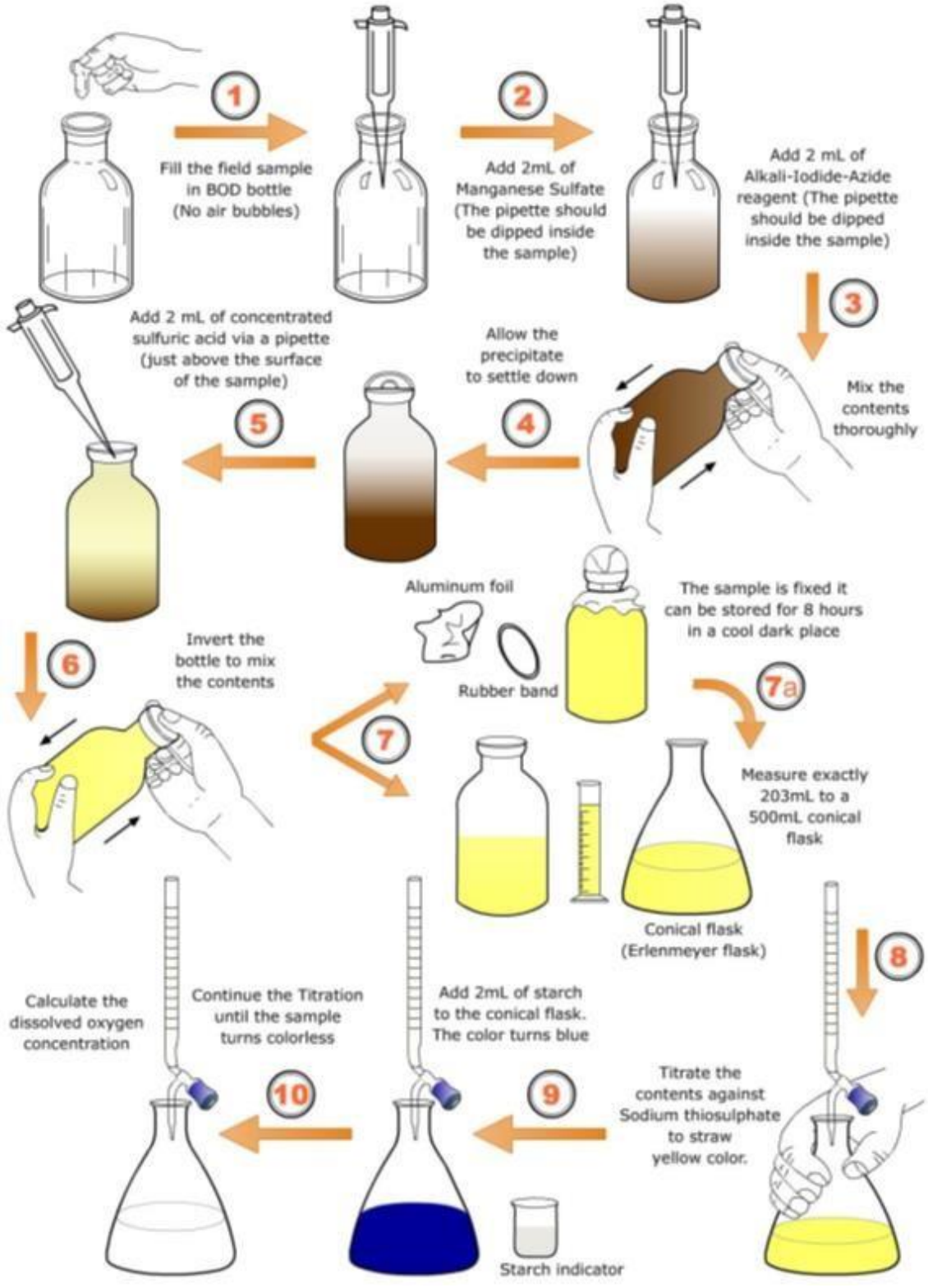
Standardisation of 0.025 N sodium thiosulphate solution:

Dissolve approximately 2 g KI in an Erlenmeyer flask with 100 to 150 mL distilled water. Add 10 mL of H_2SO_4, followed by exactly 20 mL, 0.1 N potassium dichromate solution. Place in the dark for 5 minutes, dilute to approximately 400 mL and titrate with 0.025 N sodium thiosulphate solution, adding starch towards the end of titration. Exactly 20 ml 0.025 N thiosulphate will be consumed at the end of the titration. Otherwise, the thiosulphate solution should be suitably corrected.

PROCEDURE

1. Take two 300-mL glass stoppered BOD bottle and fill it with sample to be tested. Avoid any kind of bubbling and trapping of air bubbles.
2. Add 2mL of manganese sulfate to the BOD bottle by inserting the calibrated pipette just below the surface of the liquid.
3. Add 2 mL of alkali-iodide-Azide reagent in the same manner.
4. Squeeze the pipette slowly so no bubbles are introduced via the pipette (The pipette should be dipped inside the sample while adding the above two reagents. If the reagent is added above the sample surface, you will introduce oxygen into the sample).
5. If oxygen is present, a brownish-orange cloud of precipitate or flock will appear.
6. Allow it to settle for sufficient time in order to react completely with oxygen.
7. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample.
8. Carefully stopper and invert several times to dissolve the floc.
9. At this point, the sample is "fixed" and can be stored for up to 8 hours if kept in a cool, dark place.
10. Rinse the burette with sodium thiosulphate and then fill it with sodium thiosulphate. Fix the burette to the stand.
11. Measure out 203 mL of the solution from the bottle and transfer to an conical flask.

12. Titration needs to be started immediately after the transfer of the contents to conical flask.
13. Titrate it against sodium thiosulphate using starch as indicator. (Add 3 – 4 drops of starch indicator solution)
14. End point of the titration is first disappearance of the blue color to colorless.
15. Note down the volume of sodium thiosulphate solution added which gives the dissolved oxygen



ENVIRONMENTAL SIGNIFICANCE

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement) and as a waste product of photosynthesis. Environmental impact of total dissolved solids gas concentration in water should not exceed 110% (above 13-14 mg/l). Concentration above this level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare occurrence. The bubbles or emboli block the flow of blood through blood vessels causing death. External bubbles emphysema can also occur and be seen on fins, on skin and on other tissue. Aquatic invertebrate are also affected by "gas bubble disease," but at levels higher than those lethal to fish. Adequate dissolved oxygen is necessary for good water quality
the dissolved oxygen level in natural unpolluted waters at normal temperature is found to be of the order of 10mg/l

In general, the following guidelines apply for aquatic life:

0-2 mg/L: not enough oxygen to support life
2-4 mg/L: only a few kinds of fish and insects can survive
4-7 mg/L: acceptable for warm water fish
7-11mg/L: very good for most stream fish including cold water fish

CALCULATIONS

SODIUMTHIOSUPHATE VS POTASSIUM CHROMATE

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Na2S2O3.5H2O consumed
			Initial	Final	
1					
2					
3					

$$N_1V_1=N_2V_2$$

Where
N_1 = Normality of potassium dichromate
V_1 = Volume of potassium dichromate
N_2 = Normality of sodiumthiosulphate
V_2 = Volume of potassium sodiumthiosulphate

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Volume of sodium thiosulphate Consumed (ml)
			Initial	Final	
1					
2					
3					

$$\text{Dissolved oxygen} = \frac{\text{Volume of sodiumthiosulphate consumed} \times N \times 1000}{\text{Volume of sample taken}}$$

RESULT AND REPORT

1. The DO present in a given water sample-1 is =_____ppm
2. The DO present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water will produce_____effect. It requires_____treatment.
2. The sample- 2 water will produce_____effect. It requires_____treatment.

VIVA

1. Winkler titration method is based on property of Dissolved Oxygen.
   a) Reduction b) Oxidation c) Redox d) Decomposition

2. Dissolved oxygen in the water mainly depends upon Organic content of the water.
   a) organic matter b) inorganic matter c)chemicals d)none

3. The ingredients of Alkali are NaOH, NaI
   a) NaN_4 b) NaN_3 c) NaN_2 d) NaN

4. The precipitate formed after the addition of $MnSO_4$ and Alkali azide is .
   a) Manganese Hydroxide b) Sodium sulphate
   c) Potassium sulphate d) Manganese oxide

5. Low amount of dissolved oxygen in river water indicates
   a). High level of free oxygen in water b). High level of pollution in water
   c). Low level of pollution in water
   d). That the surrounding atmosphere is having low amount of oxygen.

6. Along the stream the increase in dissolved oxygen in water will be at the
   a) riffles b) warm pool c) bank erosion d) top

7. The dissolved Oxygen in potable water .
   a) imparts freshness b) improves taste c) improves smell d) imparts colour

8. Sulphide and Sulphur dioxide interfere in the determination of dissolved oxygen.
   a) True b) False

9. The sample obtained for testing Dissolved Oxygen can be preserved by
   a) adding the reagents and stored at 10 to 20 for up to 8 hours
   b) storing at room temperature for up to 24 hours c) storing at 0 for up to 24 hours
   d) adding the reagents and stored at room temperature for up to 24 hours

10. Minimum DO in the fresh water for the survival of aquatic life is
    a) 0 mg/l b) 2 mg/l c) 8 mg/l d) 4 mg/l

KEY

1 b 2 b 3 b 4 a 5b 6a 7 a 8a 9a 10d

EXPERIMENT 10

DETERMINATION OF COD

AIM
To determine the amount of Chemical Oxygen Demand present in the given sample.

PRINCIPLE
COD test is widely used for measuring the pollution strength of waste water. All organic compounds with a few exceptions can be oxidized to C02 and water by the action of strong oxidizing agents regardless of biological assimilability of the substances.

APPARATUS REQUIRED
COD Reactor, Burette with stand, Pipette, Measuring jar, Beakers, Conical flask

CHEMICALS REQUIRED
Potassium Dichrornate, Conc. Sulphuric Acid, Ferroin Indicator Solutionferrous Ammonium Sulphate Solution, Mercuric Sulphate,

REAGENTS PREPARATION

Std. Potassium dichromate (0.25 N) solution:
Dissolve 12.26 gm of Potassium dichromate previously dried at 180°C for 2 hr in distilled water and diluted to 1 litre.

Ferroin Indicator Solution:

Dissolve 1 .485 gm of 1, 10 Phenophtholine sulphate monohydrate with 0.695gm of ferrous Sulphate ($FeSO_4.7H_20$) in water and dilute to l00ml.

