I

Name _____

Roll No. _____ Year 20____ 20____

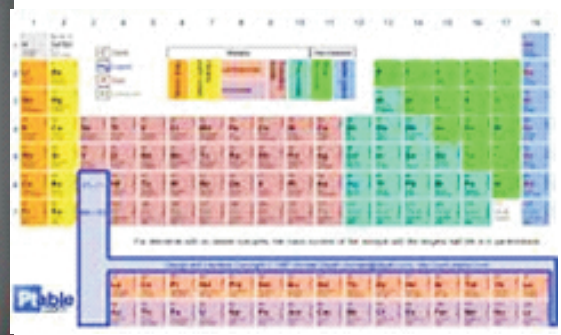
Exam Seat No. _____

CIVIL & MECHANICAL GROUPS | SEMESTER - II | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

APPLIED SCIENCE (CHEMISTRY) (22202)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual for

Applied Science – Chemistry

(22202)

Semester-II

(CE/CR/CS/ME/AE/PG/PT/FG)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
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(Printed on December, 2017)

MAHARASHTRA STATE

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This is to certify that Mr. / Ms. …… Roll No. ……., of First Semester of Diploma in…….. …… of Institute,……. …….(Code: ……...) has completed the term work satisfactorily in Subject **Applied Science-Chemistry (22202)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. Thisdisplays the great importance of laboratory work making each teacher, instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities.Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing thepractical.The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken,which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Diploma engineers have to deal with various materials and machines. The study of concepts and principles of science like metals, alloys, cement, lime, refractory materials, water treatment and analysis, fuel and combustion will help the student to select and use relevant materials and methods which will be economical and eco-friendly.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practicals

PO 1. **Basic knowledge**: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Discipline specific engineering problems.

PO 2. **Discipline knowledge**:ApplyDiscipline specificengineering knowledge to solve broad-based engineering related problems.

PO 3. **Experiments and practice**: Plan to perform experiments and practices to use the results to solve broad-based engineering problems.

PO 4. **Engineering tools**: Apply relevant technologies and tools with an understanding of the limitations

PO 5. **The engineer and society**:Assess social, health, safety, legal and cultural issues andthe consequent responsibilities relevant to practice in field of engineering.

PO 6. **Environment and sustainability**:Applyengineering solutions also forsustainable development practices in societal and environmental contexts.

PO7.**Ethics**:Apply ethical principles for commitment to professional ethics,responsibilitiesand norms of the practice also in the field of engineering.

PO 8. **Individual and team work**:Function effectively as a leader and team member indiverse/ multidisciplinary teams.

PO 9. **Communication**: Communicate effectively in oral and written form.

PO 10. **Life-long learning**: Engage in independent and life-long learning activities in the context of technological changes also in the engineering and allied industry.

Practical- Course Outcome matrix (ME/CE group)

S. No.	Title of the Practical	CO d.	CO e.	CO f.
1.	Standardization of $KMnO_4$ solution using standard oxalic acid and Determine the percentage of iron present in given Hematite ore by $KMnO_4$ solution.	√	-	-
2.	Determine the percentage of copper in given copper ore.	√	-	-
3.	Determine total hardness, temporary hardness and permanent hardness of water sample by EDTA method	-	√	-
4.	Determine the alkalinity of given water sample	-	√	-
5.	Determine the turbidity of given water sample by Nephelometric method	-	√	-
6.	Determine the moisture and ash content in given coal sample using proximate analysis.	-	-	√
7.	Determine the calorific value of given solid fuel using Bomb calorimeter.	-	-	√
8.	Determine the percentage of Sulphur in given coal sample by ultimate analysis.(Gravimetric analysis)	-	-	√

Guidelines to Teachers

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a **dated log book** for the whole semester, apart from this laboratory manual which s/he has to **submit for assessment to the teacher** in the next practical session.
2. Students should read the precaution carefully before start of experiment.

Content Page

List of Practicals and Progressive Assessment Sheet

S. No.	Practical outcomes	Page No.	Date of performance	Date of submission	Assessment marks(25)	Dated sign. of teacher	Remarks (if any)
1.	Standardization of $KMnO_4$ solution using standard oxalic acid and Determine the percentage of iron present in given Hematite ore by $KMnO_4$ solution.	1					
2.	Determine the percentage of copper in given copper ore.	9					
3.	Determine total hardness, temporary hardness and permanent hardness of water sample by EDTA method	16					
4.	Determine the alkalinity of given water sample	24					
5.	Determine the turbidity of given water sample by Nephelometric method	33					
6.	Determine the moisture and ash content in given coal sample using proximate analysis.	39					
7.	Determine the calorific value of given solid fuel using Bombcalorimeter.	45					
8.	Determine the percentage of Sulphur in given coal sample by ultimate analysis.(Gravimetric analysis)	51					
Total Marks							

* To be transferred to Proforma of CIAAN-2017 .

PRACTICAL NO.1: PERCENTAGE OF IRON IN ORE

I Practical Significance

Diploma engineers have to work in industry, which are related to different extraction processes. They have to do analysis of the ores for its metal composition which is necessary to find the amount of metallurgical coke and flux required for extraction processes. The determination of iron content in given ore using titration can be used to solve broad based engineering problems.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified
competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Handling of glassware
iii. Calculation

IV Relevant Course Outcome(s)

- Select the relevant metallurgical process related to industrial applications.

V Practical Outcome

- Standardization of KMnO4 solution using standard oxalic acid and Determine the percentage of iron present in given Hematite ore by KMnO4 solution.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Practice good housekeeping.

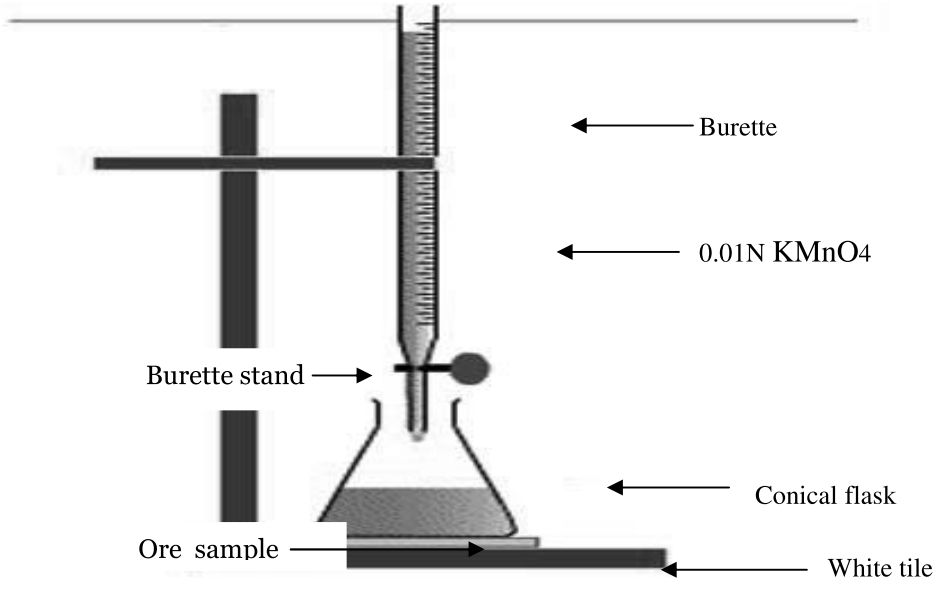
VII Minimum Theoretical Background

Haematite is an important ore of iron. For determination of the amount of iron in the given ore sample, the ore sample is dissolved in dilute HCl or dilute H_2SO_4,iron is converted in to iron (III) or iron(II) salt solution with liberation of hydrogen gas.

The reducing agent used for converting Fe^{3+} to Fe^{2+} is metallic zinc or stannous chloride. The Fe^{2+}present in the solution can be determined by titrating it with standard $KMnO_4$ solution.

$$MnO_4^- + 8\ H^+ + Fe^{2+} \longrightarrow Mn^{2+} + Fe^{3+} + 4H_2O$$

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Capacity 25 ml / 50ml	One per group
2.	Round Bottom flask	250 ml	One per group
3.	Wire gauze	6 inches x 6 inches	One per group
4.	Conical flask	Capacity 100 ml	One per group
5.	Pipette / Measuring cylinder	Capacity 10 ml	One per group
6.	Volumetric flask	Capacity 250 ml	One per group
7.	Sample material/chemicals	Ore sample, $KMnO_4$, H_2SO_4,HCl, Oxalic acid, zinc granules.	As per requirement

X Precautions to be Followed

1. Wash all the glass apparatus thoroughly with distilled water before use.
2. Rinse burette and pipette properly.
3. Remove air bubbles if present in the nozzle of the burette before taking initial reading.
4. Place the conical flask on a white tile to observe the color change at the end point.
5. Cover the flask while heating.
6. Add solution dropwise from burette, with constant shaking of flask.

