SCHEME :K

Name : ______________________________
Roll No. : ______________ Year : 20___ 20___
Exam Seat No. : ________________________

LABORATORY MANUAL FOR
BASIC SCIENCE (CHEMISTRY)
(311305)

FIRSTYEARENGINEERING

MAHARASHTRA STATE BOARD OFTECHNICAL EDUCATION, MUMBAI (Autonomous)
(ISO9001:2015) (ISO/IEC27001:2013)

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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.

A Laboratory Manual for

Basic Science-Chemistry

(311305)

Semester-I

Diploma in Engineering and Technology
(All Programme)

Maharashtra State
Board of Technical Education, Mumbai (Autonomous)
(ISO9001:2015) (1SO/IEC27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous)(ISO9001:2015)(ISO/IEC27001:2013)
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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 the Course **Basic Science- Chemistry** (311305) for the Academic Year 20.........to 20..........as prescribed in the curriculum.

Place:........................ Enrollment No:..............................

Date:...................... Exam Seat No:..................................

Course coordinator **Head of the Department** **Principal**

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Preface

The need and importance of fundamental or basic sciences have been established in all walks of technology and everyone has experienced that the most important components of basic science are Physics and Chemistry. The role of Physics and Chemistry are well accepted in the development of future technology. Therefore it has become essential for every diploma student irrespective of their core discipline to acquire basic knowledge and skills to develop insight not only into its potential and application but also to utilize technology effectively.

Focus in writing this manual has been on developing highly readable experiments that will provide learner with a successful learning experience. Method for developing laboratories begins with identifying concepts that are of particular interest or challenge to students and which would benefit from clarification through laboratory work. From this, experimental learning outcomes are developed and which serve as a key focus point for all aspects of the given experiment. The pedagogical approach of the laboratory is then chosen to make the most of the topics are trying to be learn. For example, some laboratories benefit from a discovery type approach while others are best taught following a more traditional expository approach.

In particular through this course the students acquire knowledge and skills related to basic chemistry and physics that equip them with the ability to measure, observe keenly, analyze critically, creates the documents for various purpose. The laboratory manual provides detailed guidance to perform the practical in the right way with necessary resources required to achieve desired outcome.

This lab manual is designed in a way that it is helpful to both the instructors and the students. The manual provides guidelines to help instructors effectively facilitate student-centered activities to be carried out in the lab through practical thus arranging and managing necessary resources, practical outcomes, skills to be achieved through given practical, and let students follow the procedures and precautions ensuring the achievement of outcomes and assessing the performance of students.

For students it gives complete guidance regarding minimum theoretical background required to undertake the practical, skills they achieve through the given practical, procedure and necessary precautions to be followed by them. Students can use the acquired knowledge and skills achieved through hands on to solve real-world problems in their professional life. To do this, students must first understand the topic and acquire sufficient background knowledge, and the implications and limitations of this knowledge.

Programme Outcomes (POs) to be achieved through Practical's

1. **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
2. **Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
3. **Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
4. **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
5. **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
7. **Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.

List of relevant skills

1. **Intellectual Skills:** Critical thinking & problem solving are keys of intellectual skills across various disciplines.
2. **Psychomotor Skills:** Executing precise hands on while performing practicals demonstrate, involve in psychomotor skills.
3. **Affective Domain Skills:** The affective domain includes the feelings, emotions and attitudes of the individual.
4. **Teamwork:** Teamwork in laboratory creates an environment where lab partners can learn from each other's experiences and expertise, enhancing to personal growth and skill development.
5. **Prioritisation:** Prioritizing in lab ensures a systematic & efficient approach to experimental procedures.
6. **Communication:** Communication in laboratory helps everyone to share information & work together smoothly.
7. **Interpersonal skills:** Positive relationships & understanding your partners in lab are key aspects of strong Interpersonal skills.
8. **Research skills:** Effective research skills involve collecting information, analyzing data & meaningful conclusions to contribute to more understanding of a subject.

Practical-Course Outcome Matrix

Sr. No.	Title of the Practical	CO 4.	CO 5.	CO 6.
1.	Identification of cation in given ionic solutions.	✓	-	-
2.	Identification of anion in given ionic solutions.	✓	-	-
3.	Identification of states of matter.	✓	-	-
4.	Determination of electrode potential of copper.	-	✓	-
5.	Determination of electrode potential of Iron metal.	-	✓	-
6.	Determination of the voltage generated from chemical reaction using Daniel Cell.	-	✓	-
7.	Determination of electrochemical equivalent of Cu metal using Faraday's first law.	-	✓	-
8.	Determination of equivalent weight of metal using Faraday's second law.	-	✓	-
9.	Preparation of corrosive medium for Aluminium at different temperature.	-	✓	-
10.	Determination of rate of corrosion at different temperatures for Aluminium.	-	✓	-
11.	Determination of effect of temperature on viscosity for given lubricating oil using Redwood viscometer-I.	-	-	✓
12.	Determination of the steam emulsification number of given lubricating oil.	-	-	✓
13.	Determination of flash and fire point of given lubricating oils using Cleveland open cup apparatus.	-	-	✓
14.	Determination of flash point of given lubricating oil using Abel's closed cup apparatus.	-	-	✓
15.	Determination of thinner content in oil paint.	-	-	✓

Guidelines to Course Coordinator

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 Course Coordinator*** 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 are not mentioned in the printed practicals.
3. For difficult practicals if required, Course Coordinator could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Course Coordinatorshouldgiveopportunitytostudentsforhands-onafterthedemonstration.
5. Assess the skill achievement of the students and CO's 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 Course Coordinator** in the next practical session.
2. Students should read the precaution carefully before start of experiment.

Content Page

List of Practical’s and Formative Assessment Sheet

Sr. No.	Practical Outcome	Page No.	Date of Performance	Date of Submission	Assessment Marks	Dated Sign of Faculty	Remarks if any
1	*Identification of cation in given ionic solutions.	1					
2	*Identification of anion in given ionic solutions.	13					
3	Identification of states of matter.	21					
4	*Determination of electrode potential of copper.	26					
5	Determination of electrode potential of Iron metal.	32					
6	Determination of the voltage generated from chemical reaction using Daniel Cell.	38					
7	*Determination of electrochemical equivalent of Cu metal using Faraday’s first law.	44					
8	Determination of equivalent weight of metal using Faraday’s second law.	49					
9	Preparation of corrosive medium for Aluminium at different temperature.	54					
10	*Determination of rate of corrosion at different temperatures for Aluminium.	59					
11	*Determination of effect of temperature on viscosity for given lubricating oil using Redwood viscometer-I.	65					
12	Determination of the steam emulsification number of given lubricating oil.	71					
13	*Determination of flash and fire point of given lubricating oils using Cleveland open cup apparatus.	76					
14	Determination of flash point of given lubricating oil using Abel's closed cup apparatus.	81					
15	*Determination of thinner content in oil paint.	86					
Total Marks							

- To be transferred to Proforma of Assessment Norms (K3)

'*' Marked Practicals (LLOs) are mandatory.

PracticalNo.1: Identification of Cations

I Practical Significance

The ionization phenomenon, the characteristics of solutions, and the concentration of ions are crucial factors influencing various chemical processes, catalysis, reactions, and industrial product outcomes. In the sector of chemical and allied engineering, diploma engineers are actively involved in handling diverse solutions containing specific cations and anions. Their responsibilities creates conducting sample testing in industrial settings and utilizing the resulting data. In this particular experiment, students are tasked with determining the quantity and types of cations present in a provided sample. This information is instrumental in the context of industrial sample testing; enabling engineers to better understand and manipulate chemical processes for optimal outcomes.

II Industry/ Employer Expected Outcome

1. Handling glass wares.
2. Handling reagents.
3. Observation.

III Relevant course outcome

CO4- Predict the structure, properties and behaviour of molecules and compounds based on the types of chemical bond.

IV Practical Learning Outcome

Identify cations in the given ionic solutions.

V Laboratory Learning Outcome(s)

Identify cation in given ionic solutions by performing selective test..

VI Relevant Affective domain related Outcomes

1. Follow safety practices.
2. Practice good housekeeping.

VII Relevant Theoretical Background

When acids, bases, and salts dissolve in water, they undergo a process of dissociation, breaking down into two distinct types of ions. Cations, which are positively charged ions, are formed by the loss of electrons from metallic atoms. On the other hand, anions are created by the gain of electrons by non-metallic radicals or groups of non-metals. The charges carried by cations and anions correspond to the valency of the respective elements giving rise to these ions. It is noteworthy that the total positive charges present on cations always equal the total negative charges present on anions. As a result, the overall solution maintains electrical neutrality. This balance in charges ensures that the dissolved substances in the solution collectively possess a net electric charge of zero. (Neutral)

VIII Resources required

Sr. No.	Resources	Specification	Quantity	Remark
1.	Test tube	15 ml	6 each	
2.	Test tube holder	Steel with wooden	1 each	
3.	Test tube stand	Wooden / Plastic	1 each	
4.	Chemicals	As per requirement		
5.	Beaker	100 ml	1 each	

IX Precautions

1. Use test tube holder.
2. Use funnel for transfer of solution and reagents.
3. Turn off the gas burners after use.

X Procedure

1. Ensure the test tube is thoroughly cleaned using water.
2. Using a dropper, transfer 2-3 ml of the provided solution into the test tube.
3. Add an equivalent quantity of appropriate reagents based on the qualitative analysis chart provided below.

Table for qualitative analysis:

A. Identification of Cations

Sr. No.	Test	Observation	Inference
1	O.S. + dil. HC1	White ppt.	I group present i. e Pb^{2+}may be present.
		No ppt.	I group is absent
2	O.S.+ dil. HC1 +H_2S gas	ppt. obtained	II Group Present
		1.Black ppt. of CuS	Cu^{2+} may be present
		2.Brown ppt. of SnS	Sn^{2+} may be present
		3.Yellow ppt. of SnS_2	Sn^{4+} may be present

		No ppt.	II group is absent
3	O.S.+ NH_4C1 (excess) + NH_4OH (till alkaline)	ppt. obtained	III A Group present.
		1. White gelatinous ppt. of $Al(OH)_3$	$A1^{3+}$ may be present.
		2. Dirty green ppt. of $Fe(OH)_2$	Fe^{2+} may be present
		3.Reddish brown ppt. of $Fe(OH)_3$	Fe^{3+} may be present
		4. Bluish green ppt. of $Cr(OH)_3$	Cr^{3+} may be present
		No ppt.	III A group is absent
4	O.S.+ NH_4C1 (excess) + NH_4OH (till alkaline)+ H_2S	ppt. obtained	III B Group Present
		1.White ppt. ZnS	Zn^{2+} may be present
		2.Faint pink ppt. of MnS	Mn^{2+} may be present
		3.Black ppt. of NiS or CoS	Ni^{2+} or Co^{2+} may be present
		No ppt.	III B group is absent
	Above Black ppt. obtained + Conc. HNO_3	Green solution	Ni^{2+} present
		Blue Solution	Co^{2+} present
5	O.S.+ NH_4C1 (excess) + NH_4OH (till alkaline)+$(NH_4)_2CO_3$	White ppt. of $CaCO_3$ or $BaCO_3$ No ppt.	IV group is present i.e.Ba^{2+} or Ca^{2+} may be present
		No ppt.	IV group is absent
	O.S. +K_2CrO_4	Yellow ppt.	Ba^{2+} may be present
		No ppt.	Ca^{2+} may be present
6	O.S.+ NH_4C1 (excess)	White ppt.	V Group present

	+ NH_4OH (till alkaline) + NaH_2PO_4		i.e. Mg^{2+} may be present
		No ppt.	V group is absent

If all the above groups are absent then proceed for detection of Na^+, K^+ and NH_4^+

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH (Boil)	Smell of ammonia gas or turns moist red litmus blue	NH_4^+ May be present
		No smell of ammonia does not turns moist red litmus blue	Na^+ or K^+ may be present
2.	O.S.+ Sodium cobaltinitrite [fresh solution]	Yellow ppt.	K^+ may be present
		No ppt.	Na^+ may be present

B. Confirmatory Test (C.T.) for cations

C.T. for GROUP I cations

C. T. for Pb^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S + dil. H_2SO_4	White ppt.	Pb^{2+} confirmed
2.	O.S + KI	Deep yellow ppt.	Pb^{2+} confirmed
3.	O.S.+ K_2CrO_4	Yellow ppt.	Pb^{2+} confirmed

C. T. For GROUP II cations

C.T. for Cu^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S. + $K_4[Fe(CN)_6]$	Chocolate red ppt.	Cu^{2+} Confirmed
2.	O.S.+ KI	Brown ppt.	Cu^{2+} Confirmed
3.	O.S.+ NaOH	Blue ppt.	Cu^{2+} Confirmed

C.T. for Sn^{2+}

Sr. No.	Test	Observation	Inference
1	O.S.+ $HgC1_2$	White ppt. turns gray	Sn^{2+} confirmed
2.	O.S. + NaOH	White ppt. Soluble in excess of NaOH	Sn^{2+} confirmed
3.	O.S.+Iodine solution	Decolourisation of iodine solution	Sn^{2+} confirmed

C.T. for GROUP III A cations

C.T. for $A1^{3+}$

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH	White gelatinous ppt.	Al^{3+} confirmed
2.	O.S.+ Ammonium acetate solution	No PPT. in cold but gives white gelatinous ppt. on boiling	Al^{3+} confirmed
3.	O.S.+NaH_2PO_4	white gelatinous ppt. soluble in dil. HC1	Al^{3+} confirmed

C.T. for Fe^{2+} [Ferrous]