Std.Ferrous Ammonium Sulphate(0.25N):
Dissolve 39 g $Fe(NH_4)_2(SO_4)_2.6H_2O$ in distilled water. Add 20 mL conc. H2SO4 and cool and dilute to 1 litre. Standardise this against the standard dichromate solution. Dilute 10 mL standard K2Cr2O7 solution to about 100 mL. Add 30 mL conc. H2SO4 and cool. Titrate with ferrous ammonium sulphate titrant using 2- 3 drops of ferroin indicator.

PROCEDURE
1. Take 50m1 of sample in a flask and add boiling chips and 1gm of HgSO4 and 5 ml of H2S04 add slowly to dissolve HgSO4 and cool the mixture.
2. Add 25 ml of 0.25N $K_2Cr_2O_7$ solution and gain mix. Attach the condense and start the cooling water. The remaining acid agent is added thoroughly through the open end of condenser and the efflux mixture was mixed. Apply the heat and reflux for 2hrs.
3. Dilute the mixture to about 300m1 and titrate excess dichromate with std.FAS using Ferro in indicator.
4. The colour will change from yellow to green to blue and finally red and the ml of titrate was deduced.
5. Reflux on the same manner to a flask consisting of distilled water, equal to the volume of the sample and the reagents titrate as he sample and ml of titrant was deduced.

CALCULATIONS

Table1

S.No	Volume of Potassium dichromate	Burette reading (ml)		Volume of FAS Consumed (ml)
		Initial	Final	
1				
2				
3				

$$N_1V_1=N_2V_2$$

Where
N_1 = Normality of $K_2Cr_2O_7$,
V_1 = Volume of $K_2Cr_2O_7$,
N_2 = Normality of FAS,
V_2 = Volume of FAS

Table 2

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Volume of FAS Consumed (ml)
			Initial	Final	
1					
2					
3					

CALCULATIONS

Total Chemical Oxygen Demand (mg/l) = $\frac{\text{volume of FAS consumed} \times N \times 8000}{\text{Volume of Sample Taken}}$

RESULT

1. The COD present in a given water sample-1 is =_____ppm
2. The COD present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 requires _____treatment.
2. The sample- 2 requires _____treatment.

VIVA

1. The chemical oxygen demand (COD)measures the
   a) amount of oxygen required for growth of microorganisms in water
   b) amount of oxygen that would be removed from the water in order to oxidize pollution
   c) amount of oxygen required to oxidize the calcium present in waste water
   d) none of the above

2. The correct relation between theoretical oxygen demand (TOD), Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) is given by
   a) TOD > BOD > COD b) TOD > COD > BOD
   c) BOD > COD > TOD d) COD > BOD > TOD

3. COD is a good estimate of
   a) Nitrogenous oxygen demand b)carbonaceous oxygen demand
   c)I stage oxygen demand d)20day BOD

4. the standard method specified chemical for the oxidation of organic matter in the COD test is
   a)Na2S2O3 B)KMnO4 C)K2Cr2O7 d)CCl4

5. The cod test is a measure of
   a)concentrated oxygen demand b)chemical odor demand
   c)clinical oxygen dosage d) chemical oxygen demand

6. compared with the BOD, the COD of a wastewater sample is generally
   a)greater b)equal c)less d)none

7. The COD test is considered a better operational control test than the BOD test because
   a) It takes less time to run the test b)the results are more accurate
   b) Every one uses it d)the results are independent of alkalinity

8. The non-biodegradable organics can be measured by
   a)COD b)BOD c)TOC d)colourimetrically

9. For the quantification of non biodegradable organics the ultimate BOD must be
   a) added from COD or TOC b)Subtracted form COD or TOC
   C)added from COD and subtracted from the TOC d)all of the above

2. A COD test can be used to easily quantify the amount of
   a) organics in water b) in organics in water
   c) Both a and b d) none

KEY

1 b 2 b 3 d 4 c 5d 6a 7 a 8a,c 9b 10a

EXPERIMENT 11

DETERMINATION OF BOD/DO

DETERMINATION OF DO

AIM

To find out the dissolved oxygen in a given water sample

PRINCIPLE

Dissolved Oxygen can be measured either by Titrimetric or electrometric method.

1. Titrimetric Method: Titrimetric method is based on the oxidizing property of DO while the electrometric method (using membrane electrodes) is based on the rate of diffusion of molecular oxygen across a membrane. It is most accurate method to determine DO. There are different titrimetric methods based on the nature of sample to be tested.
   a. Winkler Method
   b. Azide Modification
   c. Alum Flocculation
   d. Modification
   e. Permanganate Modification

SPECIAL APPARATUS

1. Burette
2. Burette stand
3. 300 mL glass stoppered BOD bottles
4. 500 mL conical flask
5. Pipettes with elongated tips
6. Pipette bulb
7. 250 ml graduated cylinders
8. Wash bottle

CHEMICALS REQUIRED

1. Manganous sulphate solution
2. Alkaline iodide-Azide solution
3. Sulfuric acid
4. Concentrated Starch indicator solution
5. Sodium thiosulphate
6. Distilled or deionized water
7. Potassium Hydroxide
8. Potassium Iodide
9. Sodium Azide

REAGENTS PREPARATION

Manganous Sulphate:

Dissolve 480 g $MnSO_4.4H_2O$, 400 g $MnSO_2.2H_2O$ or 364 g $MnSO_4.H_2O$ in distilled water, filter and dilute to 1 litre.

Alkali iodide-azide reagent.

Dissolve 500 g NaOH or 700 g KOH and 135 g NaI or 150 g KI in distilled water and dilute to 1 litre. Add 10 g sodium azide (NaN_3) dissolved in 40 mL distilled water. The reagent should not give colour with starch when diluted and acidified.

Starch indicator:

Add cold water suspension of 5 g soluble starch to approximately 800 mL boiling water with stirring. Dilute to 1 litre, allow to boil for a few minutes and let settle overnight. Use supernatant liquor.

Stock sodium thiosulphate, 0.1N:

Dissolve 24.82g $Na_2S_2O_3.5H_2O$ in distilled water. Preserve by adding 0.4g solid NaOH or 1.5mL of 6N NaOH and dilute to 1000mL.

Standard sodium thiosulphate, 0.025N:

Dissolve 6.205 g sodium thiosulphate ($Na_2S_2O_3.5H_2O$) in freshly boiled and cooled distilled water and dilute to 1 litre. Preserve by adding 5 mL chloroform or 0.4 g NaOH/L or 4 g borax and 5 to 10 mg HgI_2/L. Standardise this with 0.025 N potassium dichromate solution which is prepared by dissolving 1.226 g potassium dichromate in distilled water and diluted to 1 litre.

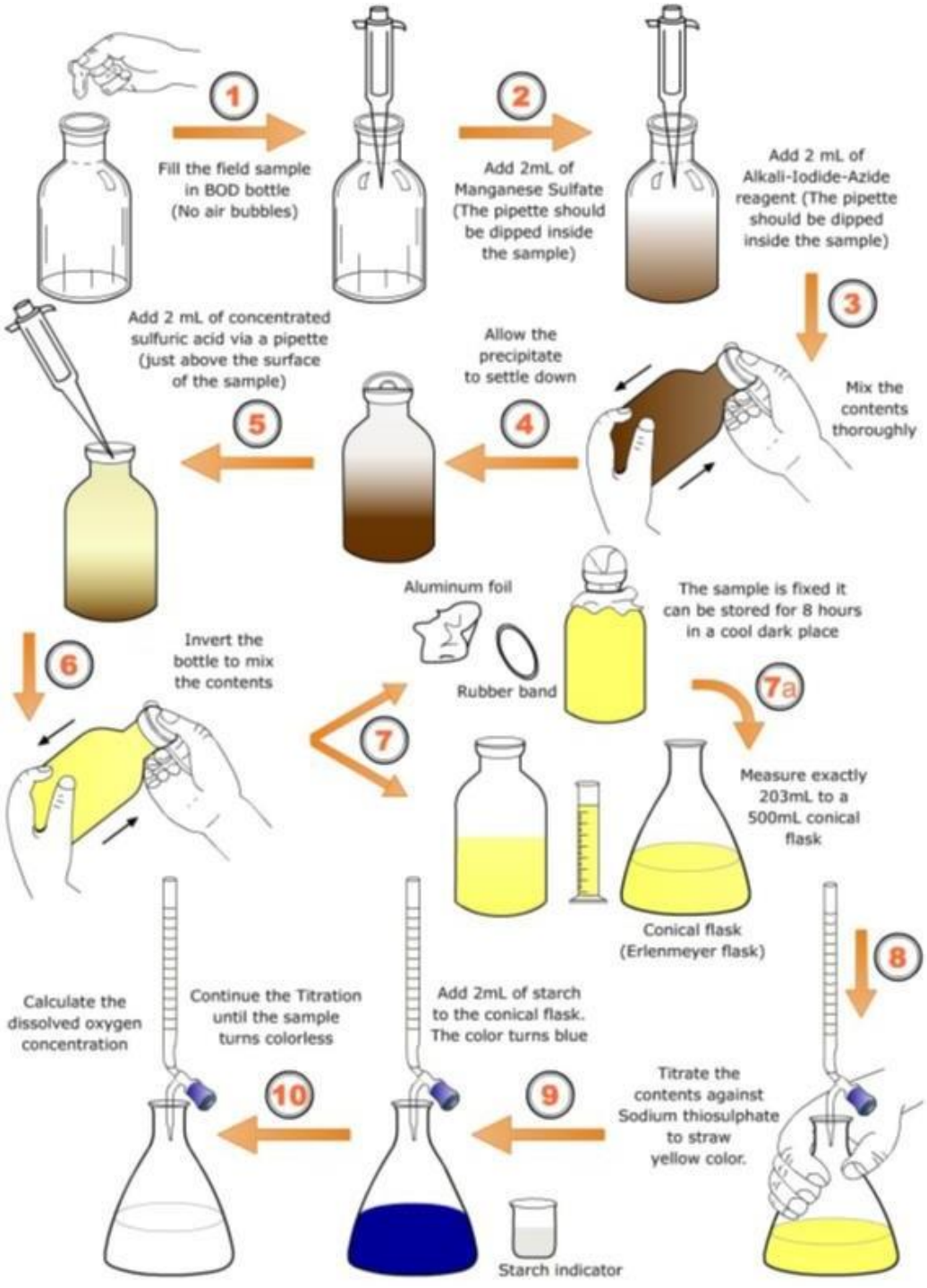
Standardisation of 0.025 N sodium thiosulphate solution:

Dissolve approximately 2 g KI in an Erlenmeyer flask with 100 to 150 mL distilled water. Add 10 mL of H_2SO_4, followed by exactly 20 mL, 0.1 N potassium dichromate solution. Place in the dark for 5 minutes, dilute to approximately 400 mL and titrate with 0.025 N sodium thiosulphate solution, adding starch towards the end of titration. Exactly 20 ml 0.025 N thiosulphate will be consumed at the end of the titration. Otherwise, the thiosulphate solution should be suitably corrected.