XI Procedure

Part A: Preparation of sample solution

1. Weigh exactly 1 gm of ore and transfer it in to 250 ml round bottom flask.
2. Add 100 ml dilute sulphuric acid in to the round bottom flask and gently heat on wire gauze till the sample dissolves completely.
3. Add a few granules of zinc when sample dissolves.
4. Cool it and transfer in to 250 ml volumetric flask, dilute the solution up to 250 ml using distilled water.

Part B: Standardization of $KMnO_4$

1. Weigh the required amount of $KMnO_4$ using electronic balance to prepare 0.1 N $KMnO_4$ solution.
2. Dissolve weighed $KMnO_4$ in the distilled water, and transfer it to the 1000 ml volumetric flask. Dilute the solution up to the mark (1000 ml) using distilled water.
3. Take 10 ml of standard (0.1N) oxalic acid in conical flask.
4. Add 10 ml dilute sulphuric acid and heat the solution up to 70^0C.
5. Titrate the above solution against standard $KMnO_4$ solution till light pink colour appears.
6. Repeat the procedure up to constant readings.

Part C: Determination of percentage of iron:

1. Rinse and fill the burette with standard $KMnO_4$ solution.
2. Take 10 ml sample solution in conical flask. Add 10 ml of dilute sulphuric acid to ensure acidic medium.
3. Add $KMnO_4$ solution drop wise using burette till light pink colour appears.
4. Repeat the procedure up to constant readings.

XII Resources Used

S. No.	Name of Resources	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Procedure Followed

1. Standardization of $KMnO_4$\
   a. Solution in conical flask:_____
   b. Solution in burette:_____
   c. Indicator used:_____
   d. End Point:_____
2. Determination of Percentage of Iron:-
   a. Solution in conical flask:_____
   b. Solution in burette:_____
   c. Indicator used:_____
   d. End Point:_____

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Colour of ore sample solution changes from colourless to light pink

Observation table 1: Standardization of $KMnO_4$:

S. No.	Burette Reading	Constant Burette Reading (Volume of $KMnO_4$)
1.	ml	V_2 = _____ ml
2.	ml	
3.	ml	

Observation table 2: Determination of percentage of iron:

S. No.	Burette Reading	Constant Burette Reading (Volume of $KMnO_4$)
1.	ml	V_3 = _____ ml
2.	ml	
3.	ml	

Calculation

(A) Calculation for standardization of $KMnO_4$

$N_1V_1 = N_2V_2$

N_1 = Normality of Oxalic acid = 0.1N

V_1 = Volume of Oxalic acid = 10 ml

N_2 = Normality of $KMnO_4$

V_2 = Volume of$KMnO_4$

(Oxalic acid) ($KMnO_4$)

$N_1V_1 = N_2V_2$

------ × ------= ------ × ------

N_2 = ----------

(B) Calculation for determination of percentage of iron

STEP 1

1000 ml 1 N $KMnO_4$ ≡ 56 g of **Fe**

V_3ml N_2N KMnO4 = $\frac{(56 \times V_3 \times N_2)}{}$ g of **Fe**

$$= \frac{(56 \times \ldots\ldots. \times \ldots\ldots\ldots)}{1000} \text{ g of } \mathbf{Fe}$$

= ……..(y) g of **Fe**

STEP 2

25 ml of ore sample solution contain(y) = ……. g of **Fe**

250 ml of ore sample solution contain (z) = (y x10) = ……. × 10 g of **Fe**

(z) = …… g of **Fe**

STEP 3

1 g of ore sample contain (z) =…… g of **Fe**

100 g ore sample contain (z x 100) =…….. g of **Fe**

XV Results :

Percentage of iron in haematite ore sample =……...%

XVI Interpretation of Results (Give meaning of the above obtained results)

……

……

XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

……

……

……

XVIII Practical Related Questions

1. Write the procedure to dissolve iron ore.
2. Name the reducing agent used in the above titration.
3. Name various ores of iron.

Space for Answer

…….

…….

…….

…….

XIX References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O. P. Vermani,A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Practical book on Engineering Chemistry, Dr.P.K.Khatua, Platinum publishers Kolkata, ISBN : 0788189872438
3. Engineering chemistry, Shashi Chavla, S. Chand publication New Delhi 2013 ISBN: 1234567155036
4. Experiments in Applied Chemistry, Sunita Rattan, *ISBN*-10: 8188458058; *ISBN*-13: 978-8188458059
5. Web Reference: academic.brooklyn.cuny.edu/chem/maggie/teach/chem41/files/feo.pdf

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: (15) Marks		**60%**
1	Preparation of $KMnO_4$	20%
2	Preparationof sample solution	20%
3	Burette Reading of Part B	10%
4	Burette Reading of Part C	10%
Product related: (10) Marks		**40%**
5	Normality of $KMnO_4$	10 %
6	Calculation for percentage of iron	10 %
7	Practical related questions	10 %
8	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.2: PERCENTAGE OF COPPER IN ORE

I Practical Significance

Diploma engineers have to perform extraction/separation processes during their work in industry, which are related to different applications. They have to do analysis of ore for their metal compositions which is necessary to find the quality and applications. The determination of copper content in given ore sample solution using titration can be used to determine the strength and other used to solve broad based engineering problems.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Handling of glassware
iii. Calculation

IV Relevant Course Outcome(s)

- **Select the relevant metallurgical process related to industrial applications.**

V Practical Outcome

- Determine the percentage of copper in given copper ore.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Practice good housekeeping.

VII Minimum Theoretical Background

Copper is important material for various industrial applications. Copper alloys are prepared as it has properties like hardness, corrosion resistance, strength, durability, abrasion resistance and machinability. When copper ore is dissolved in HNO_3, copper present in it is transformed into the solution in the form of cupric ions. By addition of concentrated sulphuric acid, copper ions present in the solution are converted into copper sulphate. Copper sulphate solution, when treated with KI at pH = 4 to 5.5, cupric iodide is formed. Cupric iodide is unstable and immediately decomposes to cuprous iodide with liberation of iodine gas. Liberated iodine is titrated against sodium thiosulphate using starch indicator.

Cu $\xrightarrow{\text{heat}}$ **Cu $(NO_3)_2$** $\xrightarrow{\text{heat}}$ **$CuSO_4$**

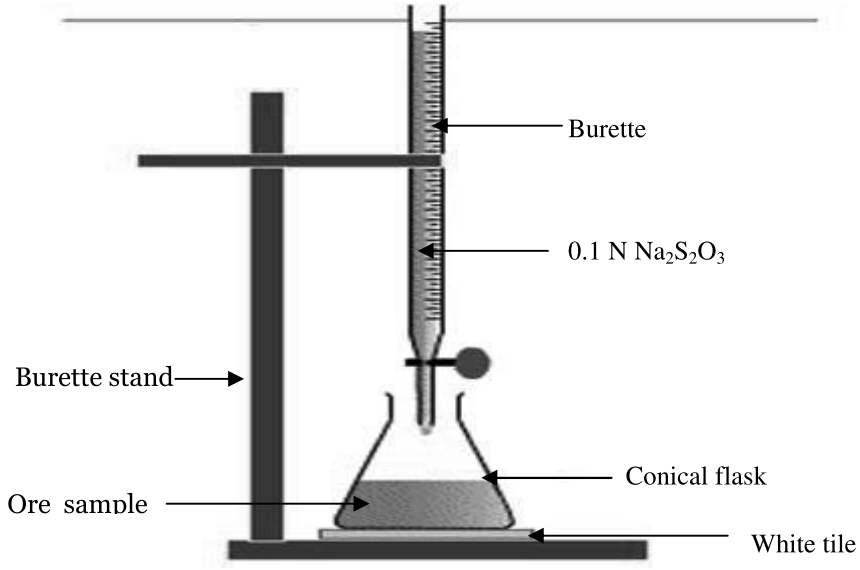
Ore Conc. HNO_3 H_2SO_4 Solution

$$2CuSO_4 + 4KI \longrightarrow 2\,CuI_2 + 2K_2SO_4$$

$$2CuI_2 \longrightarrow Cu_2I_2 + I_2\uparrow$$

$$I_2 + 2Na_2S_2O_3 \longrightarrow Na_2S_2O_6 + 2NaI$$

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Capacity 25 ml / 50ml	One per group
2.	Round Bottom flask	250 ml	One per group
3.	Wire gauze	6 inches x 6 inches	One per group
4.	Conical flask with stopper/ Iodometric flask	Capacity 100 ml	One per group
5.	Pipette / Measuring cylinder	Capacity 10 ml	One per group
6.	Volumetric flask	Capacity 250 ml	One per group
7.	Sample material/chemicals	Ore sample, 10 % KI, 0.1N $Na_2S_2O_3$, Conc. HNO_3 , Conc. H_2SO_4, 2N NaOH, starch	As per requirement