Sr. No.	Test	Observation	Inference
1.	O.S.+$K_3[Fe(CN_6)]$	Deep Blue ppt.	Fe^{2+} confirmed
2.	O.S.+ NaOH	Dirty green ppt.	Fe^{2+}confirmed
3.	O.S.+ dil. H_2SO_4 + 1% $KMnO_4$ solution.	Pink colour of $KMnO_4$ decolorizes	Fe^{2+}confirmed

C.T. for Fe^{3+}[Ferric]

Sr. No.	Test	Observation	Inference
1.	O.S.+ $K_4[Fe(CN)_6]$	Deep Blue ppt.	Fe^{3+} confirmed
2.	O.S. + NaOH	Reddish brown ppt.	Fe^{3+} confirmed
3.	O.S. + Ammonium thiocynate solution	Blood red ppt.	Fe^{3+} confirmed

C.T. for Cr^{3+}

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH	Bluish Green ppt.	Cr^{3+} confirmed
2.	O.S. + PbO_2 + NaOH Boil collect supernatant solution in another test tube and add acetic acid	Yellow ppt.	Cr^{3+} confirmed

C.T. for Group III (B) cations

C.T. for Zn^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH	White ppt. insoluble in dil. HC1	Zn^{2+} Confirmed
2.	O.S.+NaH_2PO_4	White ppt.	Zn^{2+} Confirmed
3.	O.S.+ $K_4[Fe(CN)_6]$	White ppt.	Zn^{2+} Confirmed

C.T. for Mn^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH	White ppt. soluble in excess of NaOH	Mn^{2+} confirmed
2.	O.S.+NaOH+Br_2 water	Black ppt.	Mn^{2+} confirmed
3.	O.S.+ $K_4[Fe(CN)_6]$	Pinkish white ppt. soluble in dil. HC1	Mn^{2+} confirmed

C.T. for Ni^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH + Br_2 water	Black ppt.	Ni^{2+} confirmed
2.	O.S.+NH_4OH	Pale green ppt. Soluble in excess giving blue solution	Ni^{2+} confirmed
3.	O.S.+Dimethyl glyoxime	Scarlet red ppt.	Ni^{2+} confirmed

C.T. for Co^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S.+NH_4OH	Blue ppt. turns Brown in Excess	Co^{2+} confirmed
2.	O.S.+ Ammonium thiocynate (NH_4CNS)	Black ppt.	Co^{2+} confirmed
3.	$K_4[Fe(CN)_6]$	Reddish ppt.	Co^{2+} confirmed

C.T. for Group IV cations

C.T. for Ba $^{2+}$

Sr. No.	Test	Observation	Inference
1.	O.S.+K_2CrO_4 (potassium chromate)	Yellow ppt.	Ba^{2+} Confirmed
2.	O.S.+ Ammonium oxalate	White ppt.	Ba^{2+} Confirmed
3.	O.S. + dil. H_2SO_4	White ppt.	Ba^{2+} Confirmed

C.T. for Ca^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S.+K_2CrO_4 (potassium chromate)	No ppt.	Ca^{2+} confirmed
2.	O.S.+ Ammonium oxalate	White ppt. insoluble in acetic acid	Ca^{2+} confirmed
3.	O.S. +NH_4C1(crystals) + K_4 $[Fe(CN)_6]$	White ppt.	Ca^{2+} confirmed
4.	Flame Test	Brick Red coloured flame	Ca^{2+}Confirmed

C.T. for Group V cations

C.T. for Mg^{2+}

Sr. No.	Test	Observation	Inference
1.	O.S.+ NaOH	White ppt.	Mg^{2+} confirmed
2.	O.S.+ Hypoiodide solution	Reddish brown ppt.	Mg^{2+} confirmed

C.T. for NH_4^+

Sr. No.	Test	Observation	Inference
1.	O.S.+ Nessler's reagent	Brown ppt.	NH_4^+ Confirmed
2.	O.S.+ Picric acid (alcoholic)	Yellow crystalline ppt.	NH_4^+ Confirmed

C.T. for K^+

Sr. No.	Test	Observation	Inference
1.	O.S.+ Sodium cobaltinitrite Solution (freshly prepared)	Yellow ppt.	K^+ Confirmed
2.	O.S.+ Picric acid (alcoholic)	Yellow ppt.	K^+ Confirmed
3.	O.S.+ Perchloric acid	White ppt.	K^+ Confirmed

C.T. for Na^+

Sr. No.	Test	Observation	Inference
1.	O.S. + Sodium cobaltinitrite solution	Yellow ppt.	Na^+ Confirmed
2.	Flame test	Golden yellow flame	Na^+ Confirmed

O.S. = Original water solution of given inorganic salt, **ppt.** = Precipitate.
Dil = Dilute, **Conc.** = Concentrated, **C.T.**= Confirmatory test

XI Observations

Sample Solution 1

A. Identification of Cation

Sr. No.	Test	Observation	Inference

B. Confirmatory Test (C.T.) for cation

Sr. No.	Test	Observation	Inference

Sample Solution 2

A. Identification of Cation

Sr. No.	Test	Observation	Inference

B. Confirmatory Test (C.T.) for Cation

Sr. No.	Test	Observation	Inference

XII Results

1. Cation identified in sample solution 1 is ……………. that can be obtained by dissolving …………salt in water.
2. Cation identified in sample solution 2 is ……………. that can be obtained by dissolving …………salt in water.

XIII Interpretation of results

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XIV Conclusions and Recommendations

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XV Practical Related Questions

1. Identify the basic radical present in the given solution 'A' by observing the formation of a black precipitate with diluted hydrochloric acid (HCl) and the evolution of hydrogen sulfide (H_2S) gas.
2. Explain the process for identifying either the Ba^{2+} or Ca^{2+} radical in the unknown solution.
3. Identify the cation in solution 'X' by recognizing its pale green colouration, and when combined with sodium hydroxide, observe the formation of a dirty green-coloured precipitate.

XVI References/Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010,ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015,ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, DevdattaV. Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334

XVII Assessment Scheme

Sr. No.	Process related	Weightage (60%)
1	Process for detection of cation l	15%
2	Process for detection of cation 2	15%
3	Confirmatory test for cation l	15%
4	Confirmatory test for cation 2	15%

Product related assessment scheme

Sr.	Product related	Weightage (40%)
1	Identification of cation l	10%
2	Identification of cation 2	10%
3	Answer to sample questions	10%
4	Submission of report in time	10%

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

[Space to Write Answers]

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Practical No.2: Identification of anions

I Practical Significance

The way ions form, the type of solution, and the amount of ions are crucial factors in many chemical processes, catalysis, and reactions that occur in industries. In the field of chemical and allied engineering, diploma engineers deal with various solutions and their negative ions. They are involved in conducting sample tests in industries and utilizing the information obtained from these tests. In this specific experiment, students will determine the size and kinds of negative ions present in a provided sample, which is valuable for conducting sample tests in industrial settings.

II Industry/ Employer Expected Outcome

1. Handling glass wares.
2. Handling reagents.
3. Observation

III Relevant Course Outcome

CO4-Predict the structure, properties and behaviour of molecules and compounds based on the types of chemical bond.

IV Practical Learning Outcome

Identify anion in given ionic solutions.

V Laboratory Learning Outcome(s)

Identify anion in given ionic solutions by performing selective test.

VI Relevant Affective domain related Outcomes

1. Follow safety practices.
2. Practice good housekeeping.

VII Relevant Theoretical Background

When acids, bases, and salts dissolve in water, they break down into two types of ions. Cations, which are positively charged ions, result from the loss of electrons by metallic atoms. On the other hand, anions are created through the gain of electrons by non-metallic radicals or groups of non-metals. The charges carried by cations and anions reflect the valency of the elements involved in the ion formation. Importantly, the total positive charges on cations always equal the total negative charges on anions, ensuring that the entire solution remains electrically neutral.

VIII Resources required

Sr. No.	Resources	Specification	Quantity	Remark
1.	Test tube	15 ml	6 each	
2.	Test tube holder	Steel with wooden handle	1 each	
3.	Test tube stand	Wooden / Plastic	1 each	
4.	Chemicals	As per requirement		
5.	Beaker	100 ml	1 each	

IX Precautions

1. Use test tube holder.
2. Use funnel for transfer of solution and reagents.
3. Turn off the gas burners after use.

X Procedure

1. Ensure the test tube is thoroughly cleaned using water.
2. Using a dropper, transfer 2-3 ml of the provided solution into the test tube.
3. Add an equivalent quantity of appropriate reagents based on the qualitative analysis chart provided below.

Table for qualitative analysis:

A. Identification of anions

Sr. No.	Test	Observation	Inference
1	O.S.+ dil.HNO_3	Effervescence of CO_2 gas which turns lime water milky	CO_3^{--} may be present
		No Effervescence of CO_2 gas.	CO_3^{--} is absent
2	O.S.+$AgNO_3$	White ppt. insoluble in dil. HNO_3	Cl^-, Br^- or I^- may be present
		No White ppt.	Cl^-, Br^- or I^- is absent
	O.S.+ Chloroform+ Chlorine water	1. Lower chloroform layer colourless	Cl^- may be present
		2. Lower chloroform layer yellow/ brown	Br^- may be present
		3. Lower chloroform layer pink/violet	I^- May be present
3	O.S.+ $Ba(NO_3)_2$	1. White ppt. insoluble in dil. HNO_3	SO_4^{--} may be present

		No ppt.	NO_3^- may be present

B. Confirmation of Anions

C.T. for CO3$^{- -}$

Sr. No.	Test	Observation	Inference
1.	O.S.+ $Ba(NO_3)_2$	White ppt.	$CO_3^{- -}$ confirmed
2.	O.S. + Phenolphthalein	Pink colouration	$CO_3^{- -}$ confirmed

C.T. for Cl^-

Sr. No.	Test	Observation	Inference
1.	O.S. + Lead acetate solution	White ppt.	Cl^-confirmed
2.	O.S. + K_2Cr_2O7 + Conc. H_2SO_4	Brown gas evolved when passed through water turns yellow which gives PPT with lead acetate.	Cl^- confirmed
3.	O.S. +MnO_2 + Conc. H_2SO_4	Green fumes changes moist blue litmus red and then bleaches.	Cl^- confirmed

C.T. for Br^-

Sr. No.	Test	Observation	Inference
1.	O.S. + Lead acetate solution	Brown ppt.	Br -confirmed
2.	O.S. + Chloroform + Chlorine water	Chloroform layer yellowish brown	Br -confirmed
3.	O.S.+ MnO_2 + Conc. H_2SO_4 (Heat)	Brown fumes	Br -confirmed

C.T. for I^-

Sr. No.	Test	Observation	Inference
1.	O.S. + Lead acetate solution	Yellow ppt.	I^- confirmed
2.	O.S. + Chloroform + Chlorine water	Chloroform layer pink or violet	I^- confirmed
3.	O.S. + MnO_2 + Conc. H_2SO_4(Heat)	Violet fumes	I^- confirmed

C.T. for $SO_4^{- -}$

Sr. No.	Test	Observation	Inference
1.	O.S. + Lead acetate solution	White ppt.	$SO_4^{- -}$ confirmed
2.	O.S. + $BaC1_2$	White ppt.	$SO_4^{- -}$ confirmed
3.	O.S. + $HgNO_3$	Yellow ppt.	$SO_4^{- -}$

			confirmed

C.T. for NO_3^-

Sr. No.	Test	Observation	Inference
1.	O.S. + Copper fillings + Conc. H_2SO_4 (Heat)	Evolution of brown fumes, leaving blue coloured solution.	NO_3^- confirmed
2.	O.S. + Conc. H_2SO_4 + freshly prepared $FeSO_4$solution (Add slowly from the side of the test tube without disturbing the solution in the test tube)	A brown ring appears at the junction of the two solutions.	NO_3^- confirmed

XI Observations

Sample Solution 1

A. Identification of Anion

Sr. No.	Test	Observation	Inference

B. Confirmatory Test (C.T.) for Anion

Sr. No.	Test	Observation	Inference

Sample Solution 2

A. Identification of Anion

Sr. No.	Test	Observation	Inference

B. Confirmatory Test (C.T.) for Anion

Sr. No.	Test	Observation	Inference

XII Results

1. Anion identified in sample solution 1 is .... , that can be obtained by dissolving..................salt in water.

2. Anion identified in sample solution 2 is .... , that can be obtained by dissolving……………salt in water.

XIII Interpretation of results

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XIV Conclusions and Recommendations

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XV Practical Related Questions

1. Identify the acidic radical in solution 'A' by observing the release of CO_2 gas upon reacting with diluted nitric acid (HNO_3).
2. Write the procedure for separating halides in a sample solution through a separation test.
3. Identify the anion in solution 'X' when mixed with barium nitrate which gives white ppt.

XVI References/Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, DevdattaV. Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334

XVII Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1.	Process for detection of anion 1	15%
2.	Process for detection of anion 2	15%
3.	Confirmatory test for anion 1	15%
4.	Confirmatory test for anion 2	15%
	Product related	**Weightage (40%)**
1.	Identification of anion 1	10%
2.	Identification of anion 2	10%
3.	Answer to sample questions	10%
4.	Submission of report in time	10%

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

List of Student Team Members

1. ……………………………………
2. ……………………………………
3. ……………………………………
4. ……………………………………

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Practical No.3: Identification of States of Matter

I Practical Significance

It's essential to recognize that each form of matter possesses distinct heat storage capacities, and the transition between different states of matter necessitates the input or release of energy.

II Industry/ Employer Expected Outcome

1. Observation
2. Calculation

III Relevant Course Outcomes

CO 4- Predict the structure, properties and behavior of molecules and compounds based on the types of chemical bond.

IV Practical Learning Outcome

Identification of states of matter.

V Laboratory Learning Outcome(s)

1. Identify states of matter of materials by using simulation by applying heating and cooling Techniques.
2. Relate temperature-pressure diagram.

