I

Name _____

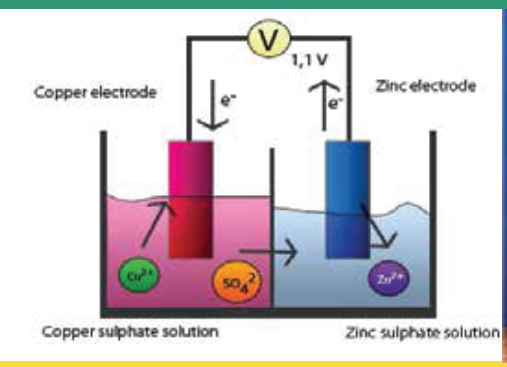
Roll No. _____ Year 20____ -20____

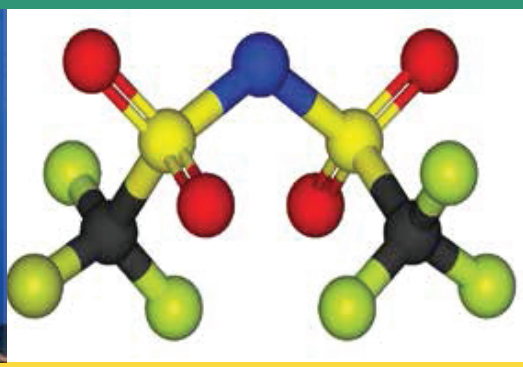
Exam. Seat No. _____

ALL PROGRAMMES | SEMESTER - I | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL FOR

BASIC SCIENCE (CHEMISTRY) (22102)





MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

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

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

MSBTE believes in the followings:

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

A Laboratory Manual

for

Basic Science – Chemistry

(22102)

Semester-I

Diploma in Engineering and Technology
(All Programme)

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

Maharashtra State Board of Technical Education,
(Autonomous) (ISO : 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2017)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

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 course **Basic Science-Chemistry (22102)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:……

Date: …… Exam. Seat No: ……

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

Seal of Institution

Preface

The 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 Practicals

PO 1. Basic knowledge: *Apply knowledge of basic mathematics, science and basic engineering to solve the problems related to application of computers and communication services in storing, manipulating and transmitting data, often in the context of a business or other enterprise.*

PO 2. Discipline knowledge: *Apply Information Technology knowledge to solve broad-based Information Technology related problems.*

PO 3. Experiments and practice: *Plan to perform experiments, practices and to use the results to solve Information Technology related problems.*

PO 4. Engineering tools: *Apply appropriate Information Technology related techniques/ tools with an understanding of the limitations.*

PO 5. The engineer and society: *Assess societal, health, safety and legal issues and the consequent responsibilities relevant to practice in the field of Information technology.*

PO 6. Environment and sustainability: *Apply Information Technology related engineering solutions for sustainable development practices in environmental contexts.*

PO 7. Ethics: *Apply ethical principles for commitment to professional ethics, responsibilities and norms of practice in the field of Information Technology.*

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

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

PO 10. Life-long learning: *Engage in independent and life-long learning along with the technological changes in the IT and allied industry.*

Practical- Course Outcome matrix

S. No.	Title of the Practical	CO d.	CO e.	CO f.
1.	Identification of Cations	√		
2.	Identification of Anions	√		
3.	Redox Titration	√		
4.	Preparation of Corrosive Medium		√	
5.	Effect of Temperature on rate of corrosion		√	
6.	Electrode Potential of Copper		√	
7.	Electrode Potential of Iron		√	
8.	Daniel Cell		√	
9.	Determination of pH Value	√	√	
10.	Electrochemical equivalent		√	
11.	Equivalent weight of metal		√	
12.	Effect of Temperature on Viscosity		√	
13.	Steam Emulsification number			√
14.	Flash and fire point by Cleveland's open cup-apparatus			√
15.	Flash point by Able's closed cup apparatus			√
16.	Thinner content in oil paint		√	√

NOTES TO TEACHERS

Hints regarding strategies to be used

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. In experiment number 1 & 2 i.e qualitative analysis teacher can give both positive and negative radical together. Two such salts can be given to the students for analysis.
7. Teacher can summaries practical significance given in the experiment in one or two lines, and explain to the students as aim of the experiment.

Hints for formulating samples questions

1. Avoid questions asked in theory exams and the answers which can be copy/pasted from text/reference books.
2. Ask students questions which have short answers related to the process of performing given task/practical.
3. Questions may also be asked following the “what if...” approach on the process of the given task/practical.

Content Page

List of Practicals and Progressive Assessment Sheet

* To be transferred to Proforma of CIAAN-2017.

Experiment No. 1: Identification of Cations

I Practical Significance

Ionization phenomenon, nature of solution and magnitude of ions plays a vital role in various chemical, catalysis processes, reactions and their products in industries. In chemical and allied engineering processes diploma engineers have to work with different solutions and respective cations and anions. They have to perform sample testing in the industries and also use the data produced from the sample testing. In this experiment students will find the magnitude and types of cations present in the given sample which help in sample testing in industries.

II Relevant Program Outcomes (POs)

PO1 Basic knowledge
PO3 Experiments and practice
PO4 Engineering tools
PO8 Individual and team work
PO9 Communication
PO10 Life-long learning

III Relevant Course Outcomes

d) Apply the catalysis process in industries.

IV Practical Learning Outcome

Identify cations in the given ionic solutions.

V Practical Skills

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

VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

Dissolution of acids, bases and salts in water dissociate into two types of ions. Positively charged ions are called as cations formed by loss of electrons from the metallic atoms, while anions are formed by gain of electrons from non metallic radicals or group of non metals. Charges present on cations and anions represent the valency of the element, from ion is derived. Total number of charges present on cations are always equal to total number of charges present on anions hence whole solution is electrically neutral.

VIII Circuit diagram / Experimental set-up / Work Situation

(N.A.)

IX 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	

X Procedure

1. Clean the test tube thoroughly with water.
2. Take 2-3 ml of given solution in test tube with the help of dropper.
3. Add equal amount of relevant reagents according to qualitative analysis chart given below.

Table for qualitative analysis:

A. Identification of Cations

Sr. No.	Test	Observation	Inference
1.	O.S. + dil. HCl	White ppt.	I group present i.e Pb^{2+} may be present.
		No ppt.	I group is absent
2.	O.S.+ dil. HCl +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_4Cl (excess) + NH_4OH (till alkaline)	ppt. obtained	III A Group present.
		1. White gelatinous ppt. of $Al(OH)_3$	Al^{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_4Cl (excess) + NH_4OH (till alkaline)+H_2S gas	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_4Cl (excess) +	White ppt. of $CaCO_3$ or	IV group is present

Sr. No.	Test	Observation	Inference
	NH_4OH (till alkaline) + $(NH_4)_2CO_3$	$BaCO_3$	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_4Cl (excess) + NH_4OH (till alkaline) + NaH_2PO_4	White ppt.	V Group present 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.+ $HgCl_2$	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 Al^{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.	3.O.S.+NaH_2PO_4	white gelatinous ppt. soluble in dil. HCl	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. HCl	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. HCl	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_4Cl(crystals) + $K_4[Fe(CN)_6]$	White ppt.	Ca^{2+} confirmed
4.	Flame Test	Brick Red colored 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 Precautions:

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

XII Actual procedure followed

.....
.....

XIII Resources used (with major specifications)

.....
.....

XIV Precautions followed

.....
.....

XV Observations and calculations

A. Identification of Cation

Sample Solution 1

Sr. No.	Test	Observation	Inference

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

Sr. No.	Test	Observation	Inference

A. Sample Solution 2

Sr. No.	Test	Observation	Inference

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

Sr. No.	Test	Observation	Inference

XVI 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.