X Precautions to be Followed

1. Wash all the glass apparatus thoroughly with distilled water before use.
2. Rinse burette and pipette properly.
3. Remove air bubbles if present in the nozzle of the burette before taking initial reading.
4. Place the conical flask on a white tile to observe the color change at the end point.
5. Cover the flask while heating.
6. Add solution dropwise from burette, with constant shaking of flask.

XI Procedure

Part A: Preparation of ore sample solution

1. Weigh exactly 1 gm. copper ore sample and transfer it in to 250 ml beaker.
2. Add 10 ml concentrated nitric acid to dissolve the ore sample.
3. Add 20 ml water and cover the beaker with watch glass. Heat the beaker gently on wire gauze to dissolve the ore sample completely.
4. Cool the beaker to room temperature and add 10 ml concentrated sulphuric acid to it.
5. Heat the solution on low flame to evolve brown fumes of NO_2 gas completely.
6. Cool the solution and transfer it in a 100 ml standard volumetric flask. Dilute the solution up to the mark using distilled water.
7. Transfer the solution to a beaker for further estimation.

Part B: Determination of percentage of copper

1. Wash and clean all glass wares. Rinse and fill the burette with 0.1 $Na_2S_2O_3$ solution adjust the zero mark.
2. Rinse the pipette and pipette out 10 ml sample solution in a stoppered conical flask or Iodometric flask.
3. Add 2 N NaOH drop wise with constant shaking to neutralize mineral acid present in the sample solution till slight blue turbidity of $Cu(OH)_2$ is obtained.

4. Add 2N acetic acid solution drop wise with constant shaking to dissolve the turbidity. A clear solution is obtained at pH 4 to 5.5.
5. The solution becomes yellowish brown due to liberation of iodine gas (equivalent of copper) when 10 ml of 10% KI solution is added.
6. Add $Na_2S_2O_3$ solution dropwise, slowly so that liberated iodine is titrated against 0.1 N $Na_2S_2O_3$ solutions till the brown solution turns pale yellow.
7. Add 1-2 ml of freshly prepared starch solution and continue titration till blue colour disappears.
8. Repeat the procedure till constant readings will be obtained.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Procedure Followed

1. Determination of percentage Copper
   a. Solution in conical flask:_____
   b. Solution in burette:_____
   c. Indicator used:_____
   d. End Point:_____

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Color of ore sample changes from blue to colorless.

Observation table 1: For determination of percentage of copper

S. No.	Burette Reading	Constant Burette Reading (Volume of 0.1 N $Na_2S_2O_3$)
1.	ml	V = _____ ml
2.	ml	
3.	ml	

Calculation

Calculation for determination of percentage of copper

STEP 1

1000 ml 1 N $Na_2S_2O_3$ ≡ 63.5 g of **Cu**

$$V \text{ ml } 0.1N\ Na_2S_2O_3 = \frac{(63.5 \times V \times 0.1)}{1000}$$

$$= \frac{(63.5 \times ….. \times 0.1)}{1000}$$

= ……..(y) g of **Cu**

STEP 2:-

10 ml of ore sample solution contain(y) = ……. g of **Cu**

100 ml of ore sample solution contain (z) = (y ×10) = ……. g of **Cu**

z = …… g of **Cu**

STEP 3:-

1 g of sample contain (z) =……. … g of **Cu**

100 g sample contain (z x 100) = ……. g of **Cu**

XV Results

Percentage of copper in ore sample = …….. %

XVI Interpretation of Results (Give meaning of the above obtained results)

……

……

……

XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

……

……

……

XVIII Practical Related Questions

1. Mention type of reaction when cupric ion converts into cuprous ion.
2. State the colour when iodine is liberated with addition of KI to ore sample.
3. Name the chemical which removes turbidity formed due to adding NaOH in sample solution.

Space for Answer

……

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……

XX References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O.P.Vermani, A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Practical book on Engineering chemistry, Dr.P.K.Khatua, Platinum publishers Kolkata, ISBN : 0788189872438
3. Engineering chemistry, Shashi Chavla,S. Chand publication New Delhi 2013 ISBN: 1234567155036
4. Experiments in Applied Chemistry, Sunita Rattan, *ISBN*-10: 8188458058; *ISBN*-13: 978-8188458059
5. Reference websites: nitmeghalaya.in/nitm_web/fp/chem

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related:15 Marks		**60%**
1	Preparationof sample solution	30%
2	Burette Reading	30%
Product related:10 Marks		**40%**
3	Calculation for percentage of copper	20 %
4	Practical related questions	10 %
5	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 3: HARDNESS OF WATER SAMPLE

I Practical Significance

Boilers are the important equipment for various industrial processes to produce steam using water. Nature of water plays an important role in terms of efficiency of boiler and various problems caused to the boiler. Water is used in different industries such as textile, paper, sugar, pharmaceuticals etc. for various industrial processes. Diploma engineers has to deal with the different uses of water during their course of work and also have to deal with the problems caused by hard water like boiler corrosion, caustic embrittlement, scales and sludge formation. This experiment will help diploma engineers to determine the magnitude of hardness along with the nature of hardness.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Calculation

IV Relevant Course Outcome(s)

- **Select relevant water treatment process for various applications.**

V Practical Outcome

- Determine total hardness, temporary hardness and permanent hardness of water sample by EDTA methods.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

Hard water contains salts of calcium and magnesium in the form of their chlorides, sulphates and carbonates. Hardness of water is determined in terms of equivalent of $CaCO_3$ in ppm. Ethylene diamine tetra acetic acid (EDTA) is a reagent that forms EDTA-metal complex with many metal ions (but not with alkali metal ions such as Na^+ and K^+). In alkaline medium (pH=10), it forms stable complexes with the alkaline earth metal ions Ca^{2+} and Mg^{2+}. The EDTA reagent can be used to measure the total quantity of dissolved Ca^{2+} and Mg^{2+} ions in a water sample.

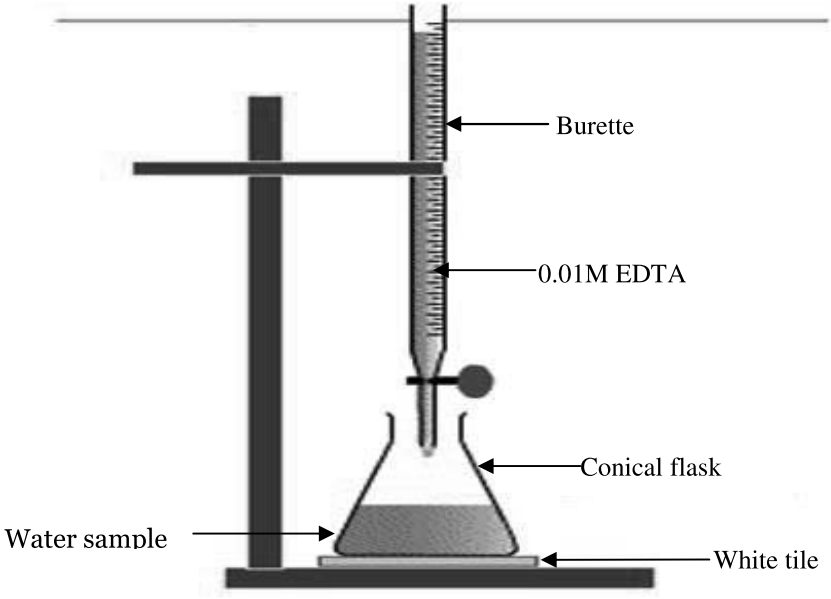
Determination of hardness of water is based on the fact that when indicator, Eriochrome Black -T (EBT) is added to hard water in alkaline medium, it forms wine red colour complex with Ca^{2+} and Mg^{2+} ions

Ca^{2+} +EBT ⟶ Ca^{2+} — EBT
(Wine red unstable complex)

Ca^{2+} — EBT +EDTA ⟶ Ca^{2+}—EDTA+EBT
(Wine red unstable complex) (Colourless stable Ca- EDTA Complex) (Blue)

Thus the total hardness of a water sample can be estimated by titration with standard solution of EDTA.