VI Relevant Affective domain related Outcomes

1. Identify states of matter of materials by using simulation by applying heating and cooling Techniques.
2. Relate temperature-pressure diagram.

VII Relevant Theoretical Background

There are three common states of matter:

1. **Solids** exhibit a characteristic rigidity and maintain both a definite volume and shape. The constituent atoms and molecules are tightly bound, undergoing vibrational motions within fixed positions without significant translational movement.
2. **Liquids** possess a definite volume but have the ability to change shape by flowing. The intermolecular bonds in liquids are less restrictive, allowing atoms and molecules to move more freely while remaining in close proximity to one another.
3. **Gases** lack a definite volume or shape, as the atoms and molecules move freely and disperse from one another. The weak intermolecular forces in gases result in a state where particles have the freedom to travel independently.

This unique characteristic sets it apart from the conventional solid, liquid, and gas phases. The transition between these states is governed by the temperature and surrounding pressure of the matter. As temperature increases or decreases under constant pressure, the phase may shift from solid to liquid, liquid to gas, or undergo a reverse transformation. The melting point signifies the temperature at which a material undergoes the transition from a solid to a liquid state, while the boiling point is the temperature at which the saturated vapor pressure of a liquid equals the atmospheric pressure, resulting in the transformation from liquid to gas.

VIII Resources required

Sr. No.	Resources	Software Link	Quantity
1.	Simulation Software	https://phet.colorado.edu/en/simulations/filter?subjects=chemistry&type=html,prototype	NA

IX Precautions

While conducting experiment follow the steps included in simulation software.

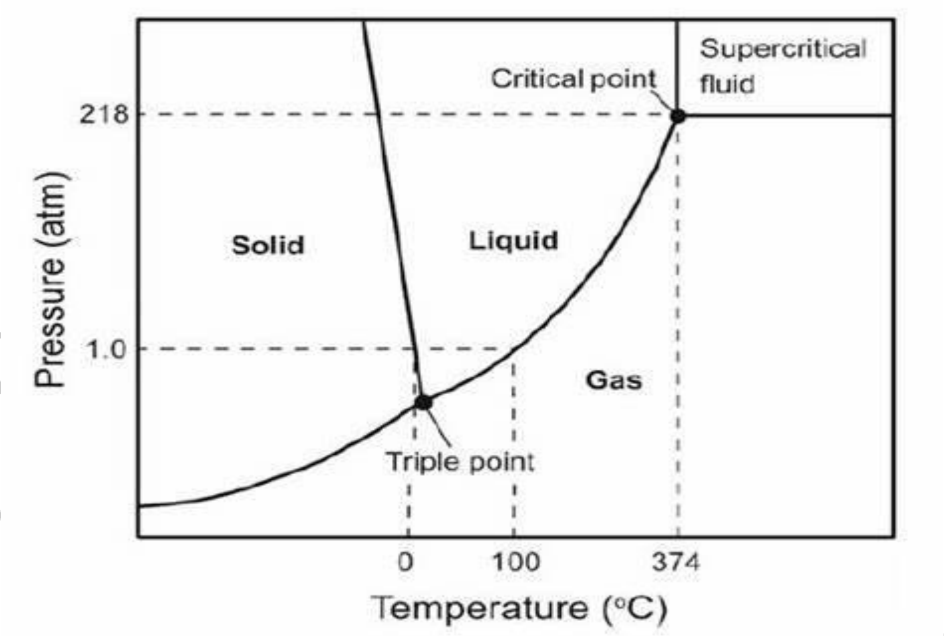
X Procedure

1. Access the simulation program through the designated pathway on your computer.
2. Select the desired substance from the given alternatives; for example, water from the available options.
3. Observe the initial state of the selected substance (water) under standard room temperature and pressure conditions.
4. Write down the substance's physical characteristics, particle arrangement, and behavioral observations.
5. Gradually apply heat to the simulation, raising the substance's temperature step by step.
6. Observe and record any changes in visual appearance and the movement of its particles as the temperature increases.
7. Analyse the specific temperature at which the substance undergoes a transition from one state to another.
8. To start cooling, reduce the temperature using a cooling source.
9. Record any alterations in the substance's appearance and the movement of its particles as the temperature decreases, observing the changes as they occur during the cooling process.

XI Observations

Sate of matter	Temperature	Pressure	Observation
Initial State			
Heating			
Cooling			

1. Plot the recorded temperature and pressure data from the simulation on a temperature pressure diagram.
2. Determine Melting Point, Boiling Point of water form temperature pressure diagram.



XII Results

1. Melting Point of Ice is ………………
2. Boiling Point of Water is ………………

XIII Interpretation of results

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XIV Conclusions and Recommendations

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XV Practical Related Questions

1. Write the characteristics of particles of matter.
2. Write the factors that determine the physical state exhibited by a substance.
3. Write the physical state of water at 0^{o}C, 100^{o}C.

XVI References/Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, DevdattaV.Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334
5	Simulation Software	https://phet.colorado.edu/en/simulations/filter?subjects=chemistry&type=html,prototype	

XVII Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1.	Observation of initial state	20%
2.	Handling of Software	30%
3.	Analyzing the changes in reading	10%

Product related assessment scheme

Sr. No.	Product related	Weightage (40%)
1.	Determination of M. P. and B. P. of water & water substances	20%
2.	Answer to sample questions	10%
3.	Submission of report in time	10%

Marks Obtained

Process Related (15)	Product Related (10)	Total(25)	Dated Signature of Faculty

List of Student Team Members

1. …………………………………
2. ……………………………………
3. ……………………………………
4. ……………………………………

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Practical No.04 Electrode Potential of Copper Metal

I Practical Significance

When we determine the electrode potential of a metal, it helps us figure out where that metal stands in the electrochemical series. Think of it like a position of metals based on their electrical behavior. Knowing this position is useful because it allows students to design structures using two different metals in a way that protects them from corrosion. This knowledge can be applied to solve various engineering problems, especially those related to preventing metal from getting damaged over time.

II Industry/ Employer Expected Outcome

1. Handling glass wares.
2. Handling reagents.
3. Observation.

III Relevant Course Outcomes

CO5- Apply the concepts of electrochemistry and corrosion preventive measures in industry

IV Practical Learning Outcome

Determine the electrode potential of copper.

V Laboratory Learning Outcome(s)

1. Determine the electrode potential of copper metal by setting Electrochemical Cell.
2. Measure electrode potential of Cu Using Voltmeter.
3. Measure the cell potential for various conditions

VI Relevant Affective domain related Outcomes

1. Determine the electrode potential of copper metal by setting Electrochemical Cell.
2. Measure electrode potential of Cu Using Voltmeter.
3. Measure the cell potential for various conditions

VII Relevant Theoretical Background

When a metal reacts with a solution, a special layer forms around it, creating a kind of electrical double layer. This results in a potential difference between the metal and the solution, which we call electrode potential. Electrode potential basically tells us how eager a metal is to either lose or gain electrons when it's in contact with a solution of its own salt at a specific temperature (25°C).

Now, there are two sides to this electrode potential.

Oxidation Potential: The tendency of electrode to lose electrons is direct measure of its tendency to get oxidized.

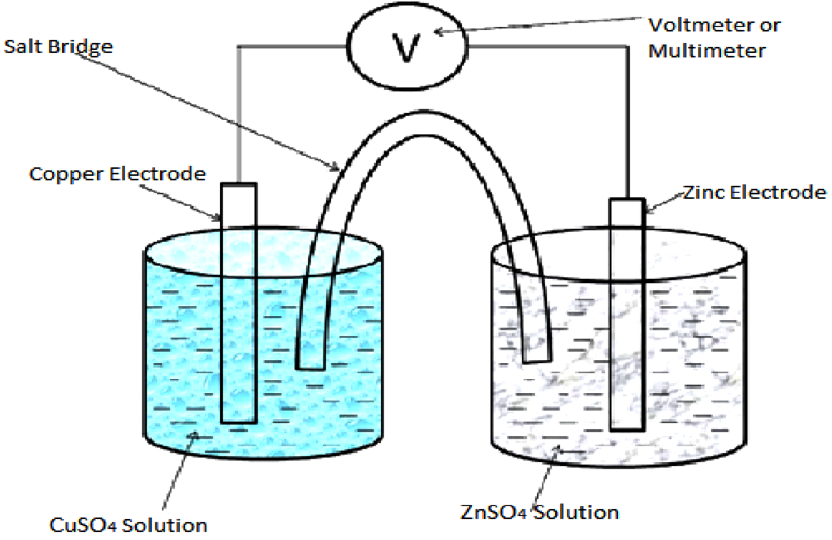
Reduction Potential: The tendency of electrode to gain electrons is direct measure of its tendency to get reduced.

To find out the electrode potential of a metal, we set up an electrochemical cell. One half of the cell has a reference electrode with a known electrode potential. In the world of metal corrosion, electrodes like the hydrogen electrode, zinc-zinc sulphate electrode, calomel, and silver-silver chloride electrode are commonly used as reference points.

Potassium	-2.92
Calcium	-2.87
Sodium	-2.71
Magnesium	-2.37
Aluminium	-1.66
Zinc	-0.76
Iron	-0.44
Tin	-0.14
Lead	-0.13
Hydrogen	0
Copper	0.34
Silver	0.8
Mercury	+0.85

Metal Activity Increasing ↑

VIII Circuit diagram / Experimental set-up / Work Situation



IX Recourses required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Beakers	Capacity -250 ml	2 per group	
2	Salt Bridge / porous pot	'U' shaped glass tube with KC1 solution	1 per group	
3	Voltmeter / multimeter		1 per group	
4	Electrodes	Zn (Rod/Plate), Cu (Rod/Plate)	1 per group	
5	Sample material/chemicals	Copper salt solution, zinc salt solution, connecting wires	As per requirement	

X Precautions

1. When setting up connections, make sure the wires are securely attached and properly connected to avoid any issues.
2. Check the voltmeter or multimeter before using.

XI Procedure

1. Make surface of zinc rod and copper rod smooth by using polish paper, then clean with dilute HC1 and then with water.
2. Take two beakers, each with a 1 M solution – one with $ZnSO_4$ and the other with $CuSO_4$.
3. Place zinc rod in $ZnSO_4$ solution and copper rod $CuSO_4$ solution.
4. Connect zinc rod to negative terminal (anode) and copper rod to positive terminal (cathode) of digital multimeter/ voltmeter.
5. Insert a salt bridge into both solutions. This helps maintain a balance between the two halves of the experiment.
6. Note down the cell EMF (E_{Cell}) in volts displayed by the digital multimeter.
7. Use the recorded values to figure out the electrode potential of copper following the provided calculations.

XII Observations for determination reduction potential of copper electrode

(E_{Cu})

1. Temperature = ... ° C.
2. Theoretical value of reduction potential of Zn= - 0.76 volts.
3. Electrode potential of cell =……….. V

XIII Calculations

$E_{\text{Cell}} = E_{\text{Reduction (Cu)}} + E_{\text{Oxidation (Zn)}}$

$E_{\text{Reduction (Cu)}} = E_{\text{Cell}} - E_{\text{Oxidation (Zn)}}$

$\therefore E_{\text{Reduction (Cu)}} = \ldots\ldots\ldots\ldots - (+0.76)$

($\because$ Oxidation Potential of Zn = +0.76 Volts)

$\therefore E_{\text{Reduction (Cu)}} = \ldots\ldots\ldots\ldots - 0.76$

$\therefore E_{\text{Reduction (Cu)}} = \ldots\ldots\ldots\ldots\ldots\text{Volts}$

XIV Results

1. Reduction electrode potential of Cu =..................... Volts.
2. Reduction electrode potential of Zn =....................... Volts.

XV Interpretation of results

In the electrochemical series, zinc is placed………… (above/before) copper.

XVI Conclusions and Recommendations

Zinc is ………. (more/less) electropositive than copper. Therefore, undergoes corrosion in preference to ………

XVII Practical Related Questions:

1. Describe the chemical reactions at the cathode and anode in the experiment.
2. Explain the relation between the reduction electrode potential of a metal electrode and its tendency towards corrosion.
3. Identify the cathode and anode in the given electrochemical cell.

XVIII References / Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, Devdatta V. Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334
5	You-Tube link	7 Active Technology Solutions Pvt.Ltd.	https://youtu.be/gdrRSUdGUuI?si=tggGN3UkH4AjkG5R

XIX Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1.	Cleaning of cathode and anode	20%
2.	Assembly set up	30%
3.	Reading of electrode potential	10%

Product related assessment scheme

Sr. No.	Product related	Weightage (40%)
1.	Calculation for electrode potential of copper	20%
2.	Answer to sample questions	10%
3.	Submission of report in time	10%

Marks Obtained

Process Related (15)	Product Related (10)	Total(25)	Dated Signature of Faculty

List of Student Team Members

1. ……………………………………
2. ……………………………………
3. ……………………………………
4. ……………………………………

[Space to Write Answers}

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Practical No. 5: Electrode potential of Iron Metal

I Practical Significance

When we determine the electrode potential of a metal, it helps us figure out where that metal stands in the electrochemical series. Think of it like a ranking of metals based on their electrical behavior. Knowing this ranking is useful because it allows students to design structures using two different metals in a way that protects them from corrosion. This knowledge can be applied to solve various engineering problems, especially those related to preventing metal from getting damaged over time.

II Relevant Industry or employer expected outcomes

1. Measurement
2. Calculation

III Relevant Course Outcomes

CO5- Apply the concepts of electrochemistry and corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the electrode potential of Iron.

V Laboratory Learning Outcomes

1. Determine the electrode potential of iron metal by setting Electrochemical Cell.
2. Measure electrode potential of Fe Using Voltmeter.
3. Measure the cell potential for various conditions.