XVII Interpretation of results

.....

.....

XVIII Conclusions and Recommendations

.....

.....

XIX Practical Related Questions

1. Solution 'A' gives black ppt. with dil. HCl and H_2S gas, which basic radical is present in given solution.
2. Describe identification procedure of Ba^{2+} or Ca^{2+} radical from given unknown solution.
3. Identify cation in solution 'X' if solution 'X' having pale green colouration and when mixed with sodium hydroxide gives dirty green color ppt.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Inorganic qualitative analysis	Vogel	Publisher: Prentice Hall, 2013 ISBN 13: 9780582218666
2.	Experiments in general chemistry Principles and modern applications	Thomas G. Greco; Lyman H. Richard; Gerald S. Weiss	Pearson,9th edition ISBN-13:978-0131493919
.	Chemistry: Inorganic Qualitative Analysis in the Laboratory	Clyde Metz	Elsevier : ISBN: 978-0-12-503354-1

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(60%)
1	Process for detection of cation1	15%
2	Process for detection of cation2	15%
3	Confirmatory test for cation1	15%
4	Confirmatory test for cation2	15%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Identification of cation1	10%
2.	Identification of cation2	10%
3.	Answer to sample questions	10%
4.	Submission of report in time	10%

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

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Experiment No. 2: Identification of anions

I Practical Significance

Ionization phenomenon, nature of solution and magnitude of ions plays a vital role in various chemical, catalysis processes, reactions and their products in industries. In chemical and allied engineering processes diploma engineers have to work with different solutions and respective anions. They have to perform sample testing in the industries and also use the data produced from the sample testing. In this experiment students will find the magnitude and types of anions present in the given sample which help in sample testing in industries.

II Relevant Program Outcomes (POs)

PO1 Basic knowledge
PO3 Experiments and practice
PO4 Engineering tools
PO8 Individual and team work
PO9 Communication
PO10 Life-long learning

III Relevant Course Outcomes

D) Apply the catalysis process in industries.

IV Practical Learning Outcome

Identify anion in given ionic solutions.

V Practical Skills

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

VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

Dissolution of acids, bases and salts in water dissociate it into two types of ions. Positively charged ions are called as cations formed by loss of electrons from the metallic atoms, while anions are formed by gain of electrons from non metallic radicals or group of non metals. Charges present on cations and anions represent the valency of the element, from ion is derived. Total number of charges present on cations are always equal to total number of charges present on anions hence whole solution is electrically neutral.

VIII Circuit diagram / Experimental set-up / Work Situation

(N.A.)

IX 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	

X Procedure

1. Clean the test tube thoroughly with water.
2. Take 2-3 ml of given solution in test tube with the help of dropper.
3. Add equal amount of relevant reagents according to qualitative analysis chart given 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
2	O.S.+$AgNO_3$	White ppt. insoluble in dil HNO_3	Cl^-, Br^- or I^- may be present
	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/voilet	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 CO_3^{--}

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. + $K_2Cr_2O_7$ + 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. + $BaCl_2$	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 Precautions:

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

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations

A. Identification of Anion
Sample Solution 1.

Sr. No.	Test	Observation	Inference

B. Confirmatory Test (C.T.) for anion……

Sr. No.	Test	Observation	Inference

A. Sample Solution 2.

Sr. No.	Test	Observation	Inference

B. Confirmatory Test (C.T.) for anion……

Sr. No.	Test	Observation	Inference

XVI 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.

XVII Interpretation of results

.....
.....

XVIII Conclusions and Recommendations

.....
.....

XIX Practical Related Questions

1. Identify acidic radical present in the given solution, 'A' which gives effervescences of CO_2 gas with dil. HNO_3.
2. Explain the separation test for halides in the sample solution.
3. Identify anion in solution 'X' when mixed with barium nitrate which gives white ppt.

XX 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.	Inorganic qualitative analysis	Vogel	Prentice Hall, 2013 ISBN 13: 9780582218666
3.	Chemistry: Inorganic Qualitative Analysis in the Laboratory	Clyde Metz	Elsevier, 2015 ISBN: 978-0-12-503354-1

XXI 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 assessment scheme

Sr. No.	Product related	Weightage(40%)
	Identification of anion 1	10%
	Identification of anion 2	10%
	Answer to sample questions	10%
	Submission of report in time	10%

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

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Experiment No. 3: Redox Titration

I Practical Significance

Reduction and oxidation are one of the most significant phenomenon in chemistry, particularly for the chemical processes, chemical reactions and property identifications of different metals and their alloys. Oxidation reduction process jointly lead towards the redox reactions which helps in determination of iron content in given sample solution using redox titration. This will help students, to understand the metallic properties of metal that can be used in solving broad based engineering problems.

II Relevant Program Outcomes (POs).

PO1 Basic knowledge
PO3 Experiments and practice
PO4 Engineering tools
PO8 Individual and team work
PO9 Communication
PO10 Life-long learning

III Relevant Course Outcomes

d) Apply the catalysis process in industries

IV Practical Learning Outcome

Determine the percentage of iron in the given sample using redox titration.

V Practical Skills

1. Measurement
2. Calculation

VI Relevant Affective domain related Outcomes

1. Follow safety practices.
2. Demonstrate working as a leader/a team member.

VII Minimum Theoretical Background

Characteristics of metal lead towards the oxidation/reduction phenomenon.

Oxidation is the process of the addition of oxygen or removal of hydrogen/electron and reduction involves the process of addition of hydrogen/electrons or removal of oxygen.

Oxidizing agents are substances that gain one or more electrons and get reduced. Reducing agents are substances that lose one or more electrons and get oxidized. That is, oxidizing agents are electron acceptors, and reducing agents are electron donors.

A solution whose concentration is known, is called as a standard solution. The substance used to prepare a standard solution is called the primary standard. Oxalic acid and sodium carbonate are some examples.

The titration based on oxidation and reduction reaction between the titrant and analyte is called redox titration. The redox titration method can be used to determine the strength of a reductant/oxidant using a redox indicator.

The oxidation-reduction reaction between $KMnO_4$ and iron (II) salts is as follows.

$5\ Fe^{2+} \rightarrow 5Fe^{3+} + 5e^-$ oxidation

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ reduction

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

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

NA

IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1.	Burette	Capacity 25 ml / 50ml	1 per student	
2.	Round Bottom flask	250 ml	1 per group	
3.	Wire gauze	6 inches x 6 inches	1 per group	
4.	Conical flask	Capacity 100 ml	1 per student	
5.	Pipette / Measuring cylinder	Capacity 10 ml	1 per student	
6.	Volumetric flask	Capacity 250 ml	1 per group	
7.	Sample material/chemicals	Any ferrous alloy, $KMnO_4$, H_2SO_4, Oxalic acid, zinc granules.	As per requirement	

X Procedure

Preparation of sample solution

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

Standardization of $KMnO_4$

1. Weigh the required amount of $KMnO_4$ using electronic/ Dhona / physical / chemical balance.
2. Dissolve weighed $KMnO_4$ in the distilled water and make the volume 1000 ml using volumetric flask.
3. Take 10 ml of standard (0.1N) oxalic acid in conical flask.
4. Add 10 ml dilute sulphuric acid and heat the solution up to 70^0C, and titrate against $KMnO_4$.
5. Repeat the procedure till concurred readings will be obtained.

Titration of sample solution with standard solution:

1. Rinse and fill the burette with $KMnO_4$ solution of given normality.
2. Take sample solution in conical flask. Add minimum amount of dilute sulphuric acid to ensure acidic medium.
3. Add $KMnO_4$ drop wise using burette till light pink color appears.
4. Repeat the procedure till concurred readings will be obtained.