VIII Practical set-up / Circuit diagram / Work Situation



Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Borosil glass , Capacity 25 ml /50 ml	One per group
2.	Conical flask	Borosil glass, Capacity 250 ml/100 ml	One per group
3.	Beaker	Borosil glass, Capacity 250 ml/100 ml	One per group
4.	Pipette	Borosil glass, Capacity 25ml / 10 ml	One per group
5.	EDTA solution	0.01 M	As per Requirement
6.	Buffer solution	pH = 10	
7.	Eriochrome Black T indicator		
8.	Water sample	Hard water sample	

IX Precautions to be Followed

1. All the glass apparatus should wash thoroughly with distilled water before use.
2. Remove an air bubbles if present in the nozzle of the burette before taking initial reading.
3. Shaking of the titration flask should be continuous during addition of the solution from burette.
4. Place the conical flask on a white tile to observe the color change at the end point.

X Procedure

Part A: Process for total hardness of water

1. Wash the burette with water.
2. Rinse the burette with 0.01 M EDTA solution.
3. Fill the burette with 0.01M EDTA solution.
4. Remove air bubble if present, and adjust zero level correctly.
5. Rinse the pipette with sample water. Take 25 ml of sample water in conical flask with the help of pipette.
6. Add 5 ml of buffer solution of pH 10 using measuring cylinder and 2 drops of Eriochrome Black -T indicator (EBT) into the conical flask.
7. Colour of the solution becomes wine red.
8. Add EDTA solution from burette into the conical flask very slowly, till wine red solution changes to light blue colour.

Part B: Process for permanent hardness of water.

1. Boil the given water sample for 5-10 minutes and filter.
2. Take 25 ml of the filtered water in the titration flask.
3. Follow the remaining procedure as part A from point 1 to 8.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII Procedure Followed:-

Hardness of Water:-

a. Solution in conical flask: _____
b. Solution in burette: _____
c. Indicator used:_____
d. End Point: _____

XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Colour of water sample changes from wine red to sky blue colour.

Observation table 1: Part A: For total hardness of water

S. No.	Burette Reading	Constant Burette Reading (Volume of 0.01M EDTA)
1.	ml	X_1 = _____ml
2.	ml	
3.	ml	

Observation table 2: Part B: For Permanent hardness of water

S. No.	Burette Reading	Constant Burette Reading (Volume of 0.01M EDTA)
1.	ml	X_2 = _____ ml
2.	ml	
3.	ml	

Calculation

Part A: For total hardness of water:

Step 1:

1000 ml of 1 M EDTA ≡ 100 g of **$CaCO_3$**

$$X_1 \text{ ml of } 0.01M \text{ EDTA} = \frac{(100 \times X_1 \times 0.01)}{1000} \text{ g of } \mathbf{CaCO_3}$$

$$= \frac{(100 \times ..... \times 0.01)}{1000} \text{ g of } \mathbf{CaCO_3}$$

= ---------- (y) g of **$CaCO_3$**

Step 2:

25 ml water sample contain (y) = --------- g of **$CaCO_3$**

1000 ml water sample contain (y × 40) = --------- g of **$CaCO_3$**

i.e. 1000 ml water sample contain (y× 40 × 1000) = ----------mg of **$CaCO_3$**

i.e. 1000 ml water sample contain --------- mg of $CaCO_3$

Part B : For Permanent hardness of water

Step 1:

1000 ml of 1 M EDTA ≡ 100 g of **$CaCO_3$**

$$X_2\text{ml of 0.01M EDTA} = \frac{(100 \times X_2 \times 0.01)}{1000}$$

$$= \frac{(100 \times \ldots\ldots \times 0.01)}{1000}$$

= ……..(z) g of **$CaCO_3$**

Step 2:

25 ml water sample contain (z) = --------- g of **$CaCO_3$**

1000 ml water sample contain (z×40) = --------- g of **$CaCO_3$**

i.e. 1000 ml water sample contain (z×40 × 1000) = ---------- mg of **$CaCO_3$**

i.e. 1000 ml water sample contain ---------- mg of **$CaCO_3$**

XIV Results

1. The total hardness of given sample of water is…….ppm of $CaCO_3$ equivalent.
2. The permanent hardness of given sample of water is…….ppm of $CaCO_3$ equivalent.
3. The temporary hardness of given sample of water is…….ppm of $CaCO_3$ equivalent.

XV Interpretation of Results (Give meaning of the above obtained results)

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XVI Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVII Practical Related Questions

1. Write the reaction between EDTA and magnesium ion in hard water.
2. Explain the process to remove temporary hardness of water.
3. State the role of buffer solution in the given titration.

Space for Answer

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XIX References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O.P.Vermani, A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Experiments and calculations in engineering chemistry, Dr. S.S. Dara S.Chand. Publication, New Delhi, 2011, *ISBN*:8121908647
3. Experiments in general chemistry Principles and modern applications, Thomas G. Greco; Lyman H. Richard; Gerald S. Weiss,Pearson, 2011,ISBN-13:978-0131493919

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Measurements of solution	10 %
2	Burette Reading of Part A	20%
3	Removal of temporary hardness	10 %
4	Burette Reading of Part B	20%
Product related: 10 Marks		**40%**
5	Calculation for Total hardness of water	10%
6	Calculation for Permanent hardness of water	10%
7	Calculation for Temporary hardness of water	05%
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 4: ALKALINITY OF WATER SAMPLE

I Practical Significance

Boiler is an important equipment for various industrial processes to produce steam using water. Nature of water plays important role in terms of efficiency of boiler and various problems caused to the boiler. Water is also used in different industries such as textile, paper, sugar, pharmaceuticals etc. for various industrial processes. Diploma engineers has to deal with the different uses of water during their course of work and also have to deal with the problems caused by hard water like boiler corrosion, caustic embrittlement, scales and sludge formation. This experiment will help diploma engineers to determine the magnitude of alkalinity along with the nature of different types of alkalinity which is required to control corrosion, amount of lime and soda needed for water softening, in conditioning of boiler feed water.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:**Apply appropriate technologies and tools with an understanding of the limitations.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Calculation

IV Relevant Course Outcome(s)

- **Select relevant water treatment process for various applications.**

V Practical Outcome

- Determine alkalinity of given water sample.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

Alkalinity is a measure of ability of water to neutralize the acids. Alkalinity of water means the total content of those substances in it which causes an increased OH^- ion concentration up on dissociation or due to hydrolysis. Alkalinity of a sample of water is due to the presence of OH^- (hydroxide ion), HCO_3^- (bicarbonate ion), CO_3^{2-} (carbonate ion) or a mixer of two ions present in water. The OH^- and HCO_3^- ions together is not possible since they combine together to form CO_3^{2-} ions.

$[(OH)^- + (HCO_3)^- \longrightarrow CO_3^{2-} + H_2O]$

The presence of OH^-, CO_3^{2-}- and HCO_3^- can be estimated separately by titration against standard acid using phenolphthalein and methyl orange as indicators

The determination is based on the following reactions

(i) $OH^- + H^+ \longrightarrow H_2O$

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

(iii) $HCO_3^- + H^+ \longrightarrow H_2O + CO_2$

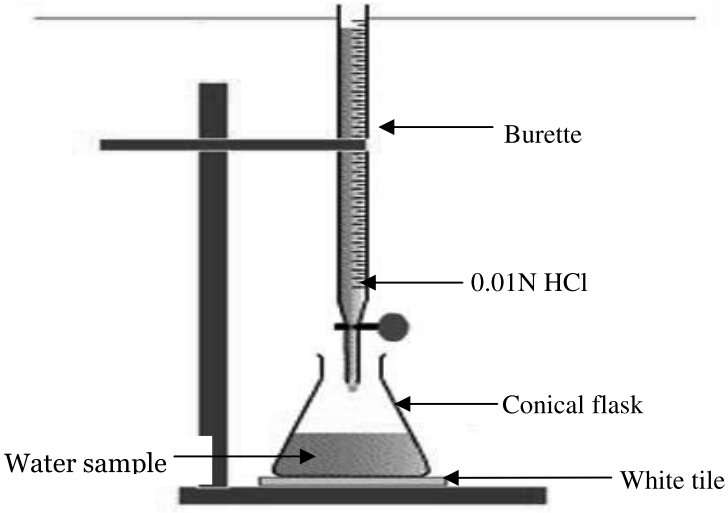
The titration of water sample against a standard acid up to phenolphthalein end point (P) marks the completion of reaction (i) and (ii) only. This amount of acid used thus corresponds to OH^- plus one half of the normal CO_3^{2-}present. On the other hand, titration of the water sample against a standard acid to methyl orange end point (M) marks the completion of reaction (i), (ii) and (iii). Hence the total amount of acid used represents the total alkalinity.