VI Relevant Affective domain related Outcomes:

1. Follow safety practices.
2. Maintain tools and equipment.
3. Follow ethical practices.

VII Relevant Theoretical Background

When a metal reacts with a solution, a special layer forms around it, creating a kind of electrical double layer. This results in a potential difference between the metal and the solution, which we call electrode potential. Electrode potential basically tells us how eager a metal is to either lose or gain electrons when it's in contact with a solution of its own salt at a specific temperature (25°C).

Now, there are two sides to this electrode potential.

Oxidation Potential: The tendency of electrode to lose electrons is direct measure of its tendency to get oxidized.

Reduction Potential: The tendency of electrode to gain electrons is direct measure of its tendency to get reduced.

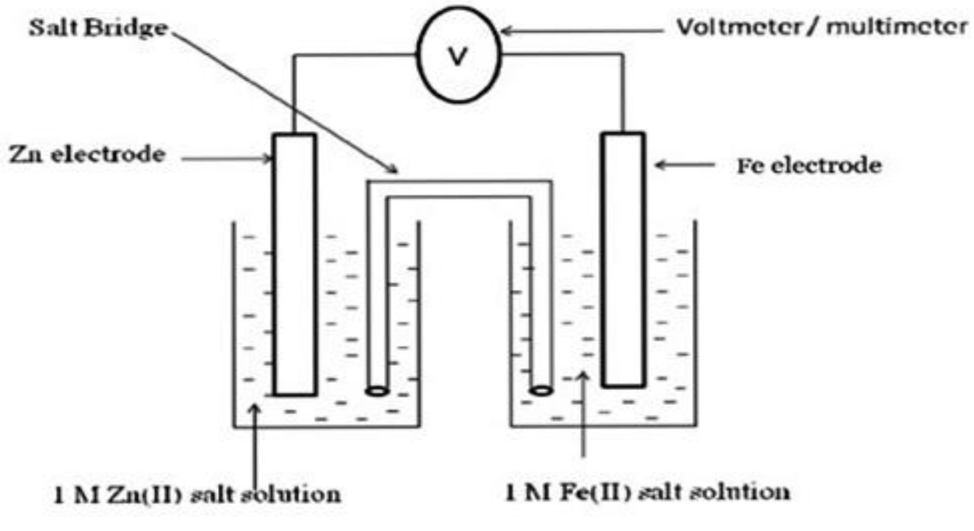
To find out the electrode potential of a metal, we set up an electrochemical cell. One half of the cell has a reference electrode with a known electrode potential. In the world of metal corrosion, electrodes like the hydrogen electrode, zinc-zinc sulphate electrode, calomel, and silver-silver chloride electrode are commonly used as reference points.

Electro-chemical Series

Potassium	-2.92
Calcium	-2.87
Sodium	-2.71
Magnesium	-2.37
Aluminium	-1.66
Zinc	-0.76
Iron	-0.44
Tin	-0.14
Lead	-0.13
Hydrogen	0
Copper	0.34
Silver	0.8
Mercury	+o.85

Metal Activity Increasing

VIII Circuit diagram / Experimental set-up / Work Situation



IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Beakers	Capacity -250 ml	2 per group	
2	Salt Bridge / porous pot	'U' shaped glass tube with KC1 solution	1 per group	
3	Voltmeter / multimeter		1 per group	
4	Electrodes	Zn(Rod/Plate), Fe(Rod/Plate)	1 per group	
5	Sample material/chemicals	Iron salt solution, zinc salt solution, connecting wires	As per requirement	

X Precautions

1. After setting up connections, make sure the wires are securely attached and properly connected to avoid any issues.
2. Check the voltmeter or multimeter before using.

XI Procedure

1. Make surface of zinc rod and iron rod smooth by using polish paper, then clean with dilute HC1 and then with water.
2. Take two beakers, each with a 1 M solution – one with $ZnSO_4$ and the other with $FeSO_4$.
3. Place zinc rod in $ZnSO_4$ solution and copper rod $FeSO_4$ solution.
4. Connect zinc rod to negative terminal (anode) and iron rod to positive terminal (cathode) of digital multimeter/ voltmeter.
5. Insert a salt bridge into both solutions. This helps maintain a balance between the two halves of the experiment.
6. Note down the cell EMF (E Cell) in volts displayed by the digital multimeter.
7. Use the recorded values to figure out the electrode potential of iron following the provided calculations.

XII Observations and Calculations

1. Temperature = ... ° C.
2. Theoretical value of reduction potential of Zn = - 0.76 volts.
3. Electrode potential of cell =.......... …….. V

XIII Calculation for determination reduction potential of Iron electrode (E_{Fe})

$$E_{\text{Cell}} = E_{\text{Reduction (Fe)}} + E_{\text{Oxidation (Zn)}}$$

$$E_{\text{Reduction (Fe)}} = E_{\text{Cell}} - E_{\text{Oxidation (Zn)}}$$

$$\therefore E_{\text{Reduction (Fe)}} = \ldots\ldots\ldots\ldots - (+0.76)$$

($\because$ Oxidation Potential of Zn = +0.76 Volts)

$$\therefore E_{\text{Reduction (Fe)}} = \ldots\ldots\ldots\ldots - 0.76$$

$$\therefore E_{\text{Reduction (Fe)}} = \ldots\ldots\ldots\ldots\ldots\text{Volts}$$

XIV Result

1. Reduction electrode potential of Fe =………… Volts.
2. Reduction electrode potential of Zn =………… Volts.

XV Interpretation of result

In the electrochemical series, zinc is placed……. (above / before) iron.

XVI Conclusions and Recommendations

Zinc is ……. (more/less) electropositive than iron therefore, undergoes corrosion in preference to ……..

XVII Practical Related Questions:

1. Define De-electronation & Electronation.
2. Write the factors influence the electrode potential of iron.
3. Write the applications of the electrode potential of iron in industries or technologies.

XVIII References / Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, Devdatta V. Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334

XIX Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1.	Cleaning of cathode and anode	20%
2.	Assembly set up	30%
3.	Reading of electrode potential	10%

Product related assessment scheme

Sr. No.	Product related	Weightage (40%)
1.	Calculation for electrode potential of copper	20%
2.	Answer to sample questions	10%
3.	Submission of report in time	10%

Marks Obtained

Process Related (15)	Product Related (10)	Total (25)	Dated Signature of Faculty

List of Student Team Members

1. ……………………………………
2. ……………………………………
3. ……………………………………
4. ……………………………………

[Space to Write Answers]

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Practical No.6: Daniel cell

I Practical Significance

Diploma engineers frequently engage with electrochemical cells as part of their coursework. These cells harness electrical energy through chemical reactions. Analyzing the voltage produced by a Daniel cell is crucial for comprehending the ion exchange reactions occurring at distinct metal electrodes. This exploration facilitates insights into the correlation between variations in electrolyte concentration and consequential voltage shifts. Such knowledge proves invaluable for diploma engineers when tackling diverse engineering challenges.

II Relevant Industry or employer expected outcomes

1. Assembly or practical set up
2. Observation.

III Relevant Course Outcomes

CO5- Apply the concepts of electrochemistry and corrosion preventive measures in industry

IV Practical Learning Outcome

Determine the voltage generated from chemical reaction using Daniel Cell.

V Laboratory Learning Outcomes

1. Determine the voltage generated from chemical reaction using Daniel Cell.
2. Set up Daniel Cell. Prepare Electrolyte Solution.
3. Measure voltage accurately

VI Relevant Affective domain related Outcomes:

1. Follow safety practices.
2. Maintain tools and equipment.

VII Relevant Theoretical Background

A galvanic cell, a fundamental electrochemical device, typically comprises two distinct metal rods, referred to as electrodes. Each electrode is immersed in a solution containing its respective ions, constituting a half cell. These half cells are linked by a salt bridge or separated by a porous membrane. The solutions, capable of conducting electricity in either a molten state or aqueous solution, are termed electrolytes. The galvanic cell operates through a redox (oxidation-reduction) reaction, with one electrode serving as the anode for oxidation and the other as the cathode for reduction. The Daniel cell demonstrates this setup.

In the Daniel cell, two half cells facilitate the redox reaction. Oxidation transpires in the half cell containing the more active metal, designated as the anode (-), while reduction occurs in the other half cell containing the less active metal, acting as the cathode (+). In the specific case of the Daniel cell, copper and zinc electrodes are immersed in $CuSO_4$ and $ZnSO_4$ solutions, respectively. The two half cells are interconnected via a salt bridge or porous partition. Zinc, as the anode, undergoes oxidation, forming zinc ions that enter the solution. Electrons produced during zinc oxidation travel through an external wire, connecting to the copper cathode. At the cathode, these electrons reduce copper ions, leading to the deposition of copper atoms. The salt bridge, connecting the two half cells, enables the flow of ions, completing the electron current circuit in the external wires. When the electrodes are linked to an electric load, such as a light bulb or voltmeter, the circuit is closed. This completion initiates the oxidation-reduction reaction, causing electrons to move from the anode (-) to the cathode (+), resulting in the generation of an electric current.

The electrode reactions in Daniel Cell are:-

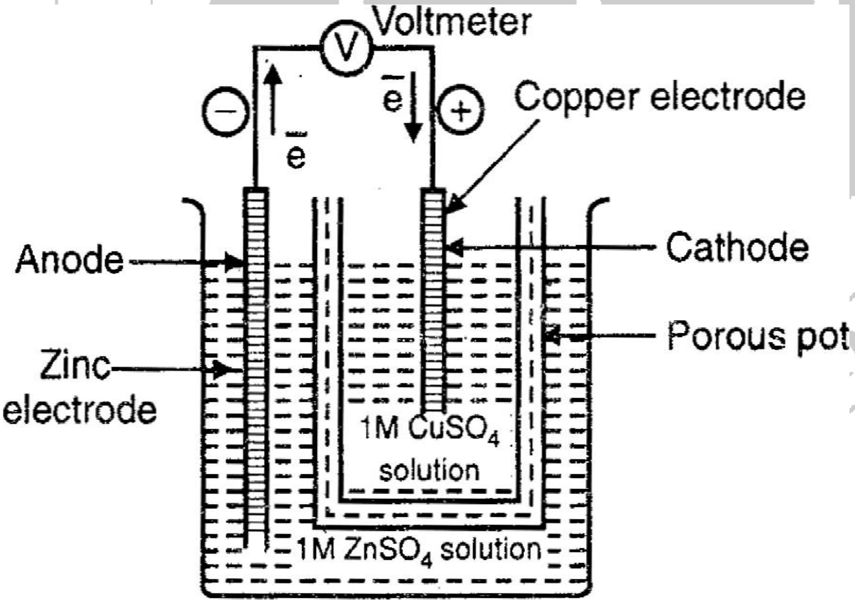
At Anode$(-$**ve Electrode**$)$: $\mathrm{Zn \rightarrow Zn^{++} + 2e^{-}}$ (Oxidation Reaction)

At Cathode$(+$**ve Electrode**$)$: $\mathrm{Cu^{++} + 2e^{-} \rightarrow Cu}$ (Reduction Reaction)

Net Reaction: $\mathrm{Zn + Cu^{++} \rightarrow Zn^{++} + Cu}$

Voltage produced in Daniel Cell ($E°_{Cell}$) = $E°_{Reduction} + E°_{Oxidation}$= (1.1 to 1.4V)

VIII Circuit diagram / Experimental set-up / Work Situation:



Representation of Daniel Cell: $^{-}$ Zn (s) / $ZnSO_4$ (aq) // $CuSO_4$ (aq) / Cu (s) $^{+}$.

IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Beakers	Capacity -250 ml	2 per group	
2	Salt Bridge / porous pot	'U' shaped glass tube with KC1/KNO_3/Na_2SO_4solution	1 per group	
3	Voltmeter / multimeter	Range 0 - 2 volt	1 per group	
4	Electrodes	Zn(Rod/Plate), Cu(Rod/Plate)	1 per group	
5	Sample material/chemicals -	$ZnSO_4$ and $CuSO_4$solution, connecting wires	As per requirement	

X Precautions

1. Before to start experiment, confirm first connections are made correctly as per setup.
2. Check voltmeter or multimeter is working properly.
3. Clean the surfaces of electrodes thoroughly before the use.

XI Procedure

1. Make surface of zinc rod and copper rod smooth by using polish paper, then clean with dilute HC1 and then with water.
2. Take $ZnSO_4$ and $CuSO_4$ solutions of required concentration in two different beakers.
3. Place zinc rod in $ZnSO_4$ solution and copper rod in $CuSO_4$ solution.
4. Connect zinc rod to negative terminal (anode) and copper rod to positive terminal (cathode) of digital multimeter.
5. Place salt bridge in both the solutions.
6. Note down the voltage developed in volts displayed by the digital multimeter.

XII Observations

Temperature = ... ° C.

XIII Observation Table

Sr. No.	Concentration of $CuSO_4$	Concentration of $ZnSO_4$	Voltage produced in volts
1	1 M	1M	
2	0.1 M	1M	
3	1M	0.1 M	
4	0.1 M	0.1 M	

XIV Results

1. Voltage developed due to chemical reaction in Daniel cell ($Zn_{(S)}$/ 1 M Zn^{2+}// 1 M Cu^{2+} / $Cu_{(S)}$) = ...V
2. Voltage developed due to chemical reaction in Daniel cell ($Zn_{(S)}$ / 1 M Zn^{2+} // 0.1 M Cu^{2+}/ $Cu_{(S)}$) =..V
3. Voltage developed due to chemical reaction in Daniel cell ($Zn_{(S)}$ /0.1 M Zn^{2+}// 1 M Cu^{2+}/ $Cu_{(S)}$) = ...V
4. Voltage developed due to chemical reaction in Daniel cell ($Zn_{(S)}$ /0.1 M Zn^{2+}// 0. 1 M Cu^{2+}/ $Cu_{(S)}$) =..V

XV Interpretation of result:

The voltage produced by a Daniel cell _____ (increases/decreases) as the concentration of electrolyte decreases around the anode and increases around the cathode.