PROCEDURE

1. Take two 300-mL glass stoppered BOD bottle and fill it with sample to be tested. Avoid any kind of bubbling and trapping of air bubbles.
2. Add 2mL of manganese sulfate to the BOD bottle by inserting the calibrated pipette just below the surface of the liquid.
3. Add 2 mL of alkali-iodide-Azide reagent in the same manner.
4. Squeeze the pipette slowly so no bubbles are introduced via the pipette (The pipette should be dipped inside the sample while adding the above two reagents. If the reagent is added above the sample surface, you will introduce oxygen into the sample).
5. If oxygen is present, a brownish-orange cloud of precipitate or flock will appear.
6. Allow it to settle for sufficient time in order to react completely with oxygen.
7. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample.
8. Carefully stopper and invert several times to dissolve the floc.
9. At this point, the sample is "fixed" and can be stored for up to 8 hours if kept in a cool, dark place.
10. Rinse the burette with sodium thiosulphate and then fill it with sodium thiosulphate. Fix the burette to the stand.
11. Measure out 203 mL of the solution from the bottle and transfer to an conical flask.
12. Titration needs to be started immediately after the transfer of the contents to conical flask.

13. Titrate it against sodium thiosulphate using starch as indicator. (Add 3 – 4 drops of starch indicator solution)
14. End point of the titration is first disappearance of the blue color to colorless.
15. Note down the volume of sodium thiosulphate solution added which gives the dissolved oxygen



ENVIRONMENTAL SIGNIFICANCE

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement) and as a waste product of photosynthesis. Environmental impact of total dissolved solids gas concentration in water should not exceed 110% (above 13-14 mg/l). Concentration above this level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare

occurrence. The bubbles or emboli block the flow of blood through blood vessels causing death. External bubbles emphysema can also occur and be seen on fins, on skin and on other tissue. Aquatic invertebrate are also affected by "gas bubble disease," but at levels higher than those lethal to fish. Adequate dissolved oxygen is necessary for good water quality
the dissolved oxygen level in natural unpolluted waters at normal temperature is found to be of the order of 10mg/l

In general, the following guidelines apply for aquatic life:

0-2 mg/L: not enough oxygen to support life
2-4 mg/L: only a few kinds of fish and insects can survive
4-8 mg/L: acceptable for warm water fish
7-11mg/L: very good for most stream fish including cold water fish

CALCULATIONS

SODIUMTHIOSUPHATE VS POTASSIUM CHROMATE

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Na2S2O3.5H2O consumed
			Initial	Final	
1					
2					
3					

$$N_1V_1=N_2V_2$$

Where
N_1 = Normality of potassium dichromate
V_1 = Volume of potassium dichromate
N_2 = Normality of sodiumthiosulphate
V_2 = Volume of potassium sodiumthiosulphate

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Volume of sodium thiosulphate Consumed (ml)
			Initial	Final	
1					
2					
3					

$$\text{Dissolved oxygen} = \frac{\text{Volume of sodiumthiosulphate consumed} \times N \times 1000}{\text{Volume of sample taken}}$$

RESULT AND REPORT

1. The DO present in a given water sample-1 is =_____ppm

2. The DO present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water will produce_____effect. It requires_____treatment.

2. The sample- 2 water will produce_____effect. It requires_____treatment.

DETERMINATION OF BOD

OBJECTIVE
To determine biochemical oxygen demand in the given water sample

PRINCIPLE
This test measures the oxygen utilised for the biochemical degradation of organic material (carbonaceous demand) and oxidation of inorganic material such as sulphides and ferrous ions during a specified incubation period. It also measures the oxygen used to oxidize reduced forms of nitrogen (nitrogenous demand) unless their oxidation is prevented by an inhibitor. Temperature effects are held constant by performing a test at fixed temperature. The methodology of BOD test is to compute a difference between initial and final Do of the samples incubation. Minimum 1.5 L of sample is required for the test. DO is estimate by iodometric titration. Since the test is mainly a bio-assay procedure, it is necessary to provide standard conditions of temperature, nutrient supply, pH (6.5-7.5), adequate population of microorganisms and absence of microbial-growth-inhibiting substances. The low solubility of oxygen in water necessitates strong wastes to be diluted to ensure that the demand does not increase the available oxygen. A mixed group of microorganisms should be present in the sample; otherwise, the sample has to be seeded. Generally, temperature is controlled at 20ºC and the test is conducted for 5 days, as 70 to 80% of the carbonaceous wastes are oxidized during this period. The test can be performed at any other temperature provided the correlation between BOD_5 20ºC is established under same experimental condition (for example BOD_5, 27ºC) is equivalent to BOD3, 27ºC) for Indian conditions. While reporting the results, the incubation period in days and temperature in ºC is essential to be mentioned.

APPARATUS REQUIRED
1. BOD Incubator
2. Burette & Burette stand
3. 300 ml glass stopper BOD bottles
4. 500 ml conical flask
5. Pipettes with elongated tips
6. Pipette bulb
7. 250 ml graduated cylinders

CHEMICALS REQUIRED
1. Calcium Chloride
2. Magnesium Sulphate
3. Ferric Chloride
4. Di Potassium Hydrogen Phosphate
5. Potassium Di Hydrogen Phosphate
6. Di sodium hydrogen phosphate
7. Ammonium Chloride
8. Manganous sulphate
9. Potassium hydroxide

10. Potassium iodide
11. Sodium Azide
12. Concentrated sulfuric acid
13. Starch indicator
14. Sodium thiosulphate.

PREPARATION OF REAGENTS

Manganous Sulphate
12 gms of Manganous Sulphate is dissolved in 25m1 of distilled water.

Alkali iodide-azide reagent.

1. To prepare this reagent we are going to mix three different chemicals
2. Dissolve either
3. 500 g of Sodium Hydroxide (or) 700 g of Potassium Hydroxide and
4. 135 g of Sodium Iodide (or) 150 g of Potassium Iodide
5. To prepare this reagent, take 700 g of Potassium hydroxide and add 150 g of potassium iodide and dissolve it in freshly boiled and cooled water, and make up to 1000 mL (One litre). Dissolve 10 g of Sodium Azide in 40 mL of distilled water and add this with constant stirring to the cool alkaline iodide solution prepared.

Starch indicator: Prepare paste or solution of 2.0g of soluble starch powder and 0.2g salicylic acid as preservative in distilled water. Pour this solution in 100mL boiling distilled water. Continue boiling for a few minutes, cool and then use.

Stock sodium thiosulphate, 0.1N: Dissolve 24.82g $Na_2S_2O_3.5H_2O$ in distilled water.
Preserve by adding 0.4g solid NaOH or 1.5mL of 6N NaOH and dilute to 1000mL.

Standard sodium thiosulphate, 0.025N: Dilute 250mL stock $Na_2S_2O_3$ solution to 1000mL with freshly boiled and cooled distilled water. Add preservative before making up the volume.(This should be standardised with standard dichromate solution for each set of titrations).

Calcium Chloride solution

Weigh accurately 27.5 g of anhydrous calcium chloride and dissolve it in distilled water. Take 100 mL standard measuring flask and place a funnel over it. Transfer it to the 100 mL standard flask and make up to 100 mL using distilled water.

Magnesium Sulphate solution

Weigh accurately 22.5 g of magnesium sulphate and dissolve it in distilled water. Take 100 mL standard measuring flask and place a funnel over it. Transfer it to the 100 mL standard flask and make up to 100 mL using distilled water.

Ferric Chloride solution

Weigh accurately 0.15 g ferric chloride and dissolve it in distilled water. Take 100 mL standard measuring flask and place a funnel over it. Transfer it to the 100 mL standard flask and make up to 100 mL using distilled water.

Phosphate buffer solution

Weigh accurately 8.5g of Potassium Di Hydrogen Phosphate (KH_2PO_4) and dissolve it in distilled water.
Then add exactly 21.75 g of Di Potassium Hydrogen Phosphate (K_2HPO_4) and dissolve it. To the same beaker 33.4 g of Di sodium hydrogen phosphate $7H_2O$), is weighed and added. Finally to the beaker containing all the salts, add accurately 1.7 g of Ammonium Chloride (NH_4Cl) and dissolve it. Take 1000 mL standard measuring flask and place a funnel over it. Transfer it to the 1000 mL standard flask and make up to 1000 mL using distilled water. The pH should be 7.2 without further adjustment.

Dilution Water

High quality organic free water must be used for dilution purposes. The required volume of water (five litres of organic free distilled water) is aerated with a supply of clean compressed air for at least 12 hours. Allow it to stabilize by incubating it at 20^{o}C for at least 4 hours. For the test we have taken five litres of organic free aerated distilled water, hence add 5mL each of the nutrients.

1. Add 5mL calcium chloride solution
2. Add 5mL magnesium sulphate solution
3. Add 5mL ferric chloride solution and
4. Add 5mL phosphate buffer solution

This is the standard dilution water. Prepare dilution water 3 to 5 days before initiating BOD test to ensure that the BOD of the dilution water is less than 0.2 mg/L.

PROCEDURE

Testing of Sample

1. Take four 300 mL glass stoppered BOD bottles (two for the sample and two for the blank).
2. Add 10 mL of the sample to each of the two BOD bottles and the fill the remaining quantity with the dilution water. i.e., we have diluted the sample 30 times.
3. The remaining two BOD bottles are for blank, to these bottles add dilution water alone.
4. After the addition immediately place the glass stopper over the BOD bottles and note down the numbers of the bottle for identification.
5. Now preserve one blank solution bottle and one sample solution bottle in a BOD incubator at 20^{o}C for five days.
6. The other two bottles (one blank and one sample) needs to be analysed immediately. Avoid any kind of bubbling and trapping of air bubbles. Remember – no bubbles!
7. Add 2mL of manganese sulfate to the BOD bottle by inserting the calibrated pipette just below the surface of the liquid.
8. Add 2 mL of alkali-iodide-azide reagent in the same manner.
9. (The pipette should be dipped inside the sample while adding the above two reagents. If the reagent is added above the sample surface, you will introduce oxygen into the sample.)
10. Allow it to settle for sufficient time in order to react completely with oxygen.
11. When this floc has settled to the bottom, shake the contents thoroughly by turning it upside down.

12. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample. Carefully stopper and invert several times to dissolve the floc.
13. Titration needs to be started immediately after the transfer of the contents to Erlenmeyer flask.
14. Rinse the burette with sodium thiosulphate and then fill it with sodium thiosulphate. Fix the burette to the stand.
15. Measure out 203 mL of the solution from the bottle and transfer to an Erlenmeyer flask.
16. Titrate the solution with standard sodium thiosulphate solution until the yellow color of liberated Iodine is almost faded out. (Pale yellow color)
17. Add 1 mL of starch solution and continue the titration until the blue color disappears to colourless.
18. Note down the volume of sodium thiosulphate solution added , which gives the D.O. in mg/L. Repeat the titration for concordant values.
19. After five days, take out the bottles from the BOD incubator and analyse the sample and the blank for DO.
20. Add 2mL of manganese sulfate to the BOD bottle by inserting the calibrated pipette just below the surface of the liquid.
21. Add 2 mL of alkali-iodide-azide reagent in the same manner.
22. If oxygen is present, a brownish-orange cloud of precipitate or floc will appear.
23. Allow it to settle for sufficient time in order to react completely with oxygen.
24. When this floc has settled to the bottom, shake the contents thoroughly by turning it upside down.
25. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample.
26. Carefully stopper and invert several times to dissolve the floc.
27. Titration needs to be started immediately after the transfer of the contents to Erlenmeyer flask.
28. Rinse the burette with sodium thiosulphate and then fill it with sodium thiosulphate. Fix the burette to the stand.
29. Measure out 203 mL of the solution from the bottle and transfer to an Erlenmeyer flask.
30. Titrate the solution with standard sodium thiosulphate solution until the yellow color of liberated Iodine is almost faded out. (Pale yellow color)
31. Add 1 mL of starch solution and continue the titration until the blue color disappears to colourless.

Note down the volume of sodium thiosulphate solution added, which gives the D.O. in mg/L. Repeat the titration for concordant values.

ENVIRONMENTAL SIGNIFICANCE

The Biochemical Oxygen Demand (BOD) is an empirical standardized laboratory test which measures oxygen requirement for aerobic oxidation of decomposable organic matter and certain inorganic materials in water, polluted waters and wastewater under controlled conditions of temperature and incubation period. The quantity of oxygen required for above oxidation processes is a measure of the test. The test is applied for fresh water sources (rivers, lakes), wastewater (domestic, industrial), polluted receiving water bodies, marine water (estuaries, coastal water) and also for finding out the level of pollution, assimilative capacity of water body and also performance of waste treatment plants. Guideline BOD values for classification of raw untreated water is given below

BOD Level	Water quality
1-2	**Very Good**: there will not be much organic matter present in the water supply
3-5	**Fair:** moderately clean
6-9	**Poor:** somewhat polluted-usaully indicates that organic matter present and micro organisms are decomposing that waste
100 or more	**Very poor:** very polluted-contains organic matter

CALCULATIONS

S.No	Name of sample	Volume of water sample	Burette reading (ml)		Volume of sodium thio sulphate Consumed (ml)
			Initial	Final	
1					
2					
3					

Dissolved oxygen = $\frac{\text{Volume of sodiumthiosulphate consumed} \times 0.2 \times 1000}{\text{Volume of sample taken}}$

Calculate BOD of the sample as follows

a. When dilution water is not seeded

BOD as O2 mg/L = (D1 –D2) x 100/% dilution

b. When dilution is seeded

BOD O2 mg/L = (D1 – D2) – (B1 –B2) x 100/ % dilution

c. When material is added to sample or to seed control

BOD O2 mg/L = (D1 – D2) – (B' 1 x B' 2) x F x 100/ % dilution

where,

D1 = DO of sample immediately after preparation, mg/L,

D2 = DO of sample after incubation period, mg/L

B1 = DO of blank (seeded dilution water) before incubation, mg/L

B2 = DO of blank (seeded dilution water) after incubation, mg/L

F = ration of seed in diluted sample to seed in seed control (Vol. Of seed in diluted sample / Vol. of seed in seed control)

B' 1 = DO of seed control before incubation, mg/L

B' 2 = DO of seed control after incubation, mg/L In CALCULATIONSs, do not make corrections for DO uptake in dilution water.

RESULT AND REPORT

1. The BOD present in a given water sample-1 is =_____ppm

2. The BOD present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water requires_____treatment.

2. The sample- 2 water requires_____treatment.

VIVA

1. Eutrophication generally
   b) Does not impact oxygen content of water
   b) Deprives water with oxygen
   c) Increase oxygen content of water
   d) All of the above

2. Higher BOD
   a) lower water pollution
   b)lesser bacteria in it
   c) more water pollution
   d)more air pollution

3. BOD measures the
   a) amount of bacteria in a given sample of water
   b) amount of algae being decomposed in a given sample
   c) amount of oxygen bacteria need to decompose organic matter in a given sample
   d) amount of oxygen bacteria need to decompose organic matter in a given sample in a fixed period of ti

4. BOD refers to the
   a) Bidding of Dermatology
   b)Binding of Dirt
   c)Biochemical occupied Date
   d)Biochemical Oxygen demand

5. Fish die as a result of water pollution due to
   a) less BOD
   b)more tolerance range for oxygen
   c) narrow tolerance range for oxygen
   d)zero tolerance range for oxygen

6. Narrow tolerance of oxygen (O_2) is found in
   a) Humans b)plants c)mammals d)fish

7. For how long would a sample of water normally be incubated during the measurement of BOD?
   a)1 day b)2days c)4days d)5days

8. Which of the following methods is used to measure the portion of total carbon oxidized by microorganisms over a 5-day period at 20 degrees Celsius
   a)TOC B)COD c)BOD d)all of the above

9. At what temperature would a sample of water normally be incubated during the measurement of BOD?
   a)0 b)5 c)15 d)20

10. Biochemical Oxygen Demand (B.O.D.) of safe drinking water must be
    a)20 b)25 c)35 d)40

11. Winkler titration method is based on property of Dissolved Oxygen.
    a) Reduction b) Oxidation c) Redox d) Decomposition

12. Dissolved oxygen in the water mainly depends upon Organic content of the water.
    a) organic matter b) inorganic matter c)chemicals d)none

13. The ingredients of Alkali are NaOH, NaI
    a) NaN_4 b) NaN_3 c) NaN_2 d) NaN

14. The precipitate formed after the addition of $MnSO_4$ and Alkali azide is .
    a) Manganese Hydroxide b) Sodium sulphate
    c) Potassium sulphate d) Manganese oxide

15. Low amount of dissolved oxygen in river water indicates
    a). High level of free oxygen in water b). High level of pollution in water
    c). Low level of pollution in water
    d). That the surrounding atmosphere is having low amount of oxygen.

16. Along the stream the increase in dissolved oxygen in water will be at the
    a) riffles b) warm pool c) bank erosion d) top

17. The dissolved Oxygen in potable water .
    a) imparts freshness b) improves taste c) improves smell d) imparts colour

18. Sulphide and Sulphur dioxide interfere in the determination of dissolved oxygen.
    a) True b) False

19. The sample obtained for testing Dissolved Oxygen can be preserved by
    a) adding the reagents and stored at 10 to 20 for up to 8 hours
    b) storing at room temperature for up to 24 hours c) storing at 0 for up to 24 hours
    d) adding the reagents and stored at room temperature for up to 24 hours

20. Minimum DO in the fresh water for the survival of aquatic life is
    a) 0 mg/l b) 2 mg/l c) 8 mg/l d) 4 mg/l

KEY

1 b	2 c	3 d	4 d	5c	6d	7 d	8c	9a	10a
11 b	12 b	13 b	14 a	15b	16a	17 a	18a	19a	20d

EXPEIRMENT 12

DETERMINATION OF RESIDUAL CHLORINE

AIM

To determine the amount of chloride present in the given sample

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 ion according to1 mole of $AgNO_3$ reacts with 1 mole of chloride. The titrant concentration is generally 0.02 M. Silver chloride is precipitated quantitatively, before red silver chromate 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).

APPARATUS REQUIRED

1. Burette with stand
2. Pipette
3. Conical flask measuring jar etc.,

CHEMICALS REQUIRED

1. Sodium Chloride
2. Silver nitrate
3. Potassium Chromate

REAGENTS PREPARATION

Standard silver nitrate solution 0.0141 N:

Dissolve 2.395 g $AgNO_3$ in distilled water and dilute to 1 litre. Standardise against 0.0141 N NaCl. Store in a brown bottle

Standard sodium chloride 0.0141N:

Dissolve 824.1 mg NaCl (dried at 140°C) in chloride free water and dilute to 1 litre.

Potassium Chromate Solution (K2CrO4)

Dissolve 1 gm of potassium chromate in 20m1 of distilled water.