Thus,

$P = OH^- + ½\ CO_3^{2-}$ (Acid required to neutralize alkalinity due to OH^- and half ofCO_3^{2-})

$M = OH^- + CO_3^{2-} + HCO_3^-$ (Acid required to neutralize alkalinity due to OH^-, CO_3^{2-}, HCO_3^-)

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Burette	Borosil glass , Capacity 25 ml /50 ml	One per group
2.	Conical flask	Borosil glass, Capacity 250 ml/100 ml	One per group
3.	Beaker	Borosil glass, Capacity 250 ml/100 ml	One per group
4.	Pipette	Borosil glass, Capacity 25ml / 10 ml	One per group
5.	Hydrochloric acid	0.01 N	As per requirement
6.	Phenolphthalein indicator		
7.	Methyl orange indicator		
8.	Water sample		

X Precautions to be Followed

1. All the glass apparatus should wash thoroughly with distilled water before use.
2. Before use, the burette & Pipette should rinse properly. Remove an air bubbles if present in the nozzle of the burette before taking an initial reading
3. Place the conical flask on a white tile to observe the color change at the end point.
4. Shaking of the titration flask should be continuous during addition of the solution from burette.

XI Procedure

Part A: For determination of alkalinity of water

1. Wash the burette with water.
2. Rinse the burette with 0.01 N HCl solution. Fill it with 0.01 N HCl.
3. Remove air bubble if present, and adjust zero level correctly.
4. Rinse the pipette with sample water. Take 25 ml of sample water in conical flask with the help of pipette.
5. Add 2-3 drops of phenolphthalein indicator into the water sample in conical flask. Color of the solution becomes pink.
6. Add 0.01N HCl solution from burette into the conical flask very slowly, till pink color changes to colorless.
7. Note volume of HCl for phenolphthalein end point (‘P’ ml.)
8. Add 2-3 drops of methyl orange indicator to the same water sample in a conical flask. Color of the solution becomes yellow. (Do not fill the burette)
9. Continue the addition of 0.01N HCl to water sample from burette till it becomes reddish orange.
10. Note the volume of HCl for methyl orange end point as ‘M’ml.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Procedure Followed:-

1. Alkalinity of Water:

a. Solution in conical flask :_____

b. Solution in burette :_____

c. Indicator used(to obtain P ml):_____

d. End Point:_____

e. Indicator used (to obtain M ml):_____

f. End Point:_____

XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Color of water sample changes from light pink to colorless and then from yellow to orange red.

Observation table 1: Alkalinity of water (Phenolphthalein end point)

S. No.	Burette Reading	Constant Burette Reading (Volume of 0.01N HCl)
1.	ml	P = _____ml
2.	ml	
3.	ml	

Observation table 2: Alkalinity of water (Methyl orange end point)

S. No.	Burette Reading	Constant Burette Reading (Volume of 0.01N HCl)
1.	ml	M = _____ml
2.	ml	
3.	ml	

Follow following table for calculation of alkalinity present due of OH^-, CO_3^{2-} and HCO_3^-

Type of Water sample	Result of titration	Acid required to neutralize Hydroxide alkalinity	Acid required to neutralize Carbonate alkalinity	Acid required to neutralize Bicarbonate alkalinity
A	**P = 0** (If phenolphthalein end point is zero, then alkalinity is due to only bicarbonate.)	**-**	**-**	**M**
B	**P = ½ M** (If phenolphthalein end point is exactly half the total titration, then only carbonate alkalinity is present.)	**-**	**2P**	**-**
C	**P= M** (If methyl orange end point is zero and only there is phenolphthalein end point, then the alkalinity is due to hydroxide alone.)	**M**	**-**	**-**
D	**P < ½ M** (If phenolphthalein end point is less than half the total titration, then alkalinity is due to both carbonate and bicarbonate.)	**-**	**2P**	**M-2P**
E	**P > ½ M**(If phenolphthalein end point is greater than half the total titration, then alkalinity is due to both carbonate and hydroxide.)	**2P-M**	**2(M-P)**	**-**

Calculation

I: <u>Alkalinity due to OH^- (if P= M)</u>

Step 1:

1000 ml of 1 N HCl ≡ 17 g of **OH^-**

'M' ml of 0.01N HCl = $\frac{(17 \times M \times 0.01)}{1000}$ g of **OH^-**

= $\frac{(17 \times \ldots\ldots\ldots \times 0.01)}{1000}$ g of **OH^-**

= ---------- (y) g of**OH^-**

Step 2:

25 ml water sample contain (y) = ---------- g of **OH^-**

1000 ml water sample contain (y × 40) = ---------- g of **OH^-**

i.e. 1000 ml water sample contain (y× 40 × 1000) = ----------mg of **OH^-**

i.e. 1000 ml water sample contain ---------- mg of **OH^-**

II: <u>Alkalinity due to CO_3^{2-} (if P < ½ M)</u>

Step 1:

1000 ml of 1 N HCl ≡ 30 g of CO_3^{2-}

$$2P \text{ ml of } 0.01N \text{ HCl} = \frac{(30 \times 2P \times 0.01)}{1000} \text{ g of } CO_3^{2-}$$

$$= \frac{(30 \times \ldots\ldots\ldots \times 0.01)}{1000} \text{ g of } CO_3^{2-}$$

= ……..(y) g of CO_3^{2-}

Step 2:

25 ml water sample contain (y) = ---------- g of CO_3^{2-}

1000 ml water sample contain (y × 40) = ---------- g of CO_3^{2-}

i.e. 1000 ml water sample contain (y× 40 × 1000) = ----------mg of CO_3^{2-}

i.e. 1000 ml water sample contain ---------- mg of CO_3^{2-}

III: <u>Alkalinity due to HCO_3^- (if P < ½ M)</u>

Step 1:

1000 ml of 1 N HCl ≡ 61 g of HCO_3^-

$$[2P\text{-}M] \text{ ml of } 0.01N \text{ HCl} = \frac{(61 \times [2P\text{-}M] \times 0.01)}{1000} \text{ g of } HCO_3^-$$

$$= \frac{(61 \times [\ldots\ldots\ldots\ldots] \times 0.01)}{1000} \text{ g of } HCO_3^-$$

= ……..…..(y) g of HCO_3^-

Step 2:

25 ml water sample contain (y) = ---------- g of HCO_3^-

1000 ml water sample contain (y × 40) = ---------- g of HCO_3^-

i.e. 1000 ml water sample contain(y× 40 × 1000) = ----------mg of HCO_3^-

i.e. 1000 ml water sample contain ---------- mg of HCO_3^-

XV Results

1. Alkalinity due to OH^- = ---------- mg/lit
2. Alkalinity due to CO_3^{2-} = ----------mg/lit
3. Alkalinity due to HCO_3^- = ----------mg/lit

XVI Interpretation of Results (Give meaning of the above obtained results)

……

……

XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

……

……

XVIII Practical Related Questions

1. 'The water sample does not contain OH^- and HCO_3^- ions together.' Give reason.
2. Explain the role of phenolphthalein and methyl orange indicator in above titration.
3. List the ions responsible to make water alkaline.