XVI Conclusions and Recommendations (if any)

The highest voltage is generated when the concentrations of ….**M** $ZnSO_4$ and ..…….**M** $CuSO_4$ reaches their maximum levels.

XVII Practical Related Questions

1. Identify the anode and cathode in a Daniel cell.
2. Describe the chemical reactions occurring at the cathode and anode in the experiment with Daniel cells.
3. Elaborate on the concept of a half cell.
4. Explain the function of a salt bridge or porous pot in the electrochemical cell.
5. Name the electrolytes suitable for incorporation into a salt bridge.

XVIII References / Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	AnjuRawlley, DevdattaV.Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334
5	You tube videos	C. Bettstetter	https://youtu.be/q3JAUMmazGQ?si=R7jlUGbMhNKMSG02

XIX Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1.	Cleaning of cathode and anode	20%
2.	Assembly set up	40%

Product related assessment scheme

Sr. No.	Product related	Weightage (40%)
1	Reading of voltage produced in Daniel Cell	20%
2	Answer to sample questions	10%
3	Submission of report in time	10%

Marks Obtained

Process Related (15)	Product Related (10)	Total (25)	Dated Signature of Faculty

List of Student Team Members

1. ……………………………………
2. ……………………………………
3. ……………………………………
4. ……………………………………

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Practical No. 7: Electrochemical Equivalent of Cu

I Practical Significance

Diploma engineers engage in electroplating, coating, and cladding of diverse metallic materials for various industrial uses. The crucial aspect in this process is the calculation of electrochemical equivalents through Faraday's first law. This calculation not only reveals the electrochemical equivalent of any metallic material but also underscores the inherent electronic characteristics of the specific metal. Such insights can guide the implementation of preventive measures against metallic corrosion and find applications across different industrial sectors.

II Relevant Industry or employer expected outcomes

1. Measurement skill
2. Practical setup

III Relevant Course Outcomes

CO5- Apply the concepts of electrochemistry and corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine electrochemical equivalent of Cu metal using Faraday's first law.

V Laboratory Learning Outcomes

1. Prepare Electrolyte Solution of $CuSO_4$of known concentration
2. Set up electrolysis apparatus.
3. Control various parameters of electrolysis.
4. Determine electrochemical equivalent of Cu metal using Faraday’s first law.

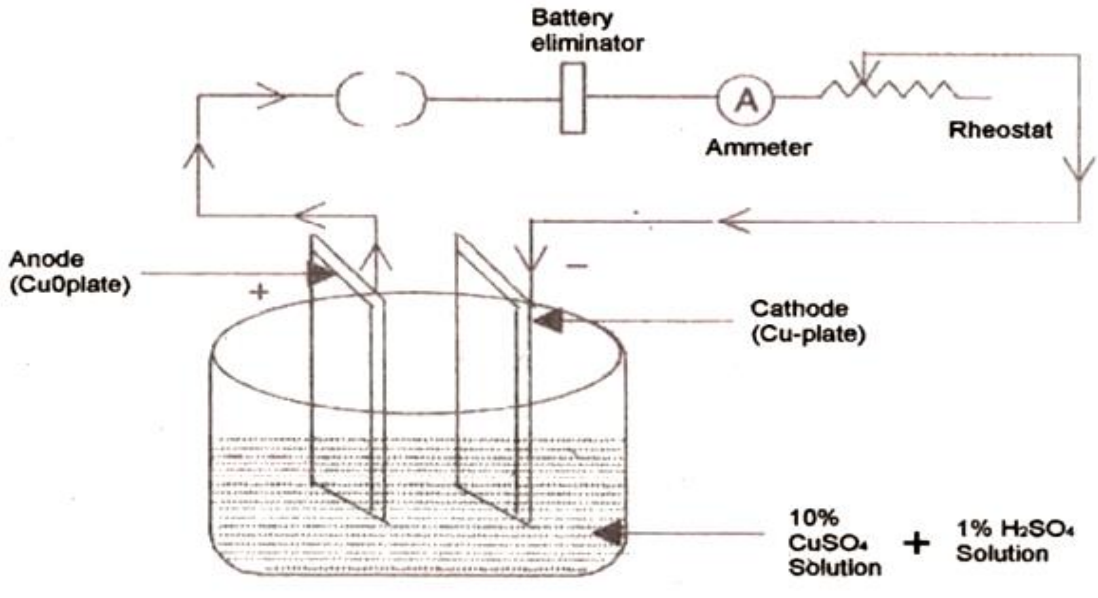
VI Relevant Affective domain related Outcomes

1. Demonstrate working as a leader/a team member.
2. Maintain tools and equipment.

VII Relevant Theoretical Background

At the core of electrolysis lies the exchange of atoms and ions, facilitated by the extraction or addition of electrons within the external circuit. The outcomes sought through electrolysis often exist in a distinct physical state compared to the electrolyte, and their extraction is achievable through various physical methods. The creation of a liquid containing mobile ions, known as the electrolyte, occurs either through the dissolution or reaction of an ionic compound with a solvent (such as water), resulting in the formation of mobile ions. Alternatively, the process involves the heating and fusion of an ionic compound. Subsequently, an electrical potential is applied across a pair of electrodes submerged in the electrolyte.

VIII Experimental Set up



Electrolysis of CuSO₄ Solution

Electrolysis of CuSO$_4$ Solution

IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Copper plates	Given weight	20	
2	CuSO$_4$ solution	10 % concentration		
3	Glass beaker	1000 ml	20	
4	Battery	12 Volts		
5	Stop watch		10	
6	Chemical Balance	Scale range of 0.001g to 500gm pan size 100 mm; response time 3-5 sec.: power requirement 90250 V, 10 watt		
7	Polish paper			
8	Drier		01	
9	Copper wires			
10	Ammeter	0-2 amp		

X Precautions

1. Thoroughly clean the copper cathode.
2. Precisely measure the weight of the copper cathode.
3. Attach the copper plates to the positive and negative terminals of the battery.

XI Procedure

1. Polish the copper cathode with polish paper, treat it with a diluted solution of hydrochloric acid (HCl), and subsequently rinse it thoroughly with water.
2. Use an oven or an air dryer to ensure the complete drying of the copper cathode.
3. Measure the weight of the copper cathode.
4. Arrange the experimental setup as per the diagram provided.
5. Establish the electrical circuit configuration in accordance with the experimental setup.
6. Adjust the current to the desired range, preferably between 1 to 2 amperes, and allow the current to flow for duration of 15 to 20 minutes.
7. Remove the cathode, delicately wash it with water, and use a drier for thorough drying.
8. Accurately measure the weight of the copper cathode.
9. Systematically record the observed data in a tabular format.

XII Observations Table

Sr. No.	Observation	Symbol	Value
1	Wt. of Cu cathode before deposition	W_1	…………………g
2	Wt. of Cu Cathode after deposition	W_2	……………………g
3	Wt. of Cu deposited	$W = W_2 - W_1$	…………………g
4	Current in Ampere	C	………………amp
5	Time in second	t	……………….sec

XIII Calculations

$$Z = \frac{W}{C \times t}$$

$$Z = \frac{\ldots\ldots\ldots\ldots\ldots\ldots}{\ldots\ldots\ldots\times\ldots\ldots\ldots}$$

Z =…………….g/C

XIV Results

Electrochemical equivalent of Copper (ECE) = ...g /C

XV Interpretation of results

The accumulation of substance on the cathode grows proportionally with an increase in time.

XVI Conclusions and Recommendations

The weight of substance liberated or deposited on electrode is directly proportional to the quantity of electricity passed through it.

XVII Practical Related Questions:

1. Describe the relation between chemical equivalence and electrochemical equivalence.
2. State the relation between the Time for which Current is passed through solution and weight of the substance deposited on electrode.
3. Identify the electrode type formed by the copper anode.

XVIII References / Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara, S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, Devdatta V. Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334
5	You tube videos	Physics 4 students	https://youtu.be/JC8xhZFOdaw?si=zH9G97YWMi4b0K2Q

XIX Assessment Scheme

Process related assessment scheme		
Sr. No.	**Process related**	**Weightage (60%)**
1	Process for removal of cathode from solution	20%
2	Process for drying of cathode	20%
3	Weighing of Copper cathode	10%
4	Cleaning of Copper cathode	10%
Product related assessment scheme		
Sr. No.	**Product related**	**Weightage (40%)**
1	Electrochemical equivalent of Copper	40%

Marks Obtained

Process Related (15)	Product Related (10)	Total (25)	Dated Signature of Faculty

List of Student Team Members

1. ……………………………………
2. ……………………………………
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Practical No. 8: Equivalent weight of metal

I Practical Significance

Diploma engineers engaged in industrial processes, particularly those related to metallurgy, electroplating, and coating of metallic substances, play a crucial role in minimizing metal corrosion. The utilization of Faraday's second law for determining the chemical equivalent of metals is instrumental in this effort. By uncovering the chemical equivalent of a given metallic substance, this approach not only sheds light on its electronic nature but also empowers industries to adopt preventive measures against metal corrosion. This experiment holds significant potential for various applications within industrial settings, offering valuable insights for corrosion prevention and enhancing overall metal-related processes.

II Relevant Industry or employer expected outcomes

1. Measurement skill
2. Weight of copper cathode
3. Weight of zinc cathode

III Relevant Course Outcomes

CO5- Apply the concepts of electrochemistry and corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine equivalent weight of metal using Faraday's second law.

V Laboratory Learning Outcomes

1. Prepare Electrolyte Solution of the given metal of known concentration.
2. Set up electrolysis apparatus.
3. Control various parameters of electrolysis
4. Analyze the data obtained from the experiment
5. Verify Faraday’s second law

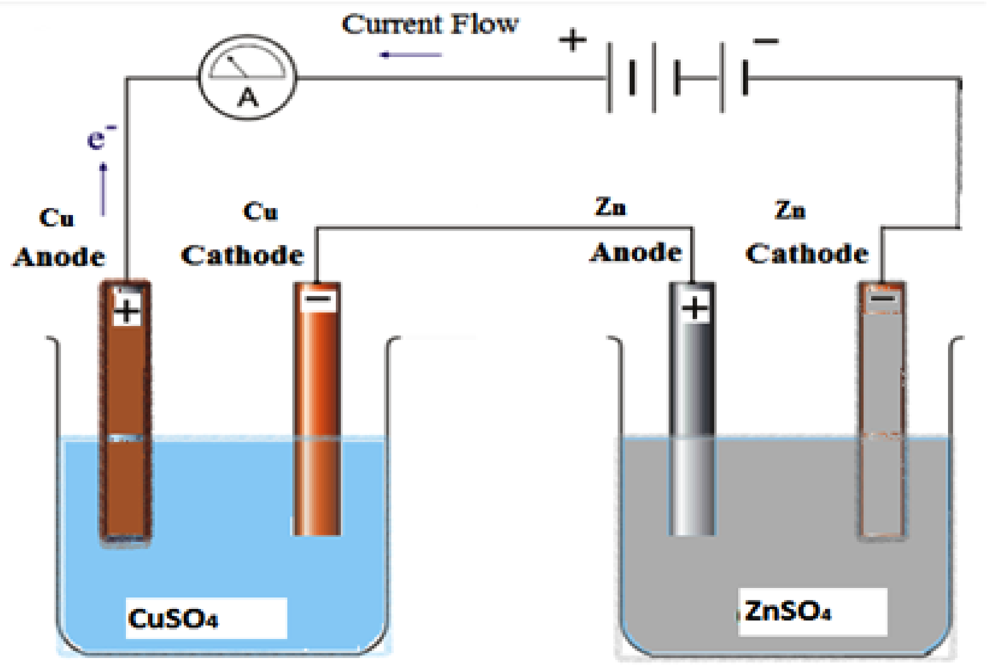
VI Relevant Affective domain related Outcomes

1. Follow safe practices
2. Practice good housekeeping.

VII Relevant Theoretical Background

Electrolysis is a process wherein the decomposition of a substance occurs due to the passage of an electric current through an electrolyte, leading to the separation of ions and subsequent chemical reactions. The electrochemical equivalent is the amount of substance that is released or deposited when a current of one ampere flows through a solution for one second. The amount of substance liberated or deposited during electrolysis is directly linked to the quantity of electricity passed through the electrolyte, indicating a proportional relationship between the two.

VIII Experimental set-up



IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Copper plates	Given weight	02 plates	
2	Zinc plates	Given weight	02 plates	
3	$CuSO_4$solution, $ZnSO_4$ solution	10 % concentration		
4	Glass beaker	250 ml/500 ml	02	
5	Battery	12 Volts	01	
6	Stop watch		01	
7	Chemical Balance	Scale range of 0.001g to 500gm pan size 100 mm; response time 3-5 sec.: power requirement 90-	01	
8	Polish paper			
9	Drier		01	
10	Copper wires			
11	Ammeter	0-2 amp	01	

X Precautions

1. Start the experiment by thoroughly cleaning both the copper and zinc cathodes.
2. Prior to initiating the experiment, ensure precise measurements by accurately weighing the copper and zinc cathodes.
3. Establish a secure connection by appropriately attaching the cleaned copper and zinc plates to the negative terminal of the battery.

XI Procedure

1. Clean the copper cathode and zinc cathode using polish paper, dilute HC1 and then with water.
2. Dry the electrodes in oven or by using an air dryer.
3. Set up the apparatus as shown in diagram.
4. Adjust the current from 0.5 to 1.5 ampere using Rheostat.
5. Pass the current for 20 - 25 minutes.
6. Remove the copper cathode and Zinc cathode, dry it.
7. Weigh the copper cathode and zinc cathode.