XI Precautions

1. Cover the flask while heating.
2. Check the color on white background.
3. Add solution dropwise with constant stirring.
4. Follow the same procedure to carry out each reading.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations and Calculations

Sample solution changes to light pink

Observation table 1: Standardization of $KMnO_4$:

Sr. No.	Burette Reading	Constant Burette Reading
1.	_____ml	V1 = _____ml
2.	_____ml	
3.	_____ml	

Observation table 2 : For determination of percentage of iron:

Sr. No.	Burette Reading	**Constant** Burette Reading
1.	_____ml	V3 = _____ml
2.	_____ml	
3.	_____ml	

Calculation

(A) Calculation for standardization of $KMnO_4$

$N_1V_1 = N_2V_2$

N_1= Normality of $KMnO_4$ = ...

V_1 = Volume of $KMnO_4$ = ...

N_2= Normality of Oxalic acid = ...

V_2 = Volume of Oxalic acid = ...

$$N_1V_1 = N_2V_2$$

$$N_1 = \frac{N_2V_2}{V_1}$$

$$N_1 = \frac{\ldots\ldots X \ldots\ldots}{\ldots\ldots}$$

N_1= …….....N

(B) Calculation for determination of percentage of iron

STEP 1

1000 ml 1 M $KMnO_4 \equiv$ 56 g of Fe

V_3 ml N_1 M KMnO4 = (56 x V_3 x N_1) / 1000

= (56 x …….x ……..) / 1000

= ……. ……..(y) g of Fe

STEP 2

25 ml of sample solution contains ……. = (y) g of Fe

250 ml of sample solution contains.= (y) x10 g of Fe.= ……. x10 g of Fe

=…….. (z) g of Fe

STEP 3

1 g of sample contains …… = (z) g of Fe

100 g sample contains = (z) x 100 g of Fe=…….. x 100 g of Fe

=…….. ..% of Fe

XVI Results

Percentage of iron in sample = …….. %

XVII Interpretation of results

.....

.....

.....

XVIII Conclusions and Recommendations

.....

.....

.....

XIX Practical Related Questions:

1. Describe the procedure for preparation of 1 normal Oxalic acid.
2. State the role of zinc granules in preparation of sample solution.
3. Write is the atomic weight of iron.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Practical Chemistry	Dr. N.K. Verma	Laxmi publications New Delhi, 2011 ISBN: 7008-594-2
2.	Applied Chemistry :Theory and practice	O.P.Vermani,A.K.Narula	New age International Publication New Delhi 2005 ISBN : 8122408141
3.	Experiments and calculations in engineering chemistry	Dr. S.S. Dara	S.Chand. Publication, New Delhi, 2011, ISBN:8121908647
4	Engineering chemistry	Shashi Chavla	S. Chand publication New Delhi 2013 ISBN : 1234567155036

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(60%)
1.	Preparation of $KMnO_4$	20%
2.	Preparation of sample solution	20%
3.	Burette Reading of Part B	10%
4..	Burette Reading of Part C	10%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Normality of $KMnO_4$	10%
2.	Calculation for percentage of iron	10%
3.	Answer to sample questions	10%
4.	Submission of report in time	10%

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

[Space to Write Answers]

Experiment No. 4: 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 Relevant Program Outcomes

PO1 Basic knowledge
PO3 Experiments and practice
PO4 Engineering tools
PO6 Environment and sustainability.
PO8 Individual and team work
PO9 Communication
PO10 Life-long learning

III Relevant Course Outcomes

e) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Prepare the corrosive acidic / basic medium for aluminium.

V Practical Skills

1. Measurement skill
2. Preparation of solutions
3. Weighing skill

VI Relevant Affective domain related Outcomes

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

VII Minimum 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 -250 ml	4 per group	
2.	Pair of tongs	Made up of Steel	1 per group	
3.	Electronic balance	L.C.= 0.001 mg		
4.	Water bath	With temperature controller		
5.	Sample material / chemicals	Aluminium strips, acids	As per requirement	

X 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. This Corrosive medium is used to carry out experiment no. 21.

XI Precautions

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

XII Actual procedure followed

(1)……..……
…….……..…
(2)……..……
……
(3)……
……..……
(4)……...…
……..

XIII Resources used (with major specifications)

.....
.....
.....

XIV Precautions followed

.....
.....
.....

XV Observations and Calculations

Sr. No.	Name of acid	Concentration of available acid (N_1)	Concentration of acid to be prepared (N_2)	Volume of acid /base required to be prepare (V_2)	Volume of acid /base to be used for Preparation of (N_2)normal acid (V_1)
1.	HCl			----------ml	----------ml
2.	H_2SO_4			----------ml	----------ml
3.	HNO_3			----------ml	----------ml
4.	NaOH			----------ml	----------ml

Calculations

$$N_1V_1 = N_2V_2$$

$$V_1 = \frac{N_2 \times V_2}{N_1}$$

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.100 ml) = ----------

XVI 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 ……NaOH =…….ml.

XVII Interpretation of results

.....

.....

XVIII Conclusions and Recommendations

.....

.....

XIX 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 250ml of 5N HCl from the given 12N HCl.

XX 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 Publication New Delhi 2005 ISBN: 8122408141
3.	Experiments and calculations in engineering chemistry	Dr. Dara, S. S.	S. Chand. Publication, New Delhi, 2011, ISBN:8121908647
.	Practical chemistry	Dr. N.K. Varma	Laxmi Publication New Delhi ISBN:8170085942

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (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 assessment scheme

Sr. No.	Product related	Weightage (40%)
1.	Calculation of volume for hydrochloric acid using normality formula	5%
2.	Calculation of volume for sulphuric acid using normality formula	5%
3.	Calculation of volume for nitric acid using normality formula	5%
4.	Calculation of volume for sodium hydroxide using normality formula	5%
5.	Answer to sample questions	10%
6.	Submission of report in time	10%

List of Student Team Members

1. ……....
2. ……..
3. …….
4. …….

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

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

Experiment No. 5: 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 Relevant Program Outcomes (POs)

PO3 Experiments and practices

PO6 Environment and sustainable development

PO10 Life-long learning

III Relevant Course Outcomes

d) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the rate of corrosion on different temperatures for Aluminum.

V Practical Skills

1. Measurement skill
2. Weighing

VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

When metal comes in the contact with atmospheric gases or liquid medium, it undergoes decay and destruction. Moisture and impurities present in the surrounding environment affects the rate of corrosion. Depending on surrounding medium corrosion are of two types, atmospheric corrosion and immersed corrosion.

VIII Circuit diagram / Experimental set-up / Work Situation

NA

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	1 per group	
3.	Electronic balance	L.C.= 0.001 mg		
4.	Water bath	With temperature controller		
5.	Thermometer	$0 - 110^0C$		
6.	Electric oven	Range up to 250^0C		
7.	Sample material /chemicals	Aluminium strips, acids	As per requirement	

X Procedure

1. Immerse accurately weighed aluminum strip in the given acids / base at room temperature for 5-6 minutes.
2. Wash it, dry it and weigh aluminium strip accurately on electronic balance.
3. Take acids/base prepared from experiment number 4 and keep on water bath.
4. Adjust temperature of water bath at required temperature (eg.50^0C)
5. Dip the weighed aluminium strip in acids/base and wait for 5-6 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.

XI Precautions

1 Handle acid carefully.

2 Clean aluminium strips properly.

XII Actual procedure followed

.....

.....

.....

XIII Resources used (with major specifications)

.....

.....

.....

XIV Precautions followed

.....

.....

.....