Space for Answer

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XXI References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O.P.Vermani, A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Practical book on Engineering chemistry, Dr.P.K.Khatua, Platinum publishers Kolkata,ISBN : 0788189872438
3. Experiments in Applied Chemistry, Sunita Rattan, *ISBN*-10: 8188458058; *ISBN*-13: 978-8188458059

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Cleaning and filling the burette	10 %
2	Measurement of water sample	10%
3	Burette reading when Phenolphthalein changes colour	20%
4	Burette reading when Methyl orange changes colour	20%
Product related: 10 Marks		**40%**
5	Alkalinity due to CO_3^{2-}	10 %
6	Alkalinity due to HCO_3^- orOH^-	10 %
7	Practical related questions	10 %
8	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 5: TURBIDITY OF WATER

I Practical Significance

Water is nature's most wonderful, abundant, useful compound and is an essential without it one cannot survive. It occupies a unique position in industries. It's most important use is as an engineering material in the steam generation, coolant in power and chemical plants. It is also used in other fields such as production of steel, rayon, paper, atomic energy, textiles, chemicals, ice and for air-conditioning, drinking, bathing, sanitary, washing, fabricating and irrigation. Turbidity in water causes troubles in water softening process, various industrial processes such as textile, sugar industry, irrigation and for steam generation in boilers. Diploma engineers requires the knowledge of the turbidity variation in raw water supplies which is useful to determine whether a supply requires special treatment by chemical coagulation and filtration before it may be used for a public water supply. Hence it is necessary to determine the turbidity and to remove by using proper water treatments.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Environment and sustainability**: Understand the impact of the engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Handling instrument
iii. Calibration skill

IV Relevant Course Outcome(s)

- **Use relevant water treatment process to solve industrial problems.**

V Practical Outcome

- Determine the turbidity of given water sample by Nephelometric method.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Practice good housekeeping.
- Maintain tools and equipment.
- Practice energy conservation.

VII Minimum Theoretical Background

Water is said to be turbid when it contains suspended particles. Turbidity may cause by foreign materials like algae, sand, clay, salt, chemical precipitate or other organisms. When water becomes stationary, large suspended particles settle down quickly due to force of gravity and the lighter particles and fine particles takes very long time to settle. Turbidity is the amount of cloudiness in water. Generally ground water is less turbid due to natural filtration.

Various units are used for the measurement of turbidity-

Standard turbidity unit (mg/lit or ppm)

Jackson turbidity unit (J.T.U)

Nephelometric turbidity unit (N.T.U)

WHO suggested that the turbidity of water should be less than 1 N.T.U.?

VIII Practical set-up / Circuit diagram / Work Situation

Nephelometer

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Nephelometer	Auto-ranging from 20-200 NTU,+/- 2% of reading plus 0.1 13 NTU, power 220 Volts +/- 10% AC 50 Hz	One per group
2.	Volumetric flask	Borosil,100ml,500 ml	One per group
3.	Plastic or glass bottle	Borosil,100ml, 250 ml,500 ml	One per group
4.	Beaker	Borosil,100ml, 250 ml,500 ml	1 per group
5.	Chemicals	Hydrazine sulphate,Hexamethylenetetramine, Water sample	As per requirement

X Precautions to be Followed

1. A sample solution should be placed in a cleaned plastic or glass bottle.
2. A sample should be analyzed as soon as possible after collection.
3. Finely divided air bubbles can cause high readings.
4. The presence of floating impurities will give low readings.

XI Procedure

Step I – To prepare 400 NTU Formazin stock suspension

1. Dissolve 1g hydrazine sulphate [$(NH_2)_2 \cdot H_2SO_4$] in filtered water and dilute to 100 ml in a volumetric flask.
2. Dissolve 10g hexamethylenetetramine [$(CH_2)_6N_4$] in filtered water and dilute to 100 mL in a volumetric flask.
3. Mix 5 ml of hydrazine sulphate and 5 ml of hexamethylenetetramine solutions in a 100 ml volumetric flask and let stand 24 hours at 25 ± 3°C; dilute up to the mark and mix. This mixture is the reagent solution.
4. To prepare 500 ml of 400 NTU standard, mix 25 ml of the reagent solutions in a 500 ml flask, dilute to the mark, and mix.

Step II – To determine the turbidity

1. Switch on the turbidity meter at least 30 minutes before the test.
2. Calibrate the turbidity meter to 400 NTU by using the standard solution by adjusting the calibration knob.
3. Calibrate the turbidity meter to zero NTU by using distilled water and by adjusting the knob.
4. To the sample cell, add the water up to the horizontal mark. Place it in the turbidity meter such that the vertical mark in the sample cell should coincide with the mark in the turbidity meter and cover the sample cell.
5. Check the reading in turbidity meter and wait until stable reading is obtained.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Procedure Followed

1. Reagent solution is prepared by mixing 5ml of_____ and 5ml of_____ in 100 ml Distilled water.
2. 400 NTU contain _____ml of _____in 500 ml Distilled water.
3. Calibration of Turbidity meter to 400 NTU by using_____.
4. Calibration of Turbidity meter to 0 NTU by using _____.
5. Record reading by placing _____in turbidity meter.

XIV Observations and Calculations(use blank sheet provided if space not sufficient)

S. No.	Water sample	Temperature of the sample (^{0}C)	Turbidity in N.T.U
1.	Sample No. 1		
2.	Sample No. 2		
3.	Sample No. 3		
4.	Sample No. 4		

Calculations NA

XV Results

1. The turbidity of sample 1 is……N.T.U.
2. The turbidity of sample 2 is …….. N.T.U.
3. The turbidity of sample 3 is…….. N.T.U.
4. The turbidity of sample 4 is……N.T.U.

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. Write the safe level turbidity of drinking water.
2. What is an N.T.U?
3. Mention the various units for measurement of turbidity.

Space for Answer

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XIX References / Suggestions for Further Reading

1. Experiments in general chemistry Principles and modern applications, Thomas G. Greco; Lyman H. Richard; Gerald S. Weiss, Pearson, 2011,ISBN-13:978-0131493919
2. Applied Chemistry: Theory and practice, O. P. Vermani, A. K.Narula,New age International Publication New Delhi 2005 ISBN: 8122408141
3. Web reference :nitttrc.in/Four%20quadrant/eel/Quadrant%20_%201/Exp2_pdf.pdf

XX Suggested Assessment Scheme

Performance Indicators		Weightage %
Process related: 15 Marks		**60%**
1	Calibration of Nephelometer.	30%
2	Measurement of turbidity of water sample	30%
Product related: 10 Marks		**40%**
3	Practical related questions	20%
4	Submitting the journal in time	20%
Total (25 Marks)		100%

Names of Student Team Members

1. ……..
2. …….
3. …….
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.6: MOISTURE AND ASH CONTENT IN COAL

I Practical Significance

Moisture, volatile matter, ash and fixed carbon are the key parameters to be determined for estimating the quality of solid fuel materials such as coal, coke. The presence of moisture content in coal alters the calorific value of the coal. The percentage of ash in coal is used in the calculation of ash load and material balance purposes in industrial boiler systems and in the ultimate analysis for calculation of oxygen content. Fixed carbon is a value obtained by subtracting the sum of ash, moisture and volatile mater from 100. Diploma engineers have to analyze and provide more data on combustion properties of the fuel materials. It provides a basis for selling and procuring solid fuel materials.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Environment and sustainability**: Understand the impact of the engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Handling of instrument
iii. Calculation

IV Relevant Course Outcome(s)

- **Use relevant fuel in relevant applications.**

V Practical Outcome

- Determine the moisture and ash content in given coal sample using proximate analysis.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Practice good housekeeping.
- Practice energy conservation.

VII Minimum Theoretical Background

The moisture in coal is an important property which should be frequently analyzed and monitored. It can be readily removed by evaporation at room temperature but moisture held within the coal itself, known as inherent moisture is difficult to remove. Its level can be analyzed by means of laboratory tests. Moisture can be determined by heating the coal in electric oven at 105 °C in presence of nitrogen atmosphere and drying in air at 100 to 105 °C. The ash content in coal is another important parameter of coal. Ash decreases the calorific value of coal. Burning coal on a large scale requires knowledge of their ash contents. The ash content is determined by heating and burning coal sample in the presence of air and determining the weight loss.