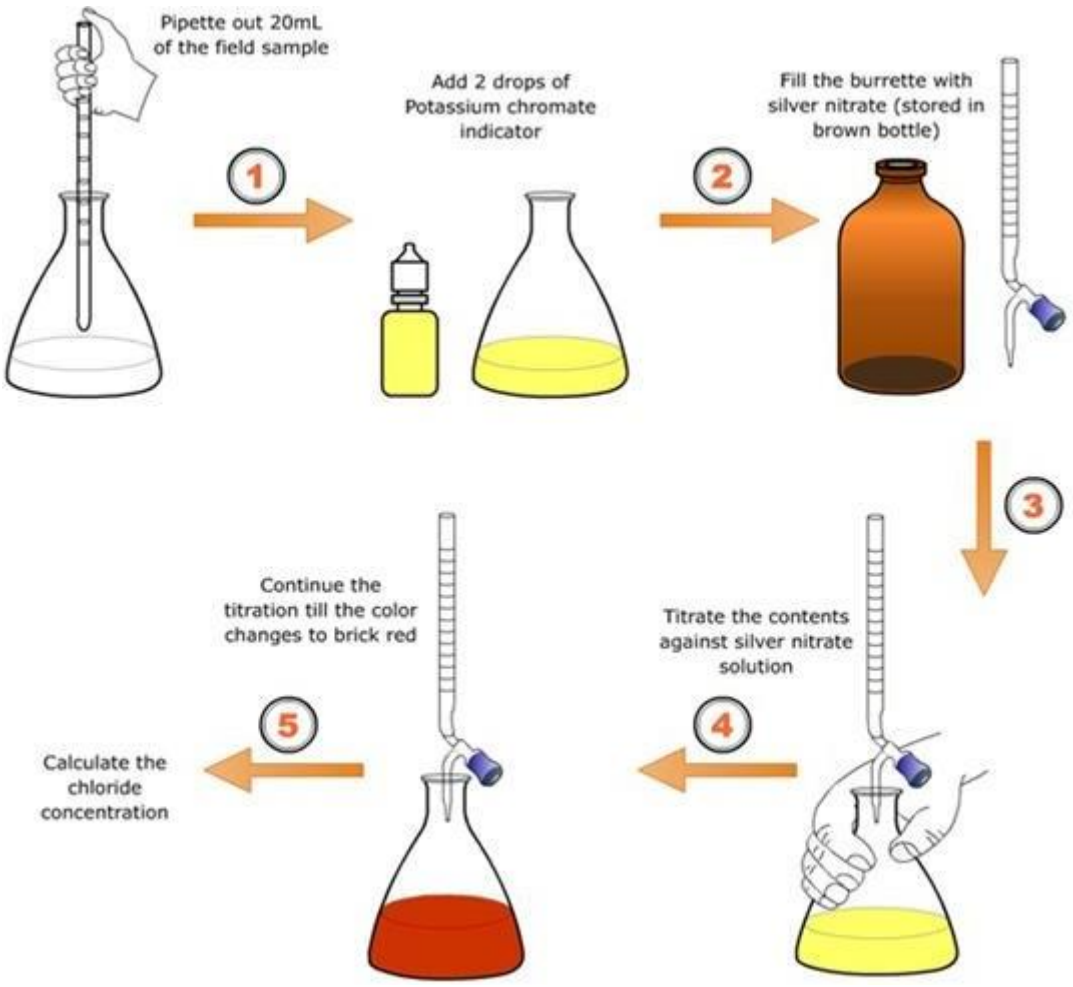
PROCEDURE

Standardization of Silver Nitrate Solution

1. Pipette 20 ml of sodium chloride solution in to the conical flask.
2. Add one or two drops of potassium chromate solution.
3. Titrate against Silver Nitrate solution until the appearance of reddish brown colour
4. Re peat the titration for concordant values.

Silver Nitrate Vs Sample -

1. Pipette 20 ml of sample in the conical flask.
2. Add one or two drops of potassium chromate solution
3. Titrate against silver Nitrate solution until the appearance of reddish brown colour.
4. Repeat the titration for concordant values.



ENVIRONMENTAL SIGNIFICANCE

Chloride associated with sodium exerts salty taste, when its concentration is more than 250 mg/1 .There is no known evidence that chloride- constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/L in supplies intended for public use. In many areas of world where water supplies are scarce, sources containing as much as 2000mg/L are used for domestic purposes without the development of adverse effect once the human system becomes adapted to the water.

It can also corrode concrete by extracting calcium in the form of calcide. Magnesium chloride in water generates hydrochloric acid after heating which is also highly corrosive and create problems in boilers.

The high concentrations of chloride ions mostly results in an unpleasant salty taste of water and it also aides the corrosion of plumbing system. Very high chloride content of water may also produce laxative effect. An upper limit of 250 mg/L has been set for the chloride ions. An increase in the normal chloride content of your water may indicate possible pollution from human sewage, animal manure or industrial wastes. As all aware the sea water is full of sodium chloride, the chloride levels will be much higher compared to the fresh water sources.

CALCULATIONS

SILVER NITRATE VS SODIUM CHLORIDE

S.No	Name of sample	Volume of water sample	Burette reading (ml)		$AgNO_3$ consumed
			Initial	Final	
1					
2					
3					

$$N_1V_1=N_2V_2$$

Where
N_1 = Normality of NaCl,
V_1 = Volume of NaCl,
N_2 = Normality of silver nitrate
V_2 = Volume of silver nitrate

SILVER NITRATE VS SAMPLE

S.No	Name of sample	Volume of water sample	Burette reading (ml)		$AgNO_3$ consumed
			Initial	Final	
1					
2					

$$\text{Chlorides} = \frac{\text{Volume of } AgNO_3 \times \text{Normality } AgNO_3 \times 35.45 \times 1000}{\text{Volume of sample taken}}$$

RESULT AND REPORT

1. The phenolphthalein alkalinity present in a given water sample-1 is =_____ppm
2. The phenolphthalein alkalinity present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water will produce_____effect. It requires_____treatment.
2. The sample- 2 water will produce_____effect. It requires_____treatment.

VIVA

1. The limit of chlorides in drinking water as per IS code is

a) 200 ppm b) 225 ppm c) 250 ppm d) 500 ppm

2. Silver nitrate is stored in a brown bottle

a) to avoid decomposition by sun light b) because it is dark in colour
d) because the solution is colourless d) to avoid heat

3.The colour of Silver Chromate is

a) Milky White b) Opale Yellow c) Colourless d) Brick Red

4. When both hardness and chloride content are very high above 500 mg/L, then the water will be

a) Non salty in nature b) Fit for drinking c) Salty in nature d) Soft water

5. Presence of chloride can corrode_____.

a) GI pipes b) Rubber tubes c) PVC pipes d) Glass pipes

6. The chloride concentration in sewage is

a) More concentrated than the municipal water supplied
b) Equal concentration to the municipal water supplied
c) Less concentrated than the municipal water supplied
d) Only in trace

7. Chloride consumed by human beings

a) Pass through the fecal matter as it is b) Gets changed into other forms
d) Gets disappeared in the body d) Stored in bones

8. Chloride gives salty taste to water particularly when present as_____.

a) Sodium chloride b) Magnesium chloride
d) Potassium chloride d) Zinc chloride

9. The point at which a clear visual change is observed after the reaction between titrant and titrates is called

a) End point b) Equivalence point c) Equal point d) Double equivalence point

10. Most common ion in the water is

a) Fluoride b) Nitrate c) Chloride d) Sulphate

KEY

1c 2 a 3 bd 4 c 5a 6a 7 a 8 a 9 a 10 c

EXPEIRMENT 13

TOTAL COUNT NO.

AIM

To find the Most Probable Number (MPN) of bacterial density by E.coli test.

PRINCIPLE

Coliform group comprises of all the aerobic, facultative and anaerobic gram- negative non-spore forming rod shaped bacteria that ferment lactose with gas formation within 48 hours at 35°C. The standard test for this group may be carried out either by multiple tube fermentation technique or by membrane filter technique. The E.coli test by multiple tube fermentation technique consists of 3 phases – presumptive, confirmed and completed. Escherichia coli (E.coli) for the purpose of sanitary examination of water, is defined as a gram-negative, nonspore forming rod which is capable of fermenting lactose with the production of acid and gas at 35°C in less than 48 hours, which produces indole peptone water containing tryptophan, which is incapable of utilising sodium citrate as its sole source of carbon, which is incapable of producing acetyl methyl carbinol, and which gives a positive methyl red test. The results are expressed in terms of MPN (Most Probable Number), which is based on certain probability formulae. The estimate may give a value greater than the actual number of coliform present. The accuracy of any single test depends on the number of tubes fermented. This method helps in describing the sanitary quality of water. The safety of the water is generally judged from the knowledge of sanitary condition and mentioned by the number of samples yielding positive or negative results. If more than 95% should yield negative results, the safety is usually assured. The scheme of the MPN test is given as follows:

APPARATUS

Fermentation tubes, Petri dishes, Autoclave, Incubator, Test tubes, Pipettes Measuring jars, Inoculating equipments,Media preparation utensils etc.

CHEMICALS REQUIRED

1. Lactose broth
2. Lauryl tryptose broth
3. Brilliant green lactose bile broth
4. Endo agar
5. Eosin methylene blue agar etc.

REAGENTS PREPARATION

Lactose broth

Beef extract 3 g, peptone 5 g, lactose 5 g and reagent grade distilled water 1 litre. Add these ingredients to reagent grade distilled water, mix thoroughly and heat to dissolve. pH should be 6.8 7.0 after sterilization.

Lauryl tryptose broth

Tryptose 20 g, lactose 5 g, K_2HPO_4 2.75 g, KH_2PO_4 2.75 g, NaCl 5 g, sodium lauryl sulphate 0.1 g, reagent grade distilled water 1 litre, sterilise and use. Add dehydrated ingredients to water, mix thoroughly and heat to dissolve. pH should be 6.8 ±2 after sterilization.

Endo agar

Peptone 10 g, lactose 10 g, K_2HPO_4 3.5 g, agar 15 g, sodium sulphite 2.5 g, basic fuchsin 0.5 g, distilled water 1 litre, pH 7.4 after sterilization.

EMB agar
Peptone 10 g, lactose 10 g, K_2HPO_4 2 g, agar 15 g, eosin 0.4 g, methylene blue 0.065 g, distilled water 1 litre, pH should be 7.1 after sterilisation.

Brilliant green lactose bile broth
Peptone 10 g, lactose 10 g, oxgall 20 g, brilliant green 0.0133 g, distilled water 1 litre, pH should be 7.2 after sterilisation and is then ready for use. Store away from direct sunlight to extend the reagent stability to 6 months.

PROCEDURE
General Clean and sterilise all the glasswares.

Presumptive Test
1. Inoculate a series of fermentation tubes with appropriate graduated quantities (multiples and sub-multiples of 10) of the water to be tested. The concentration of nutritive ingredients in the mixture of the medium should conform to the specifications. The partitions of the water sample used for inoculating lactose or lauryl tryptose broth fermentation tubes will vary in size and number with the character of the water under examination. Usually, decimal multiples and sub-multiples of 1mL of the sample are selected. Inoculate 10 mL portion of each water sample provided into different one of the three large tubes containing 10 mL of lactose or lauryl tryptose broth which has been prepared with twice the normal concentration of constituent to allow for dilution. Inoculate 1.0 mL and 0.1 mL of water into small tubes (two sets of three each) of single strength lactose or lauryl tryptose broth.
2. Incubate the inoculated fermentation tubes at 35±0.5°C. At the end of 24±2 hrs shake each tube gently and examine and if no gas is formed, repeat this test at the end of 48±3 hrs.
3. Record the presence or absence of gas formation at each examination of the tubes. Formation within 48±3 hrs of gas in any amount in the inverted fermentation tubes constitutes a positive presumptive test. Active fermentation may be shown by the continued appearance of small bubbles of gas throughout the medium outside the inner vial in the fermentation tubes. Presumptive test without confirmation should not be used routinely except in the analysis of heavily polluted water, sewage or other waste, which are not suitable for drinking purpose.

CONFIRMED TEST
1. Lactose or lauryl tryptose broth may be used for primary fermentation in presumptive test to avoid false positive results.
2. Brilliant green lactose bile broth fermentation tubes are used in confirmed test.
3. Submit all primary fermentation tubes showing any amount of gas at the end of 24 hrs incubation to the confirmed test.
4. Gently shake primary fermentation tube showing gas formation and with a sterile metal loop, transfer one loop full of medium to a fermentation tube containing brilliant green lactose bile broth.
5. Incubate the inoculated brilliant green lactose bile broth tube for 48±3 hrs at 35±0.5°C.
6. The formation of gas in any amount in the inverted vial of the brilliant green lactose bile broth fermentation tube at any time within 48±3 hrs constitutes a positive confirmed test.
7. If no gas is formed, it is a negative confirmed test and E.coli is absent.