XV Observations and Calculations

(A) Observation table for loss in weight at room temperature = ……^{0}C

Sr. No.	Solution taken	Weight of strip in mg		Change in weight of strip in mg (W_3)=(W1)-(W2)
		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 = ……^{0}C

Sr. No.	Solution taken	Weight of strip in mg		Change in weight of strip in mg (W_6)=(W4)-(W5)
		Before dipping W_4	After dipping W_5	
1.	Hydrochloric acid			
2.	Sulphuric acid			
3.	Nitric acid			
4.	Sodium Hydroxide			

XVI Results:

1. Change in weight of aluminium in hydrochloric acid at room temperature ……gms. and change in weight of aluminium in hydrochloric acid at temperature ……^{0}C is ……..gms.
2. Change in weight of aluminium in sulphuric acid at room temperature …… gms and change in weight of aluminium in sulphuric acid at temperature ……^{0}C is…….gms.
3. Change in weight of aluminium in nitric acid at room temperature ……..gms
   and change in weight of aluminium in nitric acid at temperature ……^{0}C is ……gms.
4. Change in weight of aluminium in Sodium Hydroxide is at room temperature ……gms and change in weight of aluminium in Sodium Hydroxide is at Temperature ……^{0}C is …….. gms.

XVII Interpretation of results

Maximum change in weight of aluminium is observed at …….. temperature in ……. ……Acid.

XVIII Conclusions and Recommendations (if any)

.....

.....

XIX 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. Which compound is formed when aluminium reacts with hydrochloric acid.
4. Which type of film formed after dipping metal in hydrochloric acid.
5. Describe observation when aluminium reacts with acid.

XX 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 Publication New Delhi 2005 ISBN : 8122408141
.	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

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage (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 acetic acid	15%

Product related assessment scheme

Sr. No.	Process related	Weightage (40%)
1.	Accurate interpretation of final result	20 %
2.	Answer to sample questions	10%
3.	Submission of report in time	10%

List of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

[Space to Write Answers]

Experiment No. 6: Electrode potential of Copper Metal

I Practical Significance

Determination of electrode potential of metal, enable the student to understand the position of metal in electrochemical series. This will help the student to design the structure using two dissimilar metals, to protect the metal corrosion that can be used in solving broad based engineering problems.

II Relevant Program Outcomes (POs)

PO3 Experiments and practice.

PO4 Engineering tools

III Relevant Course Outcomes

e) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the electrode potential of copper metal.

V Practical Skills:

1. Measurement
2. Calculation

VI Relevant Affective domain related Outcomes:

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

VII Minimum Theoretical Background

Due to reaction between metal and solution, an electrical double layer forms around the metal. It gives rise to potential difference between the metal and solution, known as electrode potential.

Electrode potential is a measure of tendency of metal electrode to lose or gain electrons when it is in contact with a solution of its own salt solutions of unit molar concentration at 25°C.

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 a direct measure of its tendency to get reduced.

Electrode potential of metal can be determined by building electrochemical cell in which one half cell contain reference electrode whose electrode potential is known.

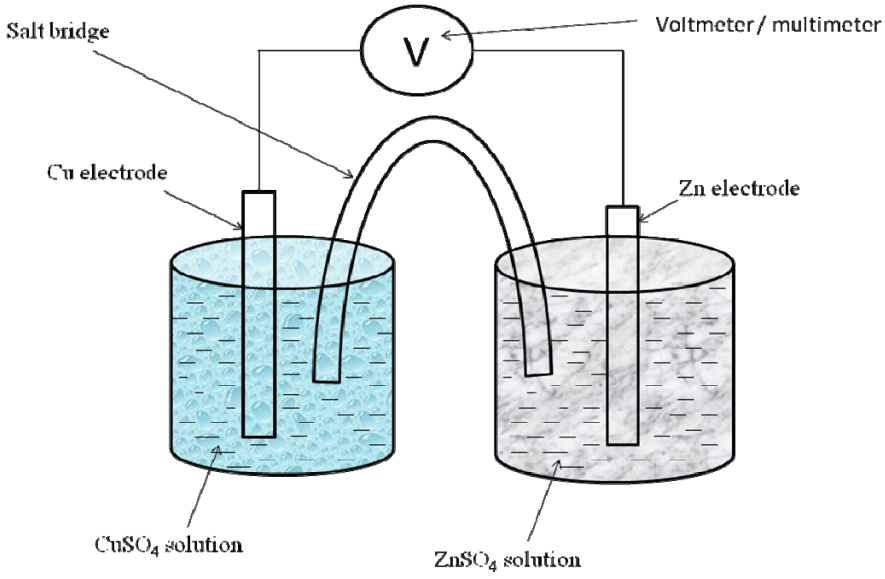
In the field of metal corrosion, reference electrode such as hydrogen electrode, the zinc-zinc sulphate electrode, calomel, silver-silver chloride electrode etc. are used.

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	0.00
Copper	+0.34
Silver	+0.80
Mercury	+0.85

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 KCl 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 Procedure

1. Make surface of zinc rod and copper rod smooth by using polish paper, then clean with dilute HCl and then with water.
2. Take 1 M $ZnSO_4$ and 1 M $CuSO_4$ solutions in two different beakers.
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. Place salt bridge in both the solutions.
6. Note down the cell EMF (E_{Cell}) in volts displayed by the digital multimeter.
7. Calculate electrode potential of copper as per the given calculations.

XI Precautions

1. While making connections take proper precautions whether wires are properly connected.
2. Check the voltmeter or multimeter before using.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations and Calculations

Observations

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

Calculation for determination reduction potential of copper electrode (E_{Cu})

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

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

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

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

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

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

XVI RESULT

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

XVII Interpretation of result

In electrochemical series zinc is placed …… (above/below) the copper metal.

XVIII Conclusions and Recommendations

Zinc is ……(more/less) electropositive than copper. Hence …… (Zn/Cu) under goes corrosion.

XIX Practical Related Questions:

1. Write the chemical reactions taking place at cathode and anode in the electrochemical cells formed in the experiment
2. State the relation between reduction electrode potential of metal electrode and its tendency towards corrosion.
3. Name cathode and anode in the given electrochemical cell.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Applied Chemistry :Theory and practice	O.P.Vermani,A.K.Narula	New age International Publication New Delhi 2005 ISBN: 8122408141
2.	Experiments and calculations in engineering chemistry	Dr.Dara, S. S.	S.Chand. Publication, New Delhi, 2011, ISBN:8121908647
3.	Practical chemistry	Dr. N.K.Varma	Laxmi Publication New Delhi ISBN:8170085942
4.	Engineering chemistry	Shashi Chavla	S. Chand publication New Delhi 2013 ISBN : 1234567155036

Sr. No.	Title of Book	Author	Publication
Link	https://www.youtube.com/watch?v=dHVFvO38nRs		

XXI 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

S. 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%

List of Student Team Members

1. ……...
2. ……
3. …….
4. ……...

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

[Space to Write Answers]

.....

.....

.....

.....

.....

Experiment No.7: Electrode potential of iron metal

I Practical Significance

Determination of electrode potential of metal enable the student to understand the position of metal in electrochemical series. This will help the student to design the structure using two dissimilar metal, to protect the metal corrosion that can be used in solving broad based engineering problems.

II Relevant Program Outcomes

PO3 Experiments and practice

PO4 Engineering tools

III Relevant Course Outcomes

e) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the electrode potential of iron metal.

V Practical Skills:

1. Measurement
2. Calculation

VI Relevant Affective domain related Outcomes:

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

VII Minimum Theoretical Background:

Due to reaction between metal and solution, an electrical double layer formed around the metal. It consequently sets up a potential difference between the metal and solution which is known as electrode potential.

Electrode potential is a measure of tendency of metal electrode to lose or gain electrons when it is in contact with its own salt solution of unit molar concentration at 25°C.

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 a direct measure of its tendency to get reduced.