VIII Practical set-up / Circuit diagram / Work Situation

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Electronic balance	Range of 0.001g to 500g. pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	One per batch
2	Electric oven	Inner size 18''x18''x18''; temperature range 100 to 250^0 C with the capacity of 40 lit	One per batch
3	Muffle furnace	Temperature up to 900^0C,digital temperature controller with an accuracy of +/- 30C	One per batch
4	Pair of tongs		One per group
5	Silica crucible		One per group
6	Coal sample		As per requirement

X Precautions to be Followed

1. Handle the oven and furnace carefully.
2. Silica crucible is removed from oven and furnace with pair of tongs only.

XI Procedure

Part A: Process for determination of moisture

1. Weigh approximately 1 g of air dried coal sample in a silica crucible.
2. Place the crucible in an electric oven maintained at 105^0C for 1 hour.
3. Find the difference between the starting weight and the final weight of coal which represents the amount of moisture, as the moisture is evaporated during the heating.

Part B: Process for determination of ash.

1. Weigh exactly moisture free (From part A) coal sample in a silica crucible.
2. Place the crucible in muffle furnace maintained at 750^0C for 1 hour.
3. Find the weight of ash formed.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Procedure Followed

1. Determination of moisture content: ____g of _____sample heated in electric oven at _____^{0}C for _____hour.
2. Determination of ash content: _____g of _____coal sample heated in muffled furnace at ____^{0}C for _____hour.

XIV Observations and Calculations(use blank sheet provided if space not sufficient)

Observation table I: Part A: Determination of moisture content

S. No.	Description	Weights in grams
1.	Weight of empty silica crucible(W_1)	
2.	Weight of silica crucible and coal sample before heating (W_2)	
3.	Weight of coal taken(W_3= W_2-W_1)	
4.	Weight of silica crucible and coal sample after heating(W_4)	
5.	Weight of moisture removed (W_5 =W_2-W_4)	

Calculation: Part A: Determination of moisture content

$$\% \text{ of moisture content} = \frac{\text{Weight of moisture removed } (W_5)}{\text{Weight of coal taken } (W_3)} \times 100$$

$$\% \text{ of moisture content} = \frac{\text{----------}}{\text{----------}} \times 100$$

% of moisture content = ……. %

Observation table II: Part B: Determination of ash content

S. No.	Description	Weights in grams
1.	Weight of empty silica crucible(W_1)	
2.	Weight of silica crucible and coal sample before burning (W_2)	
3.	Weight of coal taken(W_3= W_2-W_1)	
4.	Weight of silica crucible and ash (W_4)	
5.	Weight of ash formed (W_5 =W_4-W_1)	

Calculation: Part B: Determination of ash content

$$\% \text{ of ash content} = \frac{\text{Weight of ash formed } (W_5)}{\text{Weight of coal taken } (W_3)} \times 100$$

$$= \frac{\text{----------}}{\text{----------}} \times 100$$

% of ash content = ……. %

XV Results

1. Percentage of moisture contentin coal = ……. %
2. Percentage of ash content in coal = ……. %

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. State the temperature for removal of moisture and ash from coal sample.
2. Name the elements that are combustible in fuel.
3. What is the important factor in fuel selection?

Space for Answer

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XXII References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O.P.Vermani, A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Practical book on Engineering chemistry, Dr.P.K.Khatua, Platinum publishers Kolkata, ISBN : 0788189872438
3. Web reference: shodhganga.inflibnet.ac.in/bitstream/10603/68365/14/14_chapter%205.pdf

XX Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks:

Performance indicators		Weightage
Process related:15 Marks		**60%**
1.	Weight of silica crucible and coal sample after heating	15 %
2.	Weight of moisture removed	15 %
3.	Weight of silica crucible and ash	15 %
	Weight of the ash formed	15 %
Product related: 10 Marks		**40%**
4.	Percentage of moisture content	10%
5.	Percentage of ash content	10%
6.	Practical related questions	10 %
7.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.7: CALORIFIC VALUE OF SOLID FUEL

I Practical Significance

Calorific value of a fuel is a characteristic of fuel which is defined as the energy liberated per kg of fuel burnt. A fuel is selected for particular application and price is also decided based on calorific value. Bomb calorimeter is used to measure the calorific value of solid as well as liquid fuel. Diploma engineers have to analyze and provide more data on combustion properties of the fuel materials which provides a basis for selling and procuring fuel materials.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Engineering tools:** Apply appropriate technologies and tools with an understanding of the limitations.
- **Environment and sustainability**: Understand the impact of the engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Handling instrument
iii. Calculation

IV Relevant Course Outcome(s)

- **Use relevant fuel in relevant applications.**

V Practical Outcome

- Determine the calorific value of given solid fuel using Bomb calorimeter.

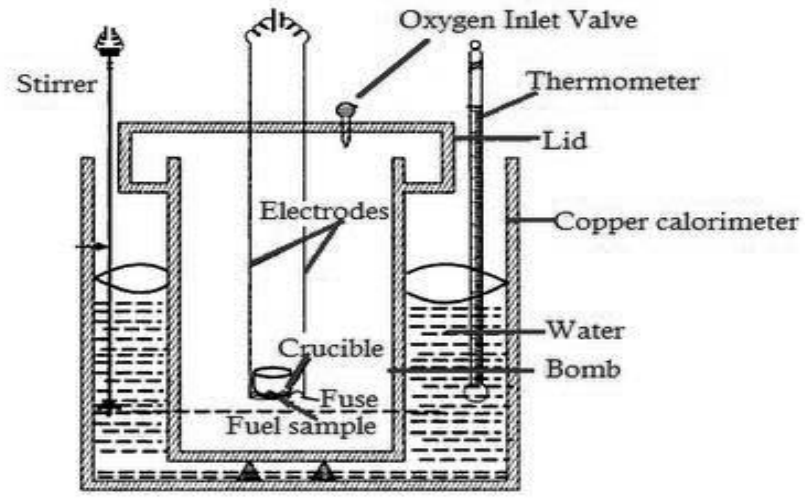
VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Practice good housekeeping.
- Practice energy conservation.

VII Minimum Theoretical Background

Bomb calorimeter is used to measure the calorific value of solid as well as liquid fuel. A calorimeter contains thick walled cylindrical vessel and it consists of the lid which supports two electrodes which are in contact with fuse wire and fuel sample of known weight. The lid also contain oxygen inlet valve through which high-pressure oxygen gas (at about 25 to 30 atm.) is supplied. Entire lid with fuel sample is now held in a copper calorimeter containing known weight of water. A mechanical stirrer is provided to stir well for uniform heating of water. A thermometer is also provided to measure the change in temperature of water due to combustion of fuel in lid. Water equivalent of bomb calorimeter can be found out for particular bomb calorimeter by first by doing an experiment based on known fuel sample whose calorific value is already known. It depends on the manufacturer of the Bomb calorimeter. A bomb calorimeter is also used for energy balance study in ecology and study of Nano-material, ceramics, zeolite. The bomb calorimeter is helpful to study the thermodynamics of common combustible materials. Unit of Calorific Value: Joule per kg (J/kg).

VIII Practical set-up / Circuit diagram / Work Situation



Bomb Calorimeter

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Electronic balance	Range of 0.001g to 500g. pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	One per batch
2.	Electric oven	Inner size 18''x18''x18''; temperature range 100 to 250^{0}C with the capacity of 40 lit	One per batch

3.	Bomb calorimeter	Standard	One per batch
4.	Pair of tongs		One per group
5.	Silica crucible		One per group
6.	Coal sample		As per requirement

X Precautions to be Followed

1. Handle the bomb calorimeter carefully.
2. Nickel or steel crucible is removed with pair of tongs only.
3. Never approach the top of the bomb due to danger of explosion.

XI Procedure

1. A known quantity (about 1 g) of air dried coal sample is taken in a nickel or steel crucible. Introduce it into the bomb.
2. Add known volume of distilled water, start the stirrer and note down the initial temperature of water.
3. Pass the oxygen gas at about 25 to 30 atm.
4. Start current through the crucible and let the fuel sample to burn in presence of oxygen.
5. Heat released during combustion of fuel is taken by water, due to which temperature of water increases.
6. Note down the final steady temperature of water.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Observations and Calculations(use blank sheet provided if space not sufficient)

S. No.	Description	Weights in grams
1.	Water equivalent of Bomb calorimeter(m_1)	
2.	Mass of water in copper calorimeter(m_2)	
3.	Specific heat of water (Cw)	
4.	Weight of empty silica crucible(W_1)	
5.	Weight of silica crucible and solid fuel (coal sample) before burning (W_2)	
6.	Weight of solid fuel (coal sample) taken ($m_f = W_2-W_1$)	
7.	Initial temperature of water (t_1)	
8.	Final temperature of water (t_2)	

Calculations

Calorific value of fuel is determined by following formula

$$\text{Calorific value} = \frac{(m_1+m_2) \times (t_2 - t_1) \times C_w}{mf}$$

$$= \frac{(\ldots\ldots\ldots\ldots..) \times (\ldots\ldots\ldots\ldots)}{\ldots\ldots\ldots\ldots}$$

Calorific value = ----------cal/g

Calorific value = ----------×4.183×10^3 J/Kg= ……. J/Kg

XV Results

Calorific value of given solid fuel (coal sample)= ---------- J/Kg

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. State the type of fuel of which calorific value is determined by using Bomb calorimeter.
2. "Bomb calorimeter is kept inside the water jacket." Explain.
3. State the significance of determination of calorific value.