COMPLETED TEST
Completed test is the next step following the confirmed test. It is applied to the brilliant green lactose bile broth fermentation tubes showing gas in the confirmed test.
1. Streak one or more endo or Eosin Methylene Blue (EMB) agar plates (taken in Petri dishes) from each tube of brilliant green lactose bile broth showing gas.

2. While streaking it is essential to ensure the presence of some discrete colonies separated by at least 0.5 cm from one another.
3. Insert the end of the streaking needle into the liquid in the tube to a depth of 5mm.
4. Streak the plate by bringing only the curved section of the needle in contact with the agar surface so that the latter will not be scratched or torn.
5. Incubate the Petri dishes (inverted) at 35 ± 0.5°C for 24 ± 2 hrs.
6. The colonies developing on endo or eosin methylene blue agar may be typical (unnucleated, with or without metallic sheen) atypical (opaque, unnucleated, mucoid, pink after incubation for 24 hrs) or negative (all others).
7. From each of these plates fish out one or two colonies and transfer to lauryl tryptose broth fermentation tubes and to nutrient agar slants.
8. Incubate the secondary broth tubes and agar slants at 35 ± 0.5°C for 24 ± 2 hrs or 48 ± 3 hrs and if gas is not produced in 24 hrs gram stained preparation from these agar slant cultures are made.
9. The gas formation in the secondary lauryl tryptose broth tubes and the demonstration of gram-negative non-spore forming rod shaped bacteria in agar culture may be considered a satisfactory positive completed test.
10. If after 48 ± 3 hrs gas is produced in the secondary fermentation tubes and no spore of gram positive rod are found on the slant, the test may be considered as positive completed test and this demonstrates the presence of coliform organisms.

(OR)

FIRST PERIOD

MATERIAL

1. Nine tubes of double-strength lactose broth
2. 10, 1.0 and 0.1 ml pipets
3. Water samples Procedure: (work in groups of four)

PROCEDURE: (work in groups of four)

Presumptive Test

1. Take a water sample (dilute as instructed in some cases) and inoculate three tubes of lactose broth with 10 ml, three tubes with 1.0 ml and three tubes with 0.1 ml.
2. Incubate all tubes at 37o C for 24 hours.

SECOND PERIOD

MATERIAL

EMB agar plates Procedure:

PRESUMPTIVE TEST

1. Observe the number of tubes at each dilution that show gas production in 24 hrs. Record results.
2. Reincubate for an additional 24 hours at 37°C.

CONFIRMED TEST

1. Inoculate an EMB plate with material from a tube containing gas.
2. Invert and incubate the plate at 37°C for 24 hours

THIRD PERIOD

MATERIAL

1. Lactose broth tubes
2. Nutrient agar slants

PROCEDURE

Presumptive Test

Observe the number of tubes at each dilution that show gas. Record results and determine the most probable number index.

Confirmed Test

Observe EMB agar plates. A positive confirmed test is indicated by small colonies with dark centers and a green metallic sheen (E. coli). Record results.

Completed Test

1. Inoculate a lactose broth tube and a nutrient agar slant with organisms from the EMB plate.
2. Incubate the broth tube and agar slant at 37°C for 24 hours.

FOURTH PERIOD

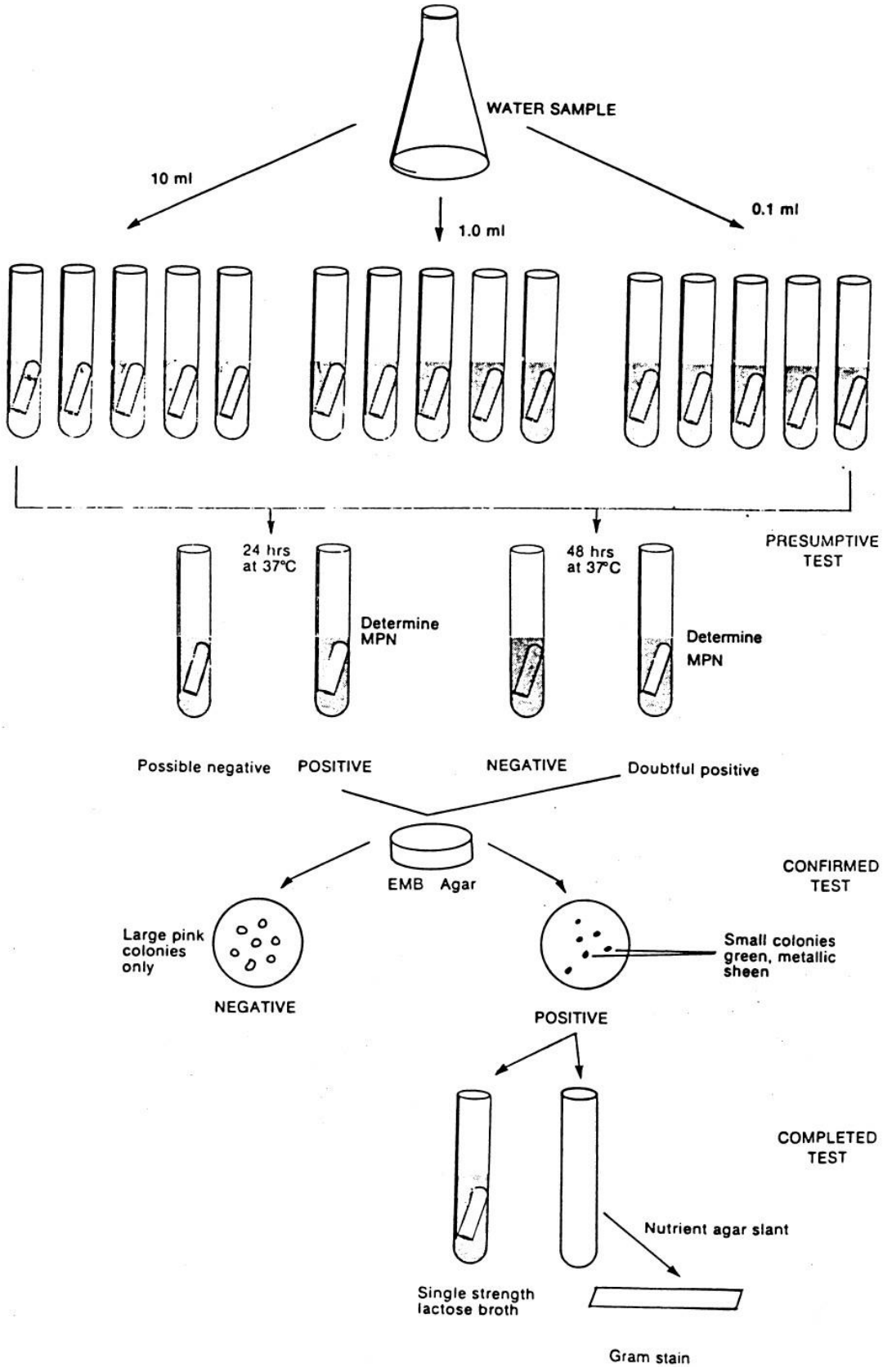
PROCEDURE

Completed Test

1. Check for gas production in the lactose broth tube.
2. Make a Gram stain from the organisms on the nutrient agar slant.
3. Record results.

TABLE: MPN DETERMINATION FROM MULTIPLE TUBE TEST

NUMBER OF TUBES GIVING POSITIVE REACTION OUT OF			MPN Index per 100ml	95 PERCENT CONFIDENCE LIMITS	
3 of 10 ml each	3 of 1ml each	3 of 0.01ml each		Lower	Upper
0	0	1	3	<0.5	9
0	1	0	3	<0.5	13
1	0	0	4	<0.5	20
1	0	1	7	1	21
1	1	0	7	1	23
1	1	1	11	3	36
1	2	0	11	3	36
2	0	0	9	1	36
2	0	1	11	3	37
2	1	0	13	3	44
2	1	1	20	7	89
2	2	0	21	4	47
2	2	1	28	10	150
3	0	0	23	4	120
3	0	1	39	7	130
3	0	2	64	15	380
3	1	0	43	7	210
3	1	1	75	14	230
3	1	2	120	30	380
3	2	0	93	15	380
3	2	1	150	30	440
3	2	2	210	35	470
3	3	0	240	36	1300
3	3	1	460	71	2400
3	3	2	1100	150	4800


WATER SAMPLE
10 ml
1.0 ml
0.1 ml
24 hrs at 37°C
48 hrs at 37°C
PRESUMPTIVE TEST
Determine MPN
Determine MPN
Possible negative
POSITIVE
NEGATIVE
Doubtful positive
EMB Agar
CONFIRMED TEST
Large pink colonies only
NEGATIVE
Small colonies green, metallic sheen
POSITIVE
COMPLETED TEST
Nutrient agar slant
Single strength lactose broth
Gram stain

CALCULATIONS

Sample No.of Description	Date time of observation	Date time of incubation	Results after incubation for various volumes of samples inculcated (ml) +ve or -ve									Test case
			10	10	10	1	1	1	0.1	0.1	0.1	
												Presumptive test 24 hrs
												Presumptive test 48 hrs
												Confirmed test 24hrs
												Confirmed test 48hrs
												Completed test 24 hrs
												Completed test 24 hrs
Number of +ve tubes												
Ml of sample in _ve tubes												

Case I
For three each of 10ml, 1ml and 0.1ml sample concentration combinations MPN from the MPN Table =_____

Case II
For other combinations and dilutions

$$\frac{\text{MPN}}{100\text{mL}} = \frac{\text{No. of } + \text{ve tubes} \times 100}{\sqrt{\text{mL Sample in} - \text{ve tubes} \times \text{mL sample in all tubes}}}$$

RESULT

MPN/100 mL = _____

INTERPRETATION OF RESULTS

The sample requires_____treatment.

.

.