XII Observations & Observation Table

Sr. No.	Observation	Symbol	Value
1	Wt. of Cu cathode before deposition	Wc_1	----------------- g
2	Wt. of Cu cathode after deposition	Wc_2	----------------- g
3	Wt. of Cu deposited	$W_{Cu}=Wc_2-Wc_1$	----------------- g
4	Wt. of Zn cathode before deposition	Wz_1	----------------- g
5	Wt. of Zn cathode after deposition	Wz_2	----------------- g
6	Wt. of Zn deposited	$W_{Zn}= Wz_2- Wz_1$	g
7	Equivalent wt. of Cu	E_{Cu}	....
8	Time in second	t	....................sec

XIII Calculations:

$$\frac{\text{Weight of Cu Deposited}(W_{Cu})}{\text{Weight of Zn Deposited}(W_{Zn})} = \frac{\text{Equivalent weight of Cu }(E_{Cu})}{\text{Equivalent weight of Zn }(E_{Zn})}$$

$$E_{Zn} = \frac{W_{Zn} \times E_{Cu}}{W_{Cu}} = \frac{\dots\dots\dots\dots\dots\dots\dots\dots .}{\dots\dots\dots\dots\dots\dots\dots\dots .}$$

XIV Results

Equivalent weight of Zinc (E_{Zn}) =……………………..g

XV Interpretation of results

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XVI Conclusions and Recommendations

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XVII Practical Related Questions

1. Explain the purposes of cleaning copper and zinc cathodes.
2. Explain the weight of Copper anode and Zinc anode decreases.
3. Describe the effect of time on the amount of substance deposited for which current is passed.
4. Describe the importance of increase in the weight of cathode.

XVIII References / Suggestions for further Reading

Sr. No.	Title	Author	Publisher
1	Engineering Chemistry	Jain and Jain	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Engineering Chemistry	Dara S. S.	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Applied Chemistry with Lab Manual	Anju Rawlley, DevdattaV.Saraf	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
4	Engineering Chemistry	Vairam S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 978812654334
5	You tube videos	Physics4 students	https://youtu.be/JC8xhZFOdaw?si=zH9G97YWMi4b0K2Q

XIX Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (60%)
1	Process for removal of cathode from solution	20%
2	Process for drying of cathode	20%
3	Weighing of Copper cathode	10%
4	Cleaning of Copper cathode	10%

Product related assessment scheme

Sr. No.	Product related	Weightage (40%)
1	Electrochemical equivalent of Copper	40%

Marks Obtained

Process Related (15)	Product Related (10)	Total (25)	Dated Signature of Faculty

List of Student Team Members

1. ……………………………………
2. ……………………………………
3. ……………………………………
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PracticalNo.9: Preparation of Corrosive Medium

I Practical Significance

Corrosion is the major industrial issue affecting the different industrial processes and products, need to be addressed. Diploma engineers have to work with various metal equipments while working under different atmospheric conditions in different industries and they have to observe the effect of surrounding environment on metal. Preparation of corrosive medium and determination of effect of temperature on rate of corrosion due to different corrosive medium enable diploma engineers to identify relevant working conditions equipments and probable quality of product which may help them to solve the broad based engineering problems.

II Industry/ Employer Expected Outcome

1. Use the techniques and procedures required to prepare standard solutions
2. Measurement Skills
3. Handling of Glassware
4. Calculations

III Relevant Course Outcomes

CO5: Apply the concepts of electrochemistry and corrosion preventive measures in Industry

IV Practical Learning Outcome

Preparation of corrosive medium for Aluminum at different temperature.

V Laboratory Learning Outcome(s)

1. Prepare corrosive solutions
2. Calculations for standard solutions.

VI Relevant Affective domain related Outcomes

1. Handle concentrated acids carefully.
2. Practice good housekeeping.

VII Relevant Theoretical Background

Corrosion is destruction of metal due to action of surrounding gases or solution.
When metal comes in the contact with atmospheric gases or liquid medium, it undergoes decay and destruction. Moisture, impurities present in the surrounding environment affects the rate of corrosion. Surrounding medium may be either acidic, alkaline or neutral which has different effect. Depending on surrounding medium, corrosion is either dry or wet corrosion.

VIII Circuit diagram/Experimental set-up / Work Situation

NA

IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1.	Beakers	Capacity- 250ml		
2.	Pair of tongs		1per group	
3.	Electronic balance	L.C.=0.001mg		
4.	Water bath	With temperature controller	4pergroup	
5.	Sample material/ chemicals	Aluminium strips, acids	As per requirement	

X Precautions

1. Handle acid/base carefully.
2. Add acid slowly to water with constant stirring.

XI Procedure

1. Prepare normal solution (eg.1N) of four different acids/base such as Hydrochloric acid, Sulphuric acid, Nitric acid, Sodium Hydroxide from concentrated acid of specified normality.
2. Using normality formula, calculate the quantity of concentrated acid/base required for preparation of desired acid / base as a corrosive medium.
3. ThisCorrosivemediumisusedtocarryoutPracticalno.10.

XII Observations and Calculations

Sr. No.	Name of acid	Concentration of available acid (N1)	Concentration of acid to be prepared (N2)	Volume of acid /base required to be prepare (V2)	Volume of acid /base to be used for Preparation of (N2) N acid (V1)
1	HCl	_______	_______	_______ ml	_________ ml
2	H_2SO_4	_______	_______	_______ ml	________ ml
3	HNO_3	_______	_______	_______ ml	_______ ml
4	NaOH	_______	_______	_______ ml	________ ml

XIII Calculations

$$N_1 \times V_1 = N_2 \times V_2$$

$$= \frac{N_2 \times V_2}{N_1}$$

$$=$$

N_1=Normality of available acid/base.
V_1 = Volume of available acid/base.
N_2= Normality of acid/base required. (eg.1N)
V_2=Volume of acid/base required (eg.100ml)

i) Calculation of Equivalent wt. of HCl

ii) Calculation of Equivalent wt. of H_2SO_4

iii) Calculation of Equivalent wt. of HNO_3

iv) Calculation of Equivalent wt. of NaOH

XIV Results

1. Volume of available hydrochloric acid required for preparation of ....N HCl= .... ml.
2. Volume of available sulphuric acid required for preparation of.....N H_2SO_4= . ... ml.
3. Volume of available nitric acid required for preparation of........N HNO_3= . ... ml.
4. Volume of available sodium hydroxide required for preparation of ...N NaOH = ...ml.

XV Interpretation of results

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XVI Conclusions and Recommendations

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XVII Practical Related Questions

1. Mention the type of corrosion takes place when metal comes in contact with acids/base.
2. State the precaution taken for preparation of dilute acids/base.
3. Prepare 250 ml of 2 N HCl from the given 10 N HCl.

XVIII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
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 PublicationNewDelhi2005 ISBN: 8122408141
3.	Experiments and Calculations in Engineering chemistry	Dr. Dara S.S.	S. Chand. Publication, New Delhi, 2011, ISBN:8121908647
4.	Practical chemistry	Dr. N. K. Varma	LaxmiPublicationNewDelhiISBN:8170085942

XIX Assessment Scheme

Performance indicators		Weightage
Process related:15 Marks		**60%**
1	Process for preparation of hydrochloric acid	15 %
2	Process for preparation of sulphuric acid	15%
3	Process for preparation of nitric acid	15 %
4	Process for preparation of sodium hydroxide	15 %
Product related:10 Marks		**40%**
5	Calculation of volume for hydrochloric acid using normality formula	5%
6	Calculation of volume for sulphuric acid using normality formula	5%
7	Calculation of volume for nitric acid using normality formula	5%
8	Calculation of volume for sodium hydroxide using normality formula	5%
9	Answer to sample questions	10%
10	Submission of report in time	10%
Total		**100 %**

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

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Practical No.10: Effect of temperature on rate of corrosion

I Practical Significance

Corrosion is the major industrial issue affecting the different industrial processes and products, need to be addressed. Diploma engineers have to work with various metal equipments while working under different atmospheric conditions in different industries. Determination of effect of temperature on rate of corrosion enable diploma engineers to identify relevant working conditions equipments and probable quality of product which may help them to solve the broad based engineering problems.

II Industry/ Employer Expected Outcome(s)

1. Ability to immerse the aluminium strip in a solution for required time.
2. Ability to observe loss in weight of aluminium strip.
3. Accuracy in weighing
4. Able to interpret the results precisely.

III Relevant Course Outcomes

CO5: Apply the concepts of electrochemistry and corrosion preventive measures in industry.

IV Practical Learning Outcome

Determination of rate of corrosion at different temperatures for Aluminium.

V Laboratory Learning Outcome(s)

1. Determine the extent of corrosion
2. Compare the corrosion behavior of Aluminum at different temperatures.

VI Relevant Affective domain related Outcomes

1. Follow safety practices.
2. Practice good housekeeping.

VII Relevant Theoretical Background

- Aluminium displaces hydrogen slowly from dilute HCl with formation concentrated acid.

$$2\,Al + 6HCl \rightarrow 2AlCl_3 + 3H_2\uparrow$$

- Aluminium has no action on dil. H2SO4 but it reduces concentration of H_2SO_4 to SO_2

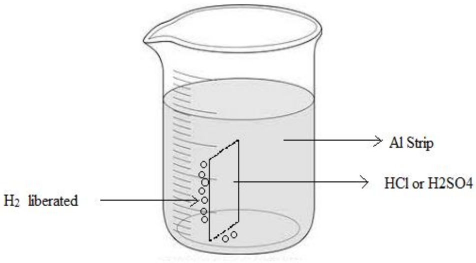
$$2Al + 6H_2SO_4\ (conc.) \rightarrow Al_2(SO_4)_3 + 6H_2O + 3SO_2\uparrow$$

- No apparent action of dilute and concentrated HNO3 as the metal becomes passive due to formation of a layer of oxide.

- Aluminium metal readily dissolves in alkaline medium (in caustic alkali solution) with formation of sodium aluminate and hydrogen.

$$2\,Al + 2NaOH \rightarrow 2NaAlO_2 + 3H_2\uparrow$$

VIII Circuit diagram/ Experimental set-up/ Work Situation



IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1.	Beakers	Capacity -250 ml	**4** per group	
2.	Pair of tongs	Made up of Steel	1pergroup	
3.	Electronic balance	L.C.=0.001 g		
4.	Water bath	With temperature controller		
5.	Thermometer	0-110°c		
6.	Electric oven	Rangeupto250°C		
7.	Sample material /chemicals	Aluminium strips, acids	As per requirement	

X Precautions

1 Handle acid carefully.
2 Clean and dry aluminium strips properly.

XI Procedure

1. Immerse accurately weighed aluminum strip in the given acids/base at room temperature for 4 minutes.
2. Wash it, dry it and weigh aluminium strip accurately on electronic balance.
3. Take acids/base prepared from experiment number 9 and keep on water bath.
4. Adjust temperature of water bath at required temperature (eg.50°C)
5. Dip the weighed aluminium strip in acids/base and wait for 4 minutes.
6. Remove the strip using pair of tongs.
7. Wash it, dry it and weigh aluminium strips accurately on electronic balance.
8. Find decrease in weight of aluminium strips.

XII Observations and Calculations

(A) Observation table for loss in weight at room temperature= .... °C

Sr. No.	Solution taken	Weight of strip in mg		Change in weight of strip in mg(W_3)=(W_1)-(W_2)
		Before dipping W_1	**After dipping W_2**	
1.	Hydrochloric acid			
2.	Sulphuric acid			
3.	Nitric acid			
4.	Sodium Hydroxide			

(B) Observation table for loss in weight at increased temperature =....... °C

Sr. No.	Solution taken	Weight of strip in mg		Change in weight of strip in mg(W_6)=(W_4)-(W_5)
		Before Dipping W_4	**After dipping W_5**	
1.	Hydrochloric acid			
2.	Sulphuric acid			
3.	Nitric acid			
4.	Sodium Hydroxide			

XIII Results:

1. Change in weight of aluminium in hydrochloric acid at room temperature..........g and change in weight of aluminum in hydrochloric acid at temperature...........°C is....... g.
2. Change in weight of aluminium in sulphuric acid at room temperature...........g and change in weight of aluminium in sulphuric acid at temperature.............°C is……………..g.
3. Change in weight of aluminium in nitric acid at room temperature…………..g and change in weight of aluminium in nitric acid at temperature……°C is ………g.
4. Change in weight of aluminium in Sodium Hydroxide is at room temperature ……………g and change in weight of aluminium in Sodium Hydroxide is at temperature...........°C is…………g.

XIV Interpretation of results

Maximum change in weight of aluminium is observed at.......................... temperature in............................. acid.

XV Conclusions and Recommendations(if any)

Metal deteriorates in ………… (acidic / alkaline) medium at higher temperature.

XVI Practical Related Questions

1. State the acid when maximum change in weight is observed.
2. Name the gas liberated when aluminium is dipped in hydrochloric acid.
3. Name the compound formed when aluminium reacts with hydrochloric acid.
4. Mention type of film formed after dipping metal in hydrochloric acid.