Space for Answer

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XXIII References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O.P.Vermani,A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Practical book on Engineering chemistry, Dr.P.K.Khatua, Platinum publishers Kolkata, ISBN : 0788189872438
3. Web reference : www.mechanicalduniya.com/2012/01/bomb-calorimeter-assignment-content-for.html
4. Web reference:https://www.youtube.com/watch?v=9suiA6EWQ18 https://www.youtube.com/watch?v=NQB3zga2Yb8

XX Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessmentregarding process and product related marks:

Performance indicators		Weightage
Process related:15 Marks		**60%**
1.	Determination of weight of sample fuel	10%
2.	Operation of Bomb calorimeter	30 %
3.	Measurement of initial and final temperature of water	20 %
Product related: 10 Marks		**40%**
4.	Formula of calorific value	10%
5.	Calculation of calorific value	10%
6.	Practical related questions	10 %
7.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No.8: SULPHUR CONTENT IN COAL

I Practical Significance

Sulphur emissions from coal combustion pollutes the atmosphere and is hazardous for the living organisms. It corrodes chimney and other equipment such as air heaters, machinery parts. It affects clinkering and slagging tendencies. Hence the presence of sulphur is undesirable. It is important to measure the sulphur content in coal samples to evaluate the potential of fuel sample. The ultimate analysis is useful in classification of coal, basically it determine the percentage of elements. If sulphur is present in metallurgical coal, is harmful for use in metallurgy, as it affects the properties of metal. Oxidation products of sulphur (SO_2 and SO_3) especially formed in presence of moisture, have corrosive effect due formation of sulphuric acid. Diploma engineers have to analyze and provide more data on combustion properties of the fuel materials which provides a basis for selling fuel materials.

II Relevant Program Outcomes (POs)

- **Basic knowledge**: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- **Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- **Environment and sustainability**: Understand the impact of the engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse/multidisciplinary teams.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of engineering industries.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply principles of advanced physics and chemistry to solve broad based engineering problems'***.

i. Measurement skill
ii. Preparation of solutions
iii. Weighing skill
iv. Calculation

IV Relevant Course Outcome(s)

- **Use relevant fuel in relevant applications.**

V Practical Outcome

- Determine the percentage of sulphur in given coal sample by ultimate analysis (Gravimetric analysis).

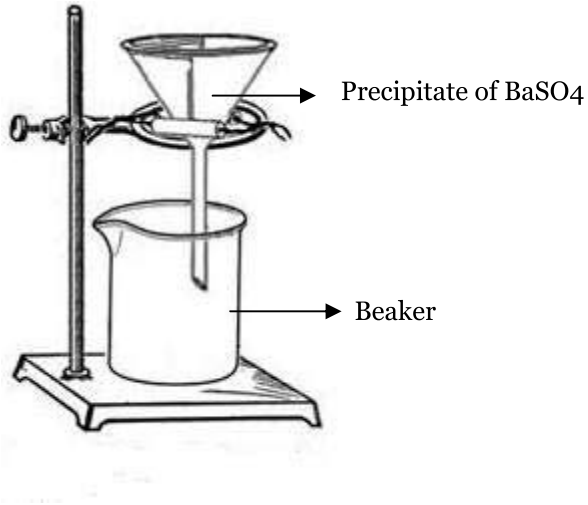
VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Practice good housekeeping.
- Practice energy conservation.

VII Minimum Theoretical Background

The ultimate analysis is used to determine the carbon, hydrogen, oxygen, sulphur, nitrogen content in the coal. Sulphur is usually present in coal in three forms - as sulphates, as iron pyrites (FeS_2) and as sulphur in organic compounds. The forms of sulphur so present are known as 'sulphate', 'pyritic' and 'organic' respectively. Sulphatesulphur is determined by extracting coal with dilute hydrochloric acid and determined gravimetrically by precipitation as barium sulphate with barium chloride. Pyritic sulphur is insoluble in dilute hydrochloric acid, but is quantitatively dissolved by nitric acid under experimental conditions and converted into sulphate. The sulphates are separated from nitric acid by evaporating nitric acid. The sulphates are extracted with hydrochloric acid and determined gravimetrically by precipitation as barium sulphate with barium chloride. Organic sulphur of coal is not determined by analytical method, it is calculated by deducting the sum of pyritic and sulphatesulphur from total sulphur.

VIII Practical set-up / Circuit diagram / Work Situation



IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Remark
1.	Electronic balance	Range of 0.001g to 500g. pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	One per batch

2.	Electric oven	Inner size 18''x18''x18''; temperature range 100 to 250^0 C with the capacity of 40 lit	One per batch
3.	Bomb calorimeter		One per batch
4.	Pair of tongs		One per group
5.	Silica crucible		One per group
6.	Beaker	Borosil glass,250ml	Two per group
7.	Funnel	Borosil glass	
8.	Chemicals	Coal sample, HCl, $BaCl_2$	As per requirement

X Precautions to be Followed

1. Handle the bomb calorimeter carefully.
2. Nickel or steel crucible is removed with pair of tongs only.
3. Handle the glassware carefully.
4. Dry and weigh the precipitate accurately.
5. Never approach the top of the bomb due to danger of explosion.

XI Procedure

1. Take 1 g of moisture and volatile matter free coal sample in a nickel or steel crucible.
2. The crucible is placed in a bomb of bomb calorimeter and burn completely in presence of oxygen.
3. The ash obtained contains sulphur of coal as a sulphate, which is extracted with dil. HCl.
4. The acid extract is treated with $BaCl_2$ solution to precipitate sulphate as $BaSO_4$.
5. The precipitate is filtered, washed and dried and weighed.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Observations and Calculations(use blank sheet provided if space not sufficient)

S. No.	Description	Weights in grams
1.	Weight of $BaSO_4$ formed (y)	
2.	Atomic weight of sulphur	32
3.	Molecular weight of $BaSO_4$	233

Calculations

Sulphur in coal is determined as,

233 g of $BaSO_4$ contains 32 g of sulphur

$$\text{y g of } BaSO_4 \text{ contains} = \frac{(32) \times (y)}{(233)} \text{ g of sulphur}$$

$$\text{i.e. y g of } BaSO_4 \text{ contains} = \frac{(32) \times (\ldots\ldots)}{(233)} \text{ g of sulphur}$$

= …… g of sulphur

Hence % of sulphur in coal is = ---------- × 100 %

XV Results

The percentage of sulphur content in coal sample = ……%.

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions

1. Write the balanced equation of the reaction when, acid extract is treated with $BaCl_2$ solution.
2. "Estimation of sulphur content in coal sample is important". Explain.
3. Which form of sulphur is determined in this experiment?

Space for Answer

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XXIV References / Suggestions for further reading

1. Applied Chemistry : Theory and practice, O.P.Vermani,A.K.Narula, New age International Publication New Delhi 2005 ISBN: 8122408141
2. Practical book on Engineering chemistry,Dr.P.K.Khatua, Platinum publishers Kolkata, ISBN : 0788189872438
3. Experiments and calculations in engineering chemistry, Dr. Dara, S. S. S. Chand. Publication, New Delhi, 2011, *ISBN*:8121908647
4. Web reference: www.mechanicalduniya.com/2012/01/bomb-calorimeter-assignment-content-for.html

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related:15 Marks		**60%**
1.	Determination of weight of coal sample	10%
2.	Preparation of acid extract of coal ash	20 %
3.	Filtration ,drying and weighing of $BaSO_4$ precipitate	30 %
Product related: 10 Marks		**40%**
4.	Calculation for percentage of Sulphur	20%
5.	Practical related questions	10 %
6.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. …….

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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