VIVA

1. The determination of whether special chemical or biological water sample tests are needed can be most aided by:

a) Water hardness b) The yield capacity of the water quality
c) A sanitary survey d) The time of year

2. The single most important consideration about any drinking water supply is its freedom from:

a) Iron staining b) Disease-producing organisms
c) Total dissolved solids d) Chlorides

3. Following are types of microorganisms that can be pathogenic (disease producing) in drinking water:

a) Bacteria b) Protozoa c) Viruses d) All of the above

4. Coliform bacteria:

a) Grow in the intestines of people and warm blooded animals b) Usually cause diseases
c) Respond to water treatment differently than do most other pathogens
d) Exist only in water that contains pathogens
e) All of the above

5. Name the two origins of water borne disease?

a). Biological and chemical b). Physical and chemical
c). Chemical d). Physical

6. A pathogenic organism of unicellular/protozoan group is

a). Escherichia coli b). Salmonella typhi c). Entamoeba hystolytica d). None of the above

7. The bacteria which survive in the absence of oxygen are called

a) Anaerobic b). Aerobic c). Facultative d). E-coli

8 The bacteria which survive in the presence as well as absence of oxygen are called

a). Anaerobic b). Aerobic c). Facultative d). E-coli

9. A harmful organism, which may be present in faecal matter is

a). Bacteria coli b). Escherichia coli c). Vibrio cholera d). None of the above

10. Spherical shaped bacteria

a). Bacilli b). Cocus c). Vibrios d). Spirilla

11. Curved bacteria

a). Bacilli b). Cocus c). Vibrios d). Spirilla

12. One micron is equal to

a). 10^{-7} meter b). 10^{-8} meter c). 10^{-6} meter d). 10^{-10} meter

13. Bacteria which requires oxygen for their survival are

a). Aerobic b). Anaerobic c). Faculative d). All of the above

14. Bacteria are harmless and under certain conditions beneficial to human beings, animals and crops are called

a). Non pathogenic bacteria b). Non pathogens

c). Both d). None

15. Bacteria which are deadly foes of man and animals and may enter their tissues, causing serious water borne diseases are

a). Pathogenic b). Aerobic c). Facultative d). All

KEY

1 c	2 b	3 d	4 a	5a	6c	7 a	8 c	9c	10b
11c	12c	13a	14c	15a					

EXPERIMENT 14

NOISE LEVEL MEASUREMENT

APPARATUS

Sound level meter, noise, walks around the building.

PROCEDURE

Make the measurements suggested below using A weighting and then C weighting. Record all the data indicated by the Table headings below, including Source of Sound, Estimated Distance from Meters, dB (A weighting), dB (C weighting), and your subjective judgments of the loudness of the sounds (such as "very quiet", "medium", "loud", "very loud", etc.). Please cover your ears for all sounds which could be potentially damaging.

REPORT

1. Measure and record the sound pressure level (SPL) produced by the background noise in the lab, along with the other data requested in the Table.
2. Measure and record the SPL produced when your lab partner screams at you as loudly as he or she can. Try two or three difference distances from the sound level meter, e.g., 5 ft., 10 ft. and 15 ft.

   Note to the screamer: Do not scream so loudly that you damage your vocal folds!

   Note to the listener: Cover your ears!
3. Measure and record the SPL produced when your lab partner speaks to you in a normal fashion.
4. Measure and record the SPL produced by singing or playing various musical instruments (if they are available) for two or three different distances from the sound level meter.
5. Have your partner try to sing (or play a musical instrument) a few notes in a scale (within an octave) at what he or she considers to be the same loudness and record the actual sound levels produced when this is attempted. (a) How large a variation typically occurs in the SPL from one note to the next?
6. If anyone has a car parked nearby, it would be interesting to measure the SPL produced by honking the horn, first when the sound level meter is relatively close to the horn, and then when the meter is several feet away from the car.
7. Whistle as loudly as you can and measure the SPL (cover your ears).
8. Record the SPL in a place which you consider to be very quiet (possibly a room next door where no one is present).
9. Turn up the volume of a stereo sound system (one will be set up in the lab) and record the SPL produced under various conditions of your choice.
10. Measure the sound pressure levels produced by anything else which intrigues you. Use your imagination, but keep in mind that you may look a bit suspicious walking around with a strange instrument taking readings now and then.

SOURCE OF SOUND	ESTIMATED DISTANCE FROM	SPL (dB) A - WEIGHTING	SPL (dB) C - WEIGHTING	COMMENTS ON SUBJECTIVE LOUDNESS

VIVA

1. The water to be used for the preparation of cement concrete products should be free from excess of sulphates and chlorides. Why?
2. What is the significance of high sulphate concentration in water supplies and in wastewater disposal?
3. What is the purpose of digestion of the sample in the gravimetric analysis for sulphates?
4. What is the significance of high sulphate concentration in water supplies and in wastewater disposal.
5. In general, what differences do you find between your measurements made with A and C weighting?
6. Why do such differences exist?
7. Based upon the observations you have made during this experiment, what types of situations have exposed your ears to the highest sound levels during your life?
8. Do you think any of these situations were hazardous based upon the Table of Permissible Noise Exposures?

CONTENT BEYOND THE SYLLABUS

DETERMINATION OF NITRATE

AIM

To find the Nitrate nitrogen may be present in small amounts in fresh domestic wastewater

PRINCIPLE

In this experiment, nitrate will be reduced to nitrite with zinc. The nitrite reacts with sulfanilic acid and N-1-naphthylethylenediamine to produce a red compound.The intensity of the red color is analyzed spectrophotometrically. The amount of zincand the contact period are important.

SPECIAL APPARATUS

A spectrophotometer with UV range is used for determination the absorbance at wave length 410nm.

CHEMICALS REQUIRED

1. Stock Nitrate Solution
2. Standard Nitrate Solution
3. Sodium Arsenite Solution
4. Brucine-Sulphanilic
5. Acid Solution
6. Sulphuric Acid Solution
7. Sodium Chloride Solution

REAGENTS

a. Stock potassium nitrate solution:

0.816 g of anhydrous KNO_3 is dissolved in purified water and diluted to 1 liter to produce a 500 mg/L nitrate solution. 100 mL ofthis solution is diluted to 1 liter to produce the stock **50 mg/L nitrate** solution which will be used in this experiment.

a. Preparation of standards:

2.5 mg/L standard : Add 2.5 mL of stock 50 mg/L nitrate solution to a 100-mL graduated cylinder. Add purified water and dilute to a volume of 50 mL. Transfer to a250-mL erlenmeyer flask.

5.0 mg/L standard: Repeat the directions for the 2.5 mg/L standard using 5.0 mL of50 mg/L nitrate solution.

10.0 mg/L standard: Repeat the directions for the 2.5 mg/L standard using 10.0 mLof 50 mg/L nitrate solution.

15.0 mg/L standard: Repeat the directions for the 2.5 mg/L standard using 15.0 mLof 50 mg/L nitrate solution.

b. Experimental: Use the following procedure for treating standards as well as river, lake, well, or sewage water sample

Note: Treated sewage effluent may require a 5 -fold or a 10-fold dilution. A 10-fold dilution can be performed by pipetting 5.0 mL of the treated wastewater (sewage) sample into a 100-mL graduated cylinder and adding enough water to bring

PROCEDURE:

1. Nitrate standards are prepared in the range 0.1–1.0 mg/L diluting 1.00, 2.00, 4.00, 7.00 and 10.0 mL standard nitrate solution to 10 mL with distilled water.
2. If residual chlorine is present 1 drop of sodium arsenite solution is added for each 0.1 mg Cl2 and mixed.
3. Set up a series of reaction tubes in test tube stand. Add 10 mL sample or a portion diluted to 10 mL to the reaction tubes.
4. Place the stand in a cool water bath and add 2 mL NaCl solution and mix well.
5. Add 10 mL H_2SO_4 solution and again mix well and allow cooling.
6. The stand is then placed in a cool water bath and add 0.5 ml brucine- sulphanilic acid reagent. Swirl the tubes and mix well and place the tubes in boiling water bath at temperature 95°C.
7. After 20 minutes, remove the samples and immerse in cool water bath.

8. The sample are then poured into the dry tubes of spectrophotometer and read the standards and sample against the reagent blank at 410 nm.
9. Prepare a standard curve for absorbance value of standards (minus the blank) against the concentration of NO^-_3N.
10. Read the concentration of NO^-_3N in the sample from the known value of absorbance.

ENVIRONMENTAL SIGNIFICANCE

Nitrate and Nitrite are naturally occurring ions that are part of nitrogen cycle. In general, vegetables are the main source of nitrate intake when level in drinking water is below 10 mg/l. When nitrate level in drinking water exceeds 50 mg/l, drinking water becomes the main source of total nitrate intake. The presence of nitrate indicates an old contamination provided nitrites are absent.

High level of nitrate in drinking water due to excessive use of agriculture fertilizers, decayed vegetable water, domestic effluent, sewage disposal industrial discharges, leachable from refuse dumps, atmospheric and atmospheric precipitation has become a serious problem

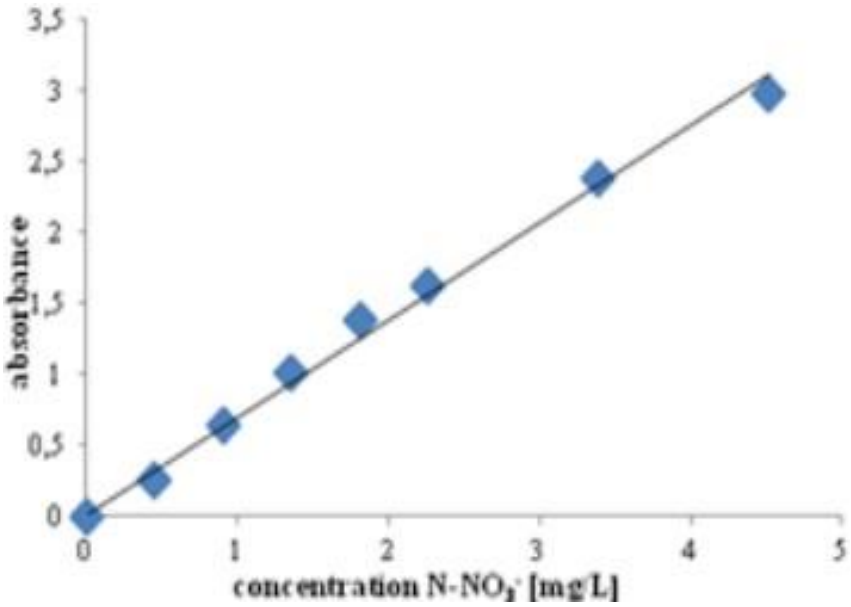
Excess concentration of nitrate causes disease. Methemoglobinemia oxygen transport depends on the maintenance of intra cellular hemoglobin in the reduced (Fe^{2+}) state. When hemoglobin is oxidized to methemoglobin, the heme iron becomes (Fe^{3+}) and is incapable of binding oxygen. Methemoglobinemia is suspected in any cyanotic patient with no evidence of heart and lung disease of cyanosis is due to decreased oxygen saturation.