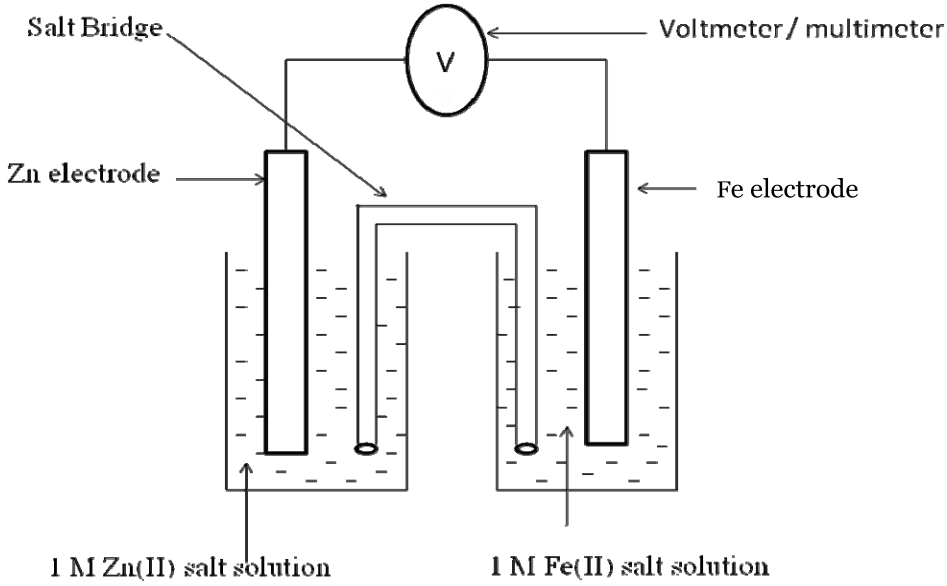
In the field of metal corrosion ,reference electrode such as hydrogen electrode, the zinc-zinc sulphate electrode, calomel, silver-silver chloride electrode etc. are used.

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	0.00
Copper	+0.34
Silver	+0.80
Mercury	+0.85

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 each group	
2.	Salt Bridge / porous pot	'U' shaped glass tube with KCl solution	1 each group	
3.	Voltmeter / multimeter		1 each group	
4.	Electrodes	Zn(Rod/Plate), Fe(Rod/Plate)	1 each group	
5.	Sample material/chemicals -	Iron (II) salt solution, zinc(II) salt solution, connecting wires	As per requiremtn	

X Procedure

1. Make surface of zinc rod and iron rod smooth by using polish paper, then clean with dilute HCl and then with water..
2. Take 1 M zinc(II) salt solution and 1 M Iron (II) salt solution solutions in two different beakers.
3. Place zinc rod in zinc(II) salt solution and iron rod in Iron (II) salt solution.
4. Connect zinc rod to negative terminal (anode) and iron rod to positive terminal (cathode) of digital multimeter.
5. Place salt bridge in both the solutions.
6. Note down the cell EMF (E_{Cell}) in volts displayed by the digital multimeter.
7. Calculate electrode potential of copper as per the given calculations.

XI Precautions

1. While making connections take proper precautions whether wires are properly connected.
2. Check the voltmeter or multimeter before using.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations and Calculations

Observations

1) Temperature = ……. ° C.

2) Theoretical value of reduction potential of Zn = - 0.76 volts.
3) Electrode potential of cell = …….. V

Calculations

Calculation for reduction potential of copper electrode (E_{Cu})

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

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

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

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

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

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

XVI RESULT

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

XVII Interpretation of result

In electrochemical series zinc is placed ……(above/below) the iron metal.

XVIII Conclusions and Recommendations (if any)

Zinc is ……(more/less) electropositive than iron. Hence …… (Zn/Fe) under goes corrosion.

XIX Practical Related Questions

1. State the chemical reactions taking place at cathode and anode in the electrochemical cells formed in the experiment.
2. State the relation between reduction electrode potential of metal electrode and its tendency towards corrosion.
3. Write the criteria required to decide the cathode and anode in the given electrochemical cell.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Applied Chemistry :Theory and practice	O.P.Vermani,A.K.Narula	New age International Publication New Delhi 2005 ISBN 8122408141
2.	Experiments and calculations in engineering chemistry	Dr.Dara, S. S.	S.Chand. Publication, New Delhi, 2011, ISBN:8121908647
3.	Practical chemistry	Dr. N.K.Varma	Laxmi Publication New Delhi ISBN:8170085942
4.	Engineering chemistry	Shashi Chavla	S. Chand publication New Delhi 2013 ISBN : 1234567155036

XXI 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%

List of Student Team Members

1. ……..
2. ……..
3. ……
4. …….

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

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

Experiment No. 8: Daniel cell

I Practical Significance

Diploma engineers have to deal with electrochemical cell during their course of work. The electrochemical cell provides electrical energy from chemical reaction. Determination of voltage generation due to reaction in Daniel cell enable students to understand the ion exchange reaction takes place at different metal electrodes. This leads to inform about the relation between change of concentration of electrolytes and relevant voltage changes that can be used in solving broad based engineering problems.

II Relevant Program Outcomes

PO3 Experiments and practice
PO4 Engineering tools

III Relevant Course Outcomes

e) Use corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the voltage generated from chemical reaction using Daniel Cell.

V Practical Skills

Assembly or practical set up

VI Relevant Affective domain related Outcomes:

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

VII Minimum Theoretical Background

A galvanic cell is an important electrochemical cell. A galvanic cell generally consists of two different metal rods called electrodes. Each electrode is immersed in a solution containing its own ions and these form a half cell. Each half cell is connected by a salt bridge, or separated by a porous membrane/partition. The solutions which conducts electricity either in molten state or in aqueous solution are called electrolytes. The chemical reaction that takes place in a galvanic cell is the redox reaction. One electrode acts as anode where oxidation takes place and the other acts as the cathode where reduction takes place. Daniel cell is an example of a galvanic cell.

Daniel cell consists of two half cells in which oxidation-reduction (redox) reaction occurs. Oxidation occurs in the half cell containing more active metal i.e. anode (-) and reduction occurs in the other half cell containing less active metal i.e. cathode (+).

In the Daniel cell, copper and zinc electrodes are immersed in a $CuSO_4$ and $ZnSO_4$ solution respectively. The two half cells are connected through a salt bridge or porous partition. Here zinc acts as anode and copper acts as cathode. At the anode, zinc undergoes oxidation to form zinc ions. The zinc ions pass into the solution. As the two electrodes are connected using an external wire, the electrons produced by the oxidation of zinc travel through the wire and enter into the copper cathode, where they reduce the copper ions present in the solution and form copper atoms that are deposited on the cathode.

The two half-cells are connected by a *salt-bridge* that allows a "current" of ions from one half-cell to other to complete the circuit of electron current in the external wires. When the two electrodes are connected to an electric load (such as a light bulb or voltmeter) the circuit is completed, the oxidation-reduction reaction occurs, and electrons move from the anode (−) to the cathode (+), producing an electric current.