XVII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Experiments in general chemistry Principles and modem 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 PublicationNewDelhi2005 ISBN: 8122408141
3.	Experiments and calculations in engineering chemistry	Dr. Dara S. S.	S. Chand. Publication, New Delhi,2011, ISBN:8121908647
4.	Practical Chemistry	Dr. N. K. Varma	Laxmi Publication New Delhi ISBN:8170085942

XVIII Assessment Scheme

Performance indicators		Weightage
Process related:15Marks		**60%**
1	Observed change in weight in hydrochloric acid	15 %
2	Observed change in weight in sulphuric acid	15%
3	Observed change in weight in nitric acid	15 %
4	Observed change in weight in sodium hydroxide	15 %

Product related:10Marks		**40%**
5	Accurate interpretation of final result	20%
6	Answer to sample questions	10%
7	Submission of report in time	10%
Total		**100 %**

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

List of Student Team Members

1. …………………………………………
2. …………………………………………
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Practical No.11: Effect of temperature on Viscosity

I Practical Significance

Redwood viscometer -1 is equipment used by the oil manufacturing companies to determine the property like viscosity of their products. Oils are used in many industries as lubricant for different machines working on different temperature levels. Determination of effect of temperature on viscosity of various lubricating oil will help in selecting the relevant lubricating oil for different machines on different temperatures. Since the viscosity of lubricating oils changes with temperature the selection of lubricating oil for any machine become critical. Determination of effect of temperature on viscosity of various lubricating oil will helps us in use of relevant engineering materials in industry.

II Industry/ Employer Expected Outcomes(s)

1. Measuring Skills
2. Observation skills
3. Ability to handle instrument and apparatus
4. Ability to record time required to flow given oil.

III Relevant Course Outcomes

CO6 - Use the appropriate engineering material and catalyst appropriately.

IV Practical Learning Outcome

Determination of effect of temperature on viscosity for given lubricating oil using Redwood viscometer-I.

V Laboratory Learning Outcome:

1. Cleaning of Redwood Viscometer - I
2. Determine the effect of temperature on viscosity for given lubricating oil using Redwood viscometer

VI Relevant Affective domain related Outcomes

1. Demonstrate working as a leader/a team member
2. Practice good housekeeping

VII Relevant Theoretical Background

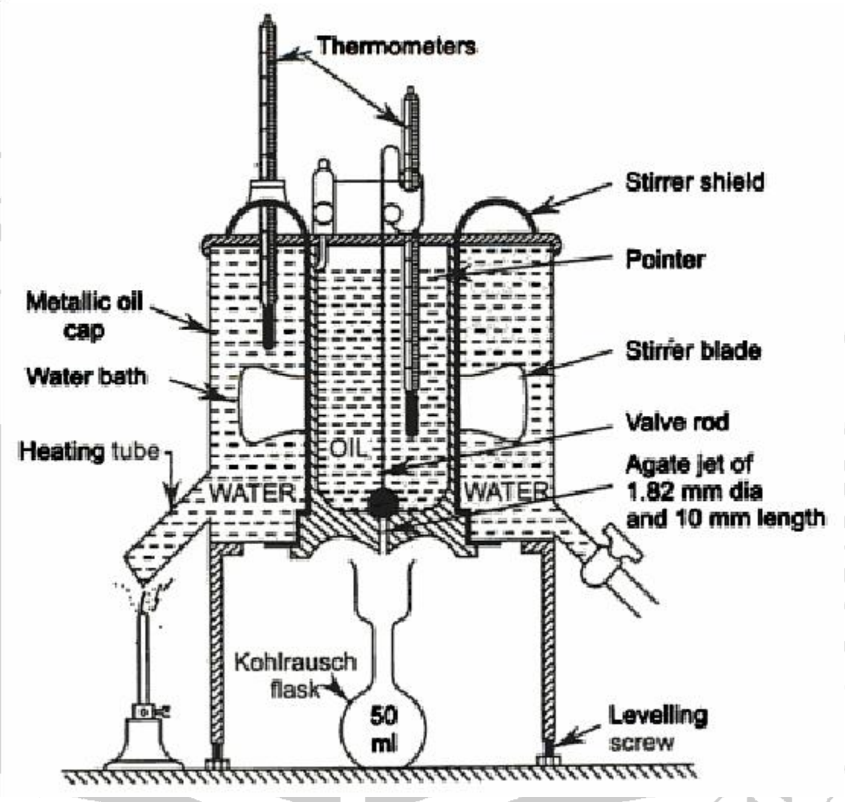
a) Viscosity is the property of a homogeneous fluid, which causes it to offer frictional resistance to motion.

b) Viscosity is the property of a fluid that determines its resistance to flow. It is an indicator of flow ability of a lubricating oil; the lowest the viscosity, greater the flow ability.

c) Viscosity generally decreases with increase in temperature. The rate of change of viscosity over the range of temperature is called as the viscosity Index. A relatively small change/no change in viscosity with temperature is indicated by high viscosity index whereas low viscosity index shows relatively large change in viscosity with temperature.

d) Viscosity is resistance to flow. Viscosity and flow rate are inversely proportional to each other. This resistance in turn is directly proportional to the viscosity.

VIII Experimental set-up



Redwood Viscometer-I

IX Resources required

Sr. No.	Name of resources	Specifications	Quantity	Remark
1	RedWoodviscometerno.1		02	
2	Stop watch		02	
3	Kohlrausch flask		02	
4	Thermometer		04	
5	Filter Paper			
6	Oil sample			

X Precautions

1. Oil should be filtered thoroughly using muslin cloth to remove solid particles

that may clog the jet.

2. The receiving flask should be placed in such a manner that the oil stream from Jet strikes the neck of receiving flask and do not cause any foaming
3. Aftereachreadingtheoilshouldbecompletelydrainedoutfromreceivingflask

XI Procedure

1. Clean the viscometer with the help of water.
2. Level the viscometer with the help of leveling screws.
3. Fill the outer cup with water for determining the viscosity at different temperatures.
4. Place the ball valve on the jet to close it and pour the test oil into the cup upto the tip of indicator.
5. Place a clean dry Kohlrausch flask immediately below and in the line with discharging jet.
6. Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
7. Heat the water bath slowly with constant stirring. When the oil in the cup attains a desired temperature, stop the heating.
8. Lift the ball valve and start the stop watch. Oil from the jet flows into the flask.
9. Stop the stop watch when lower meniscus of the oil reaches the 50ml mark on the neck of receiving flask.
10. Perform the experiment at three elevated temperatures to get readings of flow time.

XII Observations

Sr. No	Temperature of oil	Temperature of water	Flow time 't' in seconds
1	40°C		
2	60°C		
3	80°C		

XIII Results

Viscosity of oil sample at 40°C is.......................... (Highest/Moderate/Lowest)

Viscosity of oil sample at 60°C is.......................... (Highest/Moderate/Lowest)

Viscosity of oil sample at 80°C is.......................... (Highest/Moderate/Lowest)

XIV Interpretation of results

Viscosity of oil .... (increases/decreases) with................. (increase/ decrease) in temperature and thus its flow rate.... (increase/decreases)

XV Conclusions and Recommendations

As the viscosity,...

....

....

XVI Practical Related Questions

1. Describe the process for cleaning of Redwood viscometer.
2. Explain the importance of water bath in the Redwood viscometer.
3. Write precautions to be taken while performing the practical.
4. Explain proper way to place the receiving flask.
5. Name various types of viscometer.

XVII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Chemistry	Jain and Jain	Dhanpat Rai and sons; NewDelhi,2015, ISBN:9352160002
2	Engineering Chemistry	Dr. S. S. Dara	S. Chand. Publication, NewDelhi,2013, ISBN:8121997658
3	Experiments and calculations in engineering chemistry	Dr. S. S. Dara	S.Chand.Publication,NewDelhi,2011, ISBN:8121908647
4	Practical Chemistry	Dr. N. K. Verma	LaxmipublicationNewDelhi2012ISBN:81-7008-594-2
5	Engineering Chemistry	Shashi Chawla	S.Chand.Publication,NewDelhi,2013, ISBN:1234567155036

XVIII Assessment Scheme

Performance Indicators		Weightage
Processrelated:15Marks		**60%**
1	Process for cleaning of Redwood viscometer.	15 %
2	Process for maintaining temperature.	15%
3	Reading of temperature.	15 %
4	Operation of stopwatch.	15 %
Productrelated:10Marks		**40%**
5	Interpretation of result	40%
Total		**100 %**

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

List of Student Team Members

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Practical No. 12: Steam Emulsification Number

I Practical Significance

The subject of emulsification is of greatest importance in connection with high-speed engines and steam turbines. More or less water is sure to find its way into the oil from leaky stuffing boxes or cooling coils, and thus all the conditions are present for the formation of an emulsion of oil and water. It is preferential to use oil with lower emulsification number.

II Industry/ Employer Expected Outcome(s)

1. Measurement skills
2. Assembling of setup.
3. Interpretation of result

III Relevant Course Outcomes

CO6: Use the appropriate engineering material and catalyst appropriately.

IV Practical Learning Outcome

Determination of the steam emulsification number of given lubricating oil.

V Laboratory Learning Outcomes

1. Determine the steam emulsification number of given lubricating oil.
2. Measure the steam flow duration

VI Relevant Affective domain related Outcomes

1. Maintain tools and equipments

VII Relevant Theoretical Background

The time in seconds in which oil and water emulsion separates out in distinct layers is called steam emulsion number. It is the property of oils to get intimately mixed with water, forming a mixture, called emulsion. Certain oils form emulsions with water easily. Emulsions have a tendency to collect dirt, grit, foreign matter etc., thereby causing abrasion and wearing out of the lubricated parts of the machinery. If lubricating oil form emulsion with water, it should be breaks off quickly. A good oil lubricant generally has a low steam emulsion number, so that even if water comes in contact with the oil in the lubricated parts, it will not form emulsion which has tendency to collect dirt, dust, etc. Petroleum oils have very low Steam Emulsion Number (S.E.N) but vegetable oils have higher S.E.N as the vegetable oil and water molecules have affection.

VIII Circuit diagram/Experimental set-up/Work Situation

NA

IX Resources required

Sr. No.	Name of resource	Specification	Quantity	Remark
1	Test tube	30ml	10	
2	Rubber Tube		05	
3	steamer		05	
4	Water			
5	Lubricating oil	Gear oil, Engine oil, Vegetable oil	As per requirement	
6	Stop watch		05	
7	Gas burner			
8	Test tube stand		05	
9	Pinch duct		05	

IX Precautions

1. Each tube should be shaken vigorously and for same time.
2. The time should be recorded carefully.

X Procedure

1. Take 5 ml of oil in test tube
2. Pass steam around 5ml at100°C
3. Close the test tube with stopper.
4. Shake the test tube for1 minute.
5. Keep the test tube in test tube stand without disturbing and start the stop watch.
6. Note the time in second when the oil and water is separate out in distinct layers.

XI Observations

Sr. No	Oil Sample	Volume of oil	Volume of steam	Separation Time in second
1	**A**			
2	**B**			
3	**C**			

XII Results

1. Emulsion Time for Lubricant A ....sec
2. Emulsion Time for Lubricant B ....sec
3. Emulsion Time for Lubricant C ....sec

XIII Interpretation of results

Lubricant …….. has low steam emulsification number than Lubricant ……… and Lubricant …...............

XIV Conclusions and Recommendations(if any)

Lubricant ……….. is good lubricating oil.

XVI Practical Related Questions

a) Explain good lubricating oil possess a low steam emulsion.
b) Is it possible to get an emulsion by mixing two miscible liquids?

XVII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Chemistry	Jain and Jain	Dhanpat Rai and sons; New Delhi, 2015,ISBN:9352160002
2	Engineering Chemistry	Dara S.S.	S. Chand. Publication, New Delhi, 2013, ISBN:8121997658
3	Applied Chemistry: Theory and Practice	0.P.Vermani, A. K. Narula	New age International. Publication, NewDelhi,2005,ISBN:8122408141
4	Practical Chemistry	Dr. N. K. Verma	Laxmi publicationNewDelhi81-7008-594-2
5	Engineering Chemistry	Shashi Chawla	S. Chand. Publication, New Delhi, 2013,ISBN:1234567155036

XVIII Assessment Scheme

Performance Indicators		Weightage
Processrelated:15Marks		**60%**
1	Process for operation of stopwatch	20 %
2	Process for adding steam in lubricant	20%
3	Process for shaking of tubes	10 %
4	Process for producing steam	10 %
Productrelated:10Marks		**40%**
5	Identification of SEN	20%
6	Interpretation of result	20%
Total		**100 %**

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

List of Student Team Members

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Experiment No.13: Flash and fire point by Cleveland's open cup- apparatus

I Practical Significance

Lubricating oil selected for a job should have a flash-point and fire point which is reasonably above its working temperature. This test is immense importance for lubricating oils. This test helps in detecting the highly volatile constituents of the oil. If they are highly volatile at ordinary temperature, the released vapour may cause fire hazards. So to ensure safety, certain temperature are laid down for fuels and lubricating oil below which they should not give off vapour to make them burn.

II Industry/ Employer Expected Outcome(s)

1. Measurement skills
2. Adjustment of thermometer and test flame.

III Relevant Course Outcomes

CO6: Use the appropriate engineering material and catalyst appropriately.

IV Practical Learning Outcome

Determination of the flash and fire point of given lubricating oil using Cleveland open cup apparatus.

V Laboratory Learning Outcomes

Calculate the flash and fire point of given lubricating oils using Cleveland open cup apparatus

VI Relevant Affective domain related Outcomes

1. Maintain tools and equipments
2. Follow safety practices.

VII Relevant Theoretical Background

1. Good lubricating oil should not volatilize under the working temperature.
2. Even if some volatilization takes place, the vapours formed should not form inflammable mixture with air under the condition of lubrication. From this point of view, the flash point of lubricating oil is important.
3. If the liquid is having flash point less than 60°C, they are called flammable liquid and those with flash point above 60°C are called combustible liquid.
4. The flash point of oil is the minimum temperature at which the oil gives of sufficient vapour to ignite momentarily when a flame of standard direction brought near the surface of the oil for a prescribed rate in an apparatus of specified dimensions.
5. Cleveland's open cup-apparatus is generally used for determination of flash-point of fuel oils and other oils having flash-point below 79°C.
6. Fire point of oil is the lowest temperature at which it will give enough vapour,

which on rising will begin to produce a continuous flame above the oil. After the flash point has been reached the oil is heated continuously at the rate of 1°C per min. and the application of the test flame is done after every 1°C rise in temperature of oil. At certain temperature the oil will ignite and continue to burn for a period of at least 5 sec.