CALCULATIONSS

From plotting the calibration linear curve, find the concentrations of the water samples.

S.No	Sample Name	Concentration (ppm)	absorbance

1	Standard-1		
2	Standard-2		
3	Standard-3		
4	Standard-4		
5	Sample-1		
6	Sample-2		
7	Sample-3		



RESULT AND REPORT

1. The nitrate present in a given water sample-1 is =_____ppm
2. The nitrate present in a given water sample-2 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water will produce_____effect. It requires_____treatment.
2. The sample- 2 water will produce_____effect. It requires_____treatment.

VIVA

1. The removal of nitrogen and phosphorus, compounds that promote eutrophication, are removed during which stage of wastewater treatment?
   a) Primary treatment b) Secondary treatment c) Tertiary treatment d) All of the above

2. Nitrogen is removed from the water supply through which of the following chemical reactions?
   a) Denitrification b) Anammox c) Chlorination of ammonia d) All of the above

3. The presence of nitrogen in water may occur in the forms of
   a). Free ammonia b). Nitrites c). Nitrates d). All of the above

4. Nitrogen is present in wastewater in many form. Total Kjeldahlnitrogen means
   a)Ammonia nitrogen b)nitrite nitrogen c)nitrate nitrogen d)organic nitrogen

5. nitrate poisoning has been referred to as
   a)nitrosis b)methemoglobinaemia c)blue baby d)nitro lambliasis

1. Dentrification converts the nitrite and nitrate to nitrogen gas under the presence of organic matter which is
   a)ethanol b)methanol c)propanol d)chloroform

7. Ammonia and organic nitrogen are converted to nitrite and nitrate
   a)anaerobically b)aerobically c)anoxic d)none

8. In public watersup[ply the nitrate nitrogen contamination should not exceed
   a)15mg/l b)45mg/l c)10mg/l d)20mg/l

9. In polluted water most of the nitrogen is originally present in the form of
   a)nitrite nitrogen and nitrate nitrogen b)organic and ammonia nitrogen
   c)ammonia and nitrite nitrogen d) all of the above

10. The nitrate nitrogen may be measured by
    a)ultraviolet spectrophotometry b)ion chromatography method
    c)nitrate electrode method d)all of the above

KEY

1 c 2 a 3 d 4 d 5b,c 6b 7 b 8c 9b 10d

DETERMINATION OF IRON

AIM

To find out the Iron in a given water sample

PRINCIPLE

Iron is usually present in natural water and is not objectionable, if concentration is less than 0.3 ppm. It may be in true solution in colloidal state that may be peptized by organic matter, in the inorganic and organic iron complexes, or in relatively coarse suspended particles. It may be either ferrous or ferric, suspended or filterable. Iron exists in soils and minerals mainly as insoluble ferric oxide and iron sulphide (pyrite). It occurs in some areas, also as ferrous carbonate (siderite), which is very slightly soluble. The phenanthroline method is the preferred standard procedure for the measurement of iron in water except when phosphate or heavy metal interferences are present. The method depends upon the fact that 1, 10- phenanthroline combine with Fe++ to form an orange-red complex. Its colour conforms to Beer's law and is readily measured by visual or photometric comparison. Small concentration of iron can be most satisfactorily determined by colorimetric analysis. It is also based on Beer's law. By measuring the intensities of transmitted and incident light through a coloured solution and knowing its optical density or transmission, we can prepare a calibration curve and subsequent concentration can be read

SPECIAL APPARATUS

A spectrophotometer with UV range is used for determination the absorbance at wave length 510nm.

CHEMICALS REQUIRED

1. Ammonium Ferrous Sulfate
2. Hexahydrate
3. Hydroxylamine Hydrochloride
4. 1,10-Phenanthroline
5. Sodium Acetate
6. Sulphuric Acid

REAGENTS PREPARATION

a. Stock Iron solution:

Accurately weigh out about 0.100 g Ammonium Ferrous Sulfate Hexahydrate ($Fe(NH_4)_2(SO_4)_2$-$6H_20$).
Transfer quantitatively into a 500-mL volumetric flask.
Add about 10 mL of sulphuric acid and 50-mL distilled water to the flask to dissolve the $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$ completely.

a. Preparation of standards

Pipette 0, 0.5, 1.0, 1.5, 2.0, and 2.5 mL of the standard iron solution into a series of six 50 mL volumetric flasks.
Pipet the following solutions into each of the six volumetric flasks.
a) 1 mL of the hydroxylamine solution
b) 5 mL of the sodium acetate solution
c) 5 mL of the 1,10-phenanthroline solution

Fill each flask to the mark with deionized water and mix thoroughly. Allow the solutions to stand for 10 min. Mix the solutions again before measuring the absorbance. If more than half of the standard iron solution remains when you complete the experiment, you can retain it for the other experiment in this set.

b. Measuring the blank

To determine any possible absorbance from the matrix (i.e., the other reagents), deionized water will be used as the blank. Rinse the cuvette several times with tap water followed by deionized water, fill it with deionized water, place it the holder, and blank the spectrometer.

c. Measuring the standards

Rinse the cuvette with each solution (including the zero iron concentration sample) three times, and then fill it with the solution, place it in the holder, and measure the absorbance. Repeat the measurement with a fresh aliquot of the solution (no need to rinse this time.) The two absorbance values should be similar, otherwise you should measure another one. If you work from lowest iron concentration to highest, you will minimize the potential for carryover.

d. Measuring the unkown water samples

Prepare two challenge "unkown" samples, one that will end up near mid-range on the calibration curve and one near the lower end, to test for method recovery and accuracy. Pipet 25 mL aliquots of your cold and hot tap water and two unknown samples into four 50 mL volumetric flasks. Finish preparing the samples as described in the procedure (1). Measure the absorbance of the solutions. If the absorbance is outside of the range of the iron standards, you should repeat the measurement after adjusting the concentration to bring it into the range of the standards. If it is too concentrated, you can simply use a smaller volume of the sample. If it is too dilute, you may try evaporative concentration, if time permits. Be sure to document any deviations from the suggested procedure in the Experimental section of your report.

CALCULATIONS

1. Calculate the analytical concentration of iron in the standard iron solutions. Tabulate the observed absorbance and the derived concentrations (in ppm and molarity) of iron for all the standards, tap water samples, and unknown samples.

2. Plot the absorbance vs. iron concentration for the standards (including the ironfree solution. Use the method of least-squares (i.e., linear regression) to derive the Beers law equation in the form of A = m[Fe]+b. Be sure to report the calibration equation in the Results and Abstract sections of your report. If the intercept has a nonzero value, explain why, and comment on the R2 value.

3. (3) Calculate the molar absorptivity of Fe(phen)3 2+ at 508 nm. Compare your value with the literature value, 11,100 M-1cm-1. Explain possible causes for the difference, if any is observed

4. (4) Comment on whether or not the water samples meet the Federal standards for drinking water and any differences observed between the cold and hot water from the same tap

ENVIRONMENTAL SIGNIFICANCE

Iron is the most abundant element, by weight, in the earth's crust. Iron is the second most abundant metal in earth's crust. It is an essential element in human nutrition. The minimum daily requirement of iron is ranged from about 10 to 50 mg/day

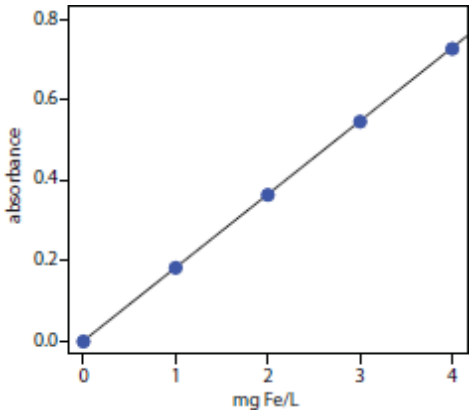
Natural water contains variable amounts of iron despite its universal distribution and abundance. Iron in ground water is normally present in the ferrous or bivalent from (Fe^{++}) or insoluble Iron urban exposure to air. Iron is a race elements required by both plants and animal. It is a vital oxygen transport mechanism in the blood all vertebrate and some invertebrate animals.

Iron in water may be present in varying qualities depending upon the geological area and other chemical component of the water way. Ferrous Fe^{++} and ferric F^{+++} irons are primary forms of concern in the aquatic environment other forms may be in either organic or inorganic waste water streams. The ferrous form Fe^{2+}can persist in water void of dissolved oxygen and usually originates from ground water or that are pumped or drained. Iron in domestic water supply system, stains laundry and porcelain. It appears to be more of a nuisance than a potential health hazard. Taste thresholds of iron in water 0.1 mg/l for ferrous iron and 0.2 mg/l ferric Iron, giving a bitter or an astringent taste. Water used in industrial processes usually contain less than 0.2 mg/l iron. Black or Brown swaps water may contain iron concentration of several mg/l in the presence or the absence of dissolved oxygen, but this iron form has little effect on aquatic life. The current aquatic life standard is 1.0 mg/l based on toxic effects.

5.8 CALCULATIONS:

From plotting the calibration linear curve, find the concentrations of the water samples.

S.No	Sample Name	Concentration (ppm)	absorbance
1	Standard-1		
2	Standard-2		
3	Standard-3		
4	Standard-4		
5	Sample-1		
6	Sample-2		
7	Sample-3		



RESULT AND REPORT

1. The Iron present in a given water sample-1 is =_____ppm
2. The Iron present in a given water sample-2 is =_____ppm
3. The Iron present in a given water sample-3 is =_____ppm

INTERPRETATION OF RESULTS

1. The sample- 1 water will produce_____effect. It requires_____treatment.
2. The sample- 2 water will produce_____effect. It requires_____treatment.
3. The sample- 2 water will produce_____effect. It requires_____treatment.

VIVA

2. The safe permissible concentration of iron in water, according to WHO standards is.
   a). 1.0 ppm b). 0.5 ppm c). 0.3 ppm d). 0.03 ppm

3. In their soluble or reduced state, iron and manganese are
   a) alkalinity enhancers b) colorless c) negatively charged d) won't dissolve in water

4. Iron and manganese removal can be accomplished by .
   a) oxidation with chlorine followed by filtration
   b) oxidation by aeration followed by filtration
   c) oxidation by potassium permanganate followed by filtration
   d) all of the above

5. High intakes of iron in certain people can lead to:
   a) anemia b) liver damage. C) hypertension d) nerve damage

6. which wave length is used for determinaqtion of iron in spectrophotometer
   a) 420 b) 510 C) 360 d) 220

KEY

1c 2 b 3 d 4 b 5b