The electrode reactions in Daniel Cell are :-

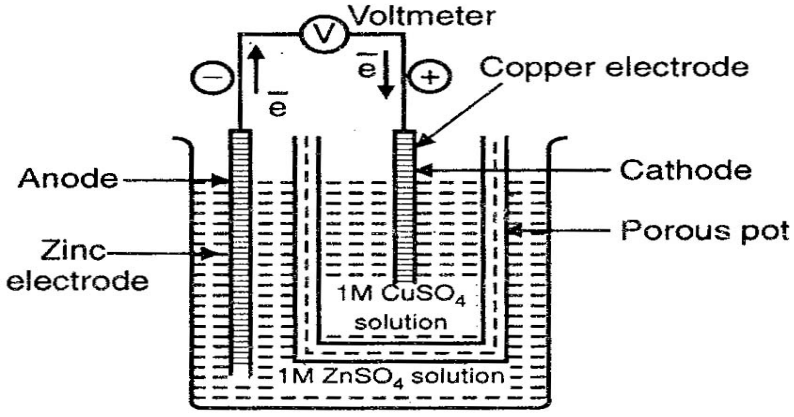
At anode (-ve electrode) : $Zn \longrightarrow Zn^{++} + 2e^{-}$ (Oxidation reaction)

At Cathode (+ve electrode) : $Cu^{++} + 2e^{-} \longrightarrow Cu$ (Reduction reaction)

Net Reaction: $Zn + Cu^{++} \longrightarrow Zn^{++} + Cu$

Voltage produced in Daniel Cell (E° Cell) = E°Reduction + E°Oxidation=(1.1 to1.4V)

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 (In tabular form)

Sr. No.	Resources	Specifications	Quantity	Remark
1	Beakers	Capacity -250 ml	2 per group	
2	Salt Bridge / porous pot	'U' shaped glass tube with KCl/KNO_3/Na_2SO_4 solution	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 Procedure

1. Make surface of zinc rod and copper rod smooth by using polish paper, then clean with dilute HCl 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
5. (cathode) of digital multimeter.
6. Place salt bridge in both the solutions.
7. Note down the voltage developed in volts displayed by the digital multimeter.

XI Precautions

1. While making connections take proper precautions whether wires are properly connected.
2. Check the voltmeter or multimeter before using.
3. Surfaces of electrodes should be cleaned before use.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations and Calculations

Observations

Temperature = ……. ° C.

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	

Calculations
Not applicable

XVI RESULT :

1) Voltage developed due to chemical reaction in Daniel cell
   (Zn | 1 M Zn^{2+} || 1 M Cu^{2+} | Cu) = ……V
2) Voltage developed due to chemical reaction in Daniel cell
   (Zn | 1 M Zn^{2+} || 0. 1 M Cu^{2+} | Cu) = ……V
3) Voltage developed due to chemical reaction in Daniel cell
   (Zn | 0.1 M Zn^{2+} || 1 M Cu^{2+} | Cu) = ……....V
4) Voltage developed due to chemical reaction in Daniel cell
   (Zn | 0.1 M Zn^{2+} || 0.1 M Cu^{2+} | Cu) = ……V

XVII Interpretation of result:

Voltage developed due to Daniel cell ……(increases/decreases) with decrease in concentration of electrolyte around anode and increase in concentration of electrolyte around cathode.

XVIII Conclusions and Recommendations (if any)

Maximum voltage produced at …….. concentration of $ZnSO_4$ and concentration of $CuSO_4$

XIX Practical Related Questions

1. Mention the names of anode and cathode in Daniel cell.
2. State the chemical reactions taking place at cathode and anode in the Daniel cells formed in the experiment?
3. Explain half cell?
4. State the function of salt bridge or porous pot.
5. Name the electrolytes that can be used in salt bridge.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Applied Chemistry :Theory and practice	O.P.Vermani,A.K.Narula	New age International Publication New Delhi 2005 ISBN: 8122408141
2.	Experiments and calculations in engineering chemistry	Dr.Dara, S. S.	S.Chand. Publication, New Delhi, 2011, ISBN:8121908647
3.	Practical chemistry	Dr. N.K.Varma	Laxmi Publication New Delhi ISBN:8170085942
4.	Engineering chemistry	Shashi Chavla	S. Chand publication New Delhi 2013 ISBN :1234567155036
5.	https://www.youtube.com/watch?v=dHVFvO38nRs https://www.youtube.com/watch?v=0MFc5n2C03o		

XXI 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%

List of Student Team Members

1. ……..
2. ……..
3. …….
4. ……..

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

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

Experiment No. 9: Determination of pH value

I Practical Significance

Determination of pH values of different solutions will make the student enable to identify the process of corrosion that may help in solving various broad based Engineering problems related to the metal corrosion.

II Relevant Program Outcomes (POs)

PO1 Basic knowledge
PO2 Experiments and practices

III Relevant Course Outcomes

e) Apply corrosion preventive measures in industry.

IV Practical Learning Outcome

Determine the pH value of the given solution using pH meter and universal indicator.

V Practical Skills

1. Measurement
   a) Measurement skills
   b) Compare colour formations.
2. Calibration
   a) Calibration skills

VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

Strength of hydrogen ion concentration in the solution, in gram ion per liter. (Already learn), ionization phenomena and anionic cationic behavior.(Already learn)

VIII Experimental set-up

IX Resources required

Sr. No.	Recourses	Specifications	Quantity	Remark
1	pH meter	pH meter reading up to pH 14 ambient temperature 40 -70 ^{O}C, pH/mV resolution 13 bit.	2	
2	Universal indicator	Colour strips specifically for pH 1-14/Mixture of Methyl red, methyl orange, bromothymol blue, phenolphthalein in ethanol or water.		
3	Chemicals	Any acid, Distilled water, alkali and salt solution.		
4	Test tube	15 ml	20	
5	Beaker	100 ml	05	

X Procedure

Part I Determination of pH by using pH meter

1. Clean the glass electrode by using distilled water.
2. Set up the apparatus as shown in figure.
3. Standardize the instrument by using standard buffer solution.
4. Take test solution A in beaker.
5. Place glass electrode in it Observe and note down the pH value in the observation table.
6. Remove glass electrode and clean it with distilled water.
7. Repeat the same procedure for remaining test solutions.

Part II Determination of pH by using universal indicator.

1. Add drops of universal indicator in each test tube and shake well.
2. Observe the colour developed in the solution.
3. Match the colour developed with standard colour strip.
4. Note down the pH value for each solution written on colour strips against that colour.

XI Precautions

1. Every time wash the test tube with distilled water when you will change the test solution.
2. Every time clean the glass electrode with distilled water.
3. Glass electrode should be properly deep in sample solution.

XII Actual procedure followed

.....

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations and Calculations

Sr. No.	Test solutions	pH by universal indicator	pH by pH meter
1	**A**		
2	**B**		
3	**C**		
4	**D**		
5	**E**		
6	**F**		
7	**G**		

XVI Results

a) Solutions with less than 7 pH= …….

b) Solutions with more than 7 pH=…….

c) Solution with exact 7 pH =……

XVII Interpretation of results

a) Solution having pH less than 7 : Acidic solution

b) Solution having pH more than 7 : Alkaline solution

c) Solution having pH 7 : Neutral solution

XVIII Conclusions and Recommendations (Acidic/ Alkaline/ Neutral)

i) Solution A is ----------

ii) Solution B is ----------

iii) Solution C is ----------

iv) Solution D is ----------

v) Solution E is ----------

vi) Solution F is ----------

vii) Solution G is ----------

XIX Practical Related Questions

1) Describe the standardization process of pH meter.

2) Name the electrode used in the method of finding pH value.

3) Name the solution used to standardize pH meter.

4) State the method which gives accurate pH value.
5) State the composition of universal indicator.

XX 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.	Fundamental of electrochemistry	Bagotsky,V.S.	Wiley International N. J.,2005, ISBN: 9780471700586
4.	Experiments and calculations in engineering chemistry	Dr.S.S.Dara	S.Chand. Publication, New Delhi, 2011, ISBN: 8121908647
5.	Engineering Chemistry	A.D. Sharma, V. Thakur	Wiley International N. J.,2012, ISBN: 9788126537419
6.	Engineering Chemistry	Shashi Chawla	S.Chand. Publication, New Delhi, 2013, ISBN: 1234567155036

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(60%)
1	Washing glass electrode.	15%
2	Assemble the instrument	15%
3	Addition of indicator.	15%
4	Standardization of instrument	15%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Identification of pH by digital pH meter	20%
2.	Identification of pH by Universal Indicator	20%

List of Student Team Members

1. …….
2. …….
3. ……..
4. ……...