7. The flash and fire points are useful in determining a lubricants volatility and fire resistance. The flash point can be used to determine the transportation and storage temperature requirements for lubricants. Lubricant producers can also use the flash point to detect potential product contamination.

VIII Experimental set-up

Cleveland's Open Cup Apparatus

IX Resources required (In tabular form)

Sr. No	Name of resource	Specification	Quantity	Remark
1	Cleveland's open cup apparatus		01	
2	Thermometer		01	
3	Lubricating oil		As per requirement	

X Precautions

1. The flash-point test should be made in a laboratory which is free from air drafts.
2. Breathing over the surface of the oil should be avoided.

XI Procedure (Stepwise)

1. Fill the cup with the oil in such a way that, the oil level is exactly up to the mark at room temperature.
2. Hold the thermometer vertically by means of the clamp in such a way that, the bottom of the bulb is about 1cm above the bottom of the cup.
3. Switch on the electrical heating device and watch the thermometer reading.
4. The oil should be heated at the rate of about 3 to 5°C per minute.

5. At every degree rise of temperature, bring the standard test flame near the surface of the oil and see whether a flash appears at any point on the surface of the oil.
6. Record the minimum temperature at which a distinct flash appears on the surface of the oil in the cup as the flash-point of the oil under test.

XII Observation Table-1

Sr. No.	Increasing temperature	Inference (No flash or flash observed)	Fire point (Not Seen or Fire Seen)
1			
2			
3			
4			
5			

XIII Results:

Given lubricating oil gives no flash up to........ ^{o}C

Given lubricating oil gives flash up to............ ^{o}C

Given lubricating oil gives fire point up to ..... ^{o}C

XIV Interpretation of results

1. The flash point of given sample determined by Cleveland's open cup apparatus is found to be ... ^{o}C
2. The fire point of given sample determined by Cleveland's open cup apparatus is found to be .... ^{o}C.

XV Conclusions and Recommendations

Given lubricating oil can be used up to …………… working temperature.

XVI Practical Related Questions

1. Write the precautions should be taken while performing the practical.
2. For which type of oil Cleveland open cup apparatus is used to determine flash point.
3. Explain the procedure to mount thermometer in the oil cup.
4. State the heating rate of oil in this experiment

XVII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Chemistry	Jain and Jain	Dhanpat Rai and sons; New Delhi, 2015,ISBN:9352160002

2	Engineering Chemistry	Dr. S. S. Dara	S. Chand. Publication, New Delhi, 2013,ISBN:8121997658
3	Experiments and calculations in engineering chemistry	Dr. S. S. Dara	S. Chand. Publication, New Delhi, 2011,ISBN:8121908647
4	Practical Chemistry	Dr. N. K. Verma	Laxmi publication New Delhi81-7008-594-2

XVIII Assessment Scheme

Performance Indicators		**Weightage**
Process related:15Marks		**60%**
1	For Mounting the thermometer	15 %
2	For introduction of test flame	15%
3	For maintaining temperature	15 %
4	For temperature reading	15 %
Product related:10Marks		**40%**
5	Identification of flash point	20%
6	Identification of fire point	20%
Total		**100 %**

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

List of Student Team Members

1. ……………………………………..
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Practical No.14: Flash point by Abel's closed cup apparatus

I Practical Significance

Lubricating oil selected for a job should have a flash-point which is reasonably above its working temperature. This ensures safety against fire hazards during the storage, transport and use of the lubricating oil. This test helps in detecting the highly volatile constituents of oil. To ensure safety certain minimum temperature are laid down fuels and lubricating oils below which they should not give off adequate vapours to make them burn. In addition, the flash point of oil is often used as a means of identification and also for detection of contamination of the lubricating oils. The Abel's closed-cup apparatus is best used for oils having flash point below 49°C.

II Industry/ Employer Expected Outcome(s)

1. Measurement skills
2. Adjustment of the rate of heating per minute
3. Introduction of the test flame over the oil surface

III Relevant Course Outcomes

CO6: Use the appropriate engineering material and catalyst appropriately.

IV Practical Learning Outcome

Determination of the flash point of given lubricating oil using Abel's closed cup apparatus.

V Laboratory Learning Outcomes

1. Determine the flash point of given lubricating oil using Abel’s closed cup apparatus.

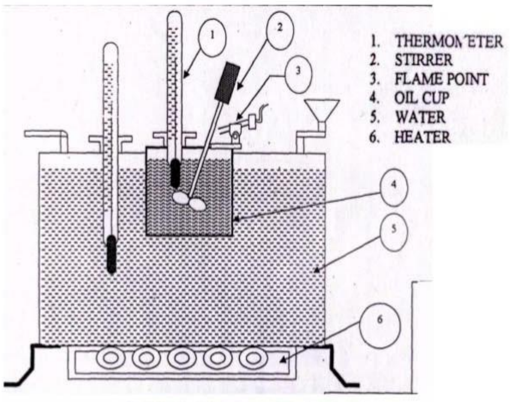
VI Relevant Affective domain related Outcomes

1. Follow safety practices.
2. Maintain tools and equipments.
3. Practice good housekeeping.

VII Minimum Theoretical Background

1. Good lubricating oil should not volatilize under the working temperature.
2. Even if some volatilization takes place, the vapours formed should not form inflammable mixture with air under the condition of lubrication. From this point of view, the flash point of lubricating oil is important.
3. The flash point of oil is the minimum temperature at which the oil gives of sufficient vapour to ignite momentarily when a flame of standard direction brought near the surface of the oil for a prescribed rate in an apparatus of specified dimensions.

VIII Experimental set-up



ABEL'S APPARATUS

IX Resources Required

Sr. No.	Name of resources	Specification	Quantity	Remark
1	Abel's apparatus		05	
2	Thermometer		05	
3	Oil sample		As per requirement	

X Precautions

1. While filling oil in the cup, take care that the surface of the oil is free from bubbles and there is no oil above the filling mark.
2. The compartment or room should be as dark as possible so that flash is readily visible.
3. Use the correct range of thermometer.
4. Temperature of oil should be increases at the rate of 1 to1.5°C.

XI Procedure

1. Fill the oil cup with the oil under test up to the point of the gauge.
2. Replace the cover.
3. Fix the oil cup in to the apparatus and assemble the paddle stirrer and the standard thermometer with its bulb dipping into the oil at their respective places provided for in the apparatus.
4. Fill the water bath with cold water.
5. Close the sliding shutter and light the standard flame.
6. Switch on the heating device and adjust the rate of heating in such a way that the temperature of the oil increases at a rate of 1 to1.5°C per minute
7. Stir the oil continuously by turning the paddle stirrer.
8. Stirring should be discontinued only during the introduction of the test

flame over the oil surface.

9. At every degree rise of oil temperature, open the sliding shutter and introduce the test flame over the oil surface through the central opening to see whether the oil gives a flash.
10. Record the minimum temperature at which a distinct flash appears as the flash point of the oil.

XII Observation Table

Sr. No.	Increasing temperature	Inference (No flash or flash observed)
1		
2		
3		
4		
5		

XIII Results

1. Given lubricating oil gives no flash up to................ °C.
2. Given lubricating oil gives flash up to .... °C.

XIV Interpretation of results

The flash point of given sample determined by Abel's closed cup apparatus is found to be………°C

XV Conclusions and Recommendation (if any)

Given lubricating oil can be used up to………..°C working temperature.

XVI Practical Related Questions

1. Write the precautions while performing the practical.
2. Give the limitations of Abel's close cup apparatus.
3. Explain the significance of fire & flash point.
4. Name the apparatus used for flash point & fire point determination.

XVII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Chemistry	Jain and Jain	Dhanpat Rai and sons; New Delhi, 2015,ISBN:9352160002
2	Engineering Chemistry	Dr. S. S. Dara	S.Chand.Publication,NewDelhi,2013, ISBN:8121997658
3	Experiments and calculations in engineering chemistry	Dr. S. S. Dara	S.Chand.Publication,NewDelhi,2011,ISBN:8121908647

4	Applied Chemistry: Theory and Practice	0.P.Vermani, A.K. Narula	Newage International. Publication, New Delhi,2005,ISBN:8122408141

XVIII Assessment Scheme

Performance Indicators		Weightage
Process related:15Marks		**60%**
1	For Mounting the thermometer	15 %
2	For introduction of test flame	15%
3	For maintaining temperature	15 %
4	For temperature reading	15 %
Product related:10Marks		**40%**
5	Identification of flash point	40%
Total		**100 %**

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

List of Student Team Members

1. ………………………
2. ………………………
3. ……………………..
4. ……………………

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Practical No.15: Thinner content in oil paint

I Practical Significance

The concept of drying of paint film due to evaporation of volatile solvent and the role of volatile solvent in paint. Addition of Thinner in paint reduces the viscosity so that it can be easily applied on metallic and non-metallic surface.

II Industry/ Employer Expected Outcome(s)

1. Ability to weigh the paint accurately.
2. Ability to measure temperature and time for heating the paint.
3. Ability to clean and handle the apparatus.
4. Interpretation of the result
5. Discrimination between thinner and paint.

III Relevant Course Outcomes

CO6 - Use the appropriate engineering material and catalyst appropriately.

IV Practical Learning Outcome:

Determination of thinner content in oil paint.

V Laboratory Learning Outcome:

1. Determine thinner content in oil paint using electric oven

VI Relevant Affective domain related Outcomes:

Maintain tools and equipment.

VII Minimum Theoretical Background:

Paint is applied on metallic surfaces to prevent corrosion. Addition of thinner reduces viscosity of paint. Paint thinner is a solvent used to thin oil-based paints or clean up after their use. Commercially, solvents labeled "Paint Thinner" are usually mineral spirits having a flash point at about 40°C (104°F), the same as some popular brands of charcoal starter.

VIII Experimental set-up

Porcelain Dish

Weighing Balance

IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Crucible	Silica	01	
2	Electric Oven	Electric oven inner size 18"x18"x18"; temperature range100to250°Cwiththe capacity of 40 lt.	01	
3	Chemical balance	Scale range of 0.001gto500g Pan size100 mm; response time 3-5sec.:power requirement 90-250V, 10watt	01	
4	Desiccators	4”	01	
5	$CaCO_3$	Crystals		
6	Oil Paint			

X Precautions:

1. Handle the crucible carefully.
2. Cool the crucible in Desiccator.

XI Procedure:

1. Weigh approximately l g (W) of paint on an electronic weighing balance in a porcelain dish.
2. Keep the porcelain dish in a previously heated electric oven at 120°C and heat for one hour.
3. Keep the crucible in desiccators to cool down to room temperature.
4. Weigh the sample accurately.
5. By knowing the loss in weight of paint, calculate the thinner content in paint.

XII Observation table:

Sr. No.	Observations	Symbol	Value
1	Weight of empty porcelain dish	W_1	…………….g
2	Weight of porcelain dish + paint (before heating)	W_2	…………….g
3	Weight of a paint(W)	$W=W_2-W_1$	…………….g
4	Weight of porcelain dish +paint (After heating)	W_3	…………….g
5	Loss in weight of a paint(Z)	$Z = W_2-W_3$	…………….g

XIII Calculations

Calculate percentage of thinner content

If (W) g of paint contain= (Z) g of thinner

$$100 \text{ g of paint contains} = \frac{Z\times 100}{W} \text{ \% of thinner}$$

$$100 \text{ g paint contains} = \frac{\ldots\ldots\ldots\times 100}{\ldots\ldots\ldots} \text{ \% of thinner}$$

The paint contains= ....% of thinner

XIV Results

Thinner content of paint is ……….. %

XV Interpretation of results

……………………………………………………………………………………

……………………………………………………………………………………

XVI Conclusions and Recommendations(if any)

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XVII Practical Related Questions:

1. Weight of paint decreases after heating, explain.
2. Write the use of Desiccator.
3. Give reason, the oven should be previously heated.
4. Mention the role of $CaCO_3$ in desiccator.
5. Write the temperature at which paint is heated in electric oven.

XVIII References/Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Chemistry	Jain and Jain	Dhanpat Rai and sons; New Delhi, 2015, ISBN:9352160002
2	Engineering Chemistry	Dr. S. S. Dara	S. Chand.Publication,NewDelhi,2013, ISBN:8121997658
3	Fundamental of electrochemistry	Bagotsky, V.S.	WileyInternationalN.J.,2005,ISBN: 9780471700586

4	Experiments and calculations in engineering chemistry	Dr. S. S. Dara	S. Chand. Publication, NewDelhi,2011, ISBN:8121908647
5	Engineering Chemistry	A. D. Sharma, V. Thakur	WileyInternationalN.J.,2012,ISBN: 9788126537419
6	Engineering Chemistry	Shashi Chawla	S. Chand. Publication, NewDelhi,2013,ISBN: 1234567155036

XIX Assessment Scheme

Performance Indicators		**Weightage**
Process related:15Marks		**60%**
1	Preheating of oven.	15 %
2	Weight of empty crucible.	15%
3	Weight of crucible with paint.	15 %
4	Process for cooling of crucible after heating.	15 %
Product related:10Marks		**40%**
5	Percentage of thinner content in oil paint	20%
6	Interpretation of result	20%
Total		**100 %**

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

List of Student Team Members

1. ……………………….
2. ……………………….
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