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

[Space to Write Answers]

Experiment No.10: Electrochemical equivalent

I Practical Significance

Diploma engineers have to work for electroplating coating and cladding of various metallic substances for different industrial applications. The determination of electrochemical equivalent using Faraday's first law is the key to lead the phenomenon of electroplating. It informs about the electrochemical equivalent of any metallic substance and highlights the electronic nature of the particular metal. This may help to take preventive measures in metallic corrosion and various applications in industries.

II Relevant Program Outcomes

PO1 Basic knowledge
PO3 Experiments and practice

III Relevant Course Outcomes

e) Apply corrosion preventive measures in industry.

IV Practical Learning Outcome

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

V Practical Skills

1. Measurement skill
2. Practical setup

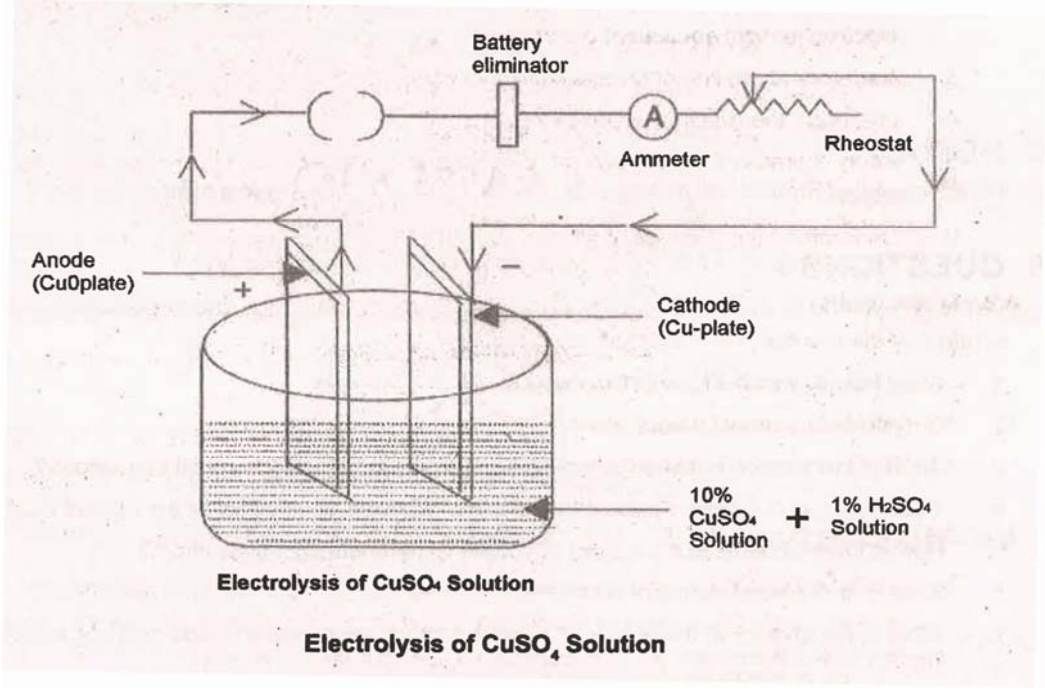
VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

The key process of electrolysis is the interchange of atoms and ions by the removal or addition of electrons from the external circuit. The desired products of electrolysis are often in a different physical state from the electrolyte and can be removed by some physical processes. A liquid containing mobile ions (electrolyte) is produced by solution or reaction of an ionic compound with a solvent (such as water) to produce mobile ions or an ionic compound is fused by heating. An electrical potential is applied across a pair of electrodes immersed in the electrolyte.

VIII Experimental set-up



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 90-250 V, 10 watt		
7	Polish paper			
8	Drier		01	
9	Copper wires			
10	Ammeter	0-2 amp		

X Procedure

1. Clean the copper cathode using polish paper, dilute HCl and then wash with water.
2. Dry it in oven or by using air drier.
3. Weigh the copper cathode.
4. Set up the apparatus as indicated in the diagram.
5. Connect the circuit as shown in figure.

6. Adjust the required current between 1 to 2 ampere and pass the current for 15/20 minutes.
7. Remove the cathode, wash with water gently and dry it using drier.
8. Weigh the copper cathode accurately.
9. Tabulate the observations.

XI Precautions

1. Clean the copper cathode.
2. Weigh the copper cathode accurately.
3. Connect the copper plates to positive and negative terminal of the battery

XII Actual procedure followed

.....
.....
.....

XIII Resources used (with major specifications)

.....
.....
.....

XIV Precautions followed

.....
.....

XV Observations and Calculations

Sr. No.	Observation	Symbol	Value
1	Wt. of Cu cathode before deposition	W1	**----------gm**
2	Wt. of Cu cathode after deposition	W2	**----------gm**
3	Wt. of Cu deposited	W =W2-W1	**----------gm**
4	Current in Ampere	C	**----------amp**
5	Time in second	t	**……sec**

Calculations

Z = W / Ct

= …….. / (……..×…….)

= …….gm /C

XVI Results

Electrochemical equivalent of Copper (ECE) =…….gm/C

XVII Interpretation of results

As the time increases, the weight of substance deposited on cathode increases.

XVIII Conclusions and Recommendations

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

XIX Practical Related Questions:

1. State the relation between chemical equivalent and electrochemical equivalent.
2. What will be the effect of increasing time for which current is passed on the amount of substance depositing?
3. Which type of electrode does copper anode forms?

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Experiments and calculations in engineering chemistry	Dr. S.S.Dara	S.Chand. Publication, New Delhi, 2011, ISBN: 8121908647
2	An Introduction To Electrochemistry	Samuel Glasstone	Maurice press, London, ISBN : 9781406717792
3	Engineering Chemistry	A.D. Sharma, V. Thakur	Wiley International N. J.,2012, ISBN: 9788126537419

XXI 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%

List of Student Team Members

1. ……
2. …….
3. ……
4. ……..

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

[Space to Write Answers]

Experiment No. 11: Equivalent weight of metal

I Practical Significance

Diploma engineers have to work for various industrial processes related to metallurgy, electroplating, coating and cladding of various metallic substances. The determination of chemical equivalent of metal using Faraday's second law lead towards the minimization of metal corrosion by informing about the chemical equivalent of any metallic substance. That it highlights the electronic nature of the particular metal. This experiment may help to take preventive measures in metallic corrosion and various applications in industries.

II Relevant Program Outcomes (POs)

PO1 Basic knowledge
PO3 Experiments and practice

III Relevant Course Outcomes

d) Apply corrosion preventive measures in industry**.**

IV Practical Learning Outcome

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

V Practical Skills

Measurement skill

a) Weight of copper cathode
b) Weight of zinc cathode

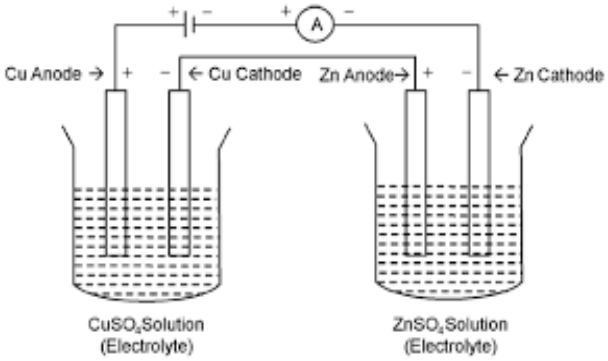
VI Relevant Affective domain related Outcomes

1. Follow safe practices
2. Practice good housekeeping.

VII Minimum Theoretical Background

1. Electrolysis mechanism.
2. The weight of substance liberated or deposited when current of one ampere is passed through a solution for one second is called electrochemical equivalent.
3. The weight of substance liberated or deposited is directly proportional to the quantity of electricity passed through an electrolyte.

VIII Experimental set-up



IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Copper plates	Given weight	20 plates	
2	Zinc plates	Given weight	20 plates	
3	$CuSO_4$ solution, $ZnSO_4$ solution	10 % concentration		
4	Glass beaker	1000 ml	20	
5	Battery	12 Volts	10	
6	Stop watch		10	
7	Chemical Balance	Scale range of 0.001g to 500gm pan size 100 mm; response time 3-5 sec.: power requirement 90-250 V, 10 watt	01	
8	Polish paper			
9	Drier		01	
10	Copper wires			
11	Ammeter	0-2 amp	10	

X Procedure

1. Clean the copper cathode and zinc cathode using polish paper, dilute HCl 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.

XI Precautions

1. Clean the copper and zinc cathode.
2. Weigh the copper and zinc cathode accurately.
3. Connect the cleaned copper and zinc plate to negative terminal of the battery properly.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations and Calculations

Observation

Sr. No.	Observation	Symbol	Value
1	Wt. of Cu cathode before deposition	Wc_1	**----------gm**
2	Wt.of Cu cathode after deposition	Wc_2	**----------gm**
3	Wt. of Cu deposited	$W_{Cu}=Wc_2-Wc_1$	**----------gm**
4	Wt. of Zn cathode before deposition	Wz_1	**----------gm**
5	Wt.of Zn cathode after deposition	W_{Z2}	**----------gm**
6	Wt. of Zn deposited	$Wzn= Wz_2-Wz_1$	**----------gm**
7	Equivalent wt. of Cu	E_{Cu}	**……..**
8	Time in second	t	**……..sec**

Calculations

$$\frac{\text{Wt. of Cu deposited (Wcu)}}{\text{Wt. of Zn deposited (Wzn)}} = \frac{\text{Eq. wt. of Cu (Ecu)}}{\text{Eq. wt. of Zn (Ezn)}}$$

$$\frac{(Wcu)}{(Wzn)} = \frac{(Ecu)}{\text{Eq. wt. of Zn (Ezn)}}$$

$$\text{Eq. wt. of Zn (Ezn)} = \frac{(Wzn)\ldots\ldots\ldots \times (Ecu)\ldots\ldots\ldots\ldots}{(Wcu)\ldots\ldots\ldots\ldots\ldots}$$

XVI Results

Equivalent weight of Zinc (Ezn) = **----------**

XVII Interpretation of results

Decrease in the weight of Copper anode indicates the corrosion of copper anode. Decrease in the weight of Zinc anode indicates the corrosion of Zinc anode.

XVIII Conclusions and Recommendations

Weight of Copper and Zinc cathode increases and weight of copper and Zinc anode decreases.

XIX Practical Related Questions

1. Explain the purposes of cleaning copper and zinc cathodes.
2. The weight of Copper anode and Zinc anode decreases. Explain
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.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	An Introduction to Electrochemistry	Samuel Glasstone	Maurice press, London, ISBN : 9781406717792
2	Engineering Chemistry	Dara, S. S.	S.Chand. Publication, New Delhi, 2013, ISBN: 8121997658
3	Engineering Chemistry	Shashi Chawla	S.Chand. Publication, New Delhi, 2013, ISBN: 1234567155036
4	Engineering Chemistry	A.D. Sharma, V. Thakur	Wiley International N. J.,2012, ISBN: 9788126537419

XXI Assessment Scheme

Process related assessment scheme

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

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Weight of Copper and Zinc	40%

List of Student Team Members

1. …….
2. ……..….
3. …….
4. …….

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

[Space to Write Answers]

Experiment No. 12*:* 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 Relevant Program Outcomes (POs).

PO3 Experiments and practices

PO10 Life-long learning

III Relevant Course Outcomes

e) Use paints, varnishes and relevant engineering materials in industry.

IV Practical Learning Outcome

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

V Practical Skills

Measurement skills

1. Measurement of the temperature
2. Measurement of flow rate

VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

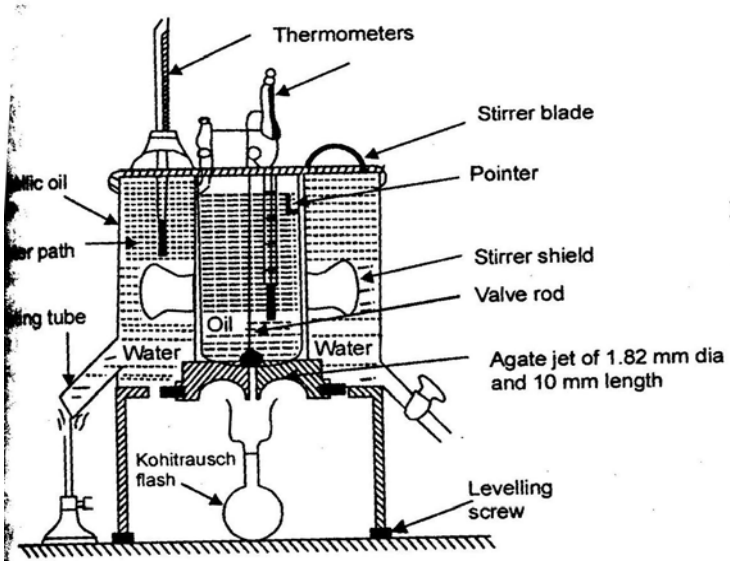
a) Viscosity is the property of a homogeneous fluid, which causes it to offer frictional resistance to motion.

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

IX Resources required

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

X 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 up to 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 50 ml mark on the neck of receiving flask.
10. Perform the experiment at three elevated temperatures to get readings of flow time.

XI Precautions

1. An 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. After each reading the oil should be completely drained out from receiving flask

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations

Sr. No	Temperature of oil	Temperature of water	Flow time 't' in seconds
1	40^0C		
2	60^0C		
3	80^0C		

XVI Results

Viscosity of oil sample at 40^0C is ……. (Highest/Moderate/Lowest)
Viscosity of oil sample at 60^0C is ……. (Highest/Moderate/Lowest)
Viscosity of oil sample at 80^0C is ……. (Highest/Moderate/Lowest)

XVII Interpretation of results

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

XVIII Conclusions and Recommendations

As the viscosity

XIX 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.

XX 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	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 Delhi 2012 ISBN : 81-7008-594-2
5	Engineering Chemistry	Shashi Chawla	S.Chand. Publication, New Delhi, 2013, ISBN: 1234567155036

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(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%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Determination of the viscosity index	40%

List of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

[Space to Write Answers]

Experiment No. 13: 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 Relevant Program Outcomes (POs) and PSOs

PO1 Basic knowledge
PO3 Experiments and practice
PO4 Engineering tools

III Relevant Course Outcomes

f) Use relevant engineering materials in industry.

IV Practical Learning Outcome

Determine the steam emulsification number of given lubricating oil.

V Practical Skills

1. Measurement skill
2. Assembling of setup

VI Relevant Affective domain related Outcomes

Maintain tools and equipments

VII Minimum 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 lubricant should possess low steam emulsion.

VIII Circuit diagram / Experimental set-up / Work Situation

NA

IX Resources required

Sr. No.	Name of resource	Specification	Quantity	Remark
1	Test tube	30 ml	10	
2	Rubber Tube		05	
3	steamer		05	
4	Water			

Sr. No.	Name of resource	Specification	Quantity	Remark
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	

X Procedure (Step wise)

1. Take 5 ml of oil in test tube
2. Pass steam around 5 ml at 100^0c
3. Close the test tube with stopper.
4. Shake the test tube for 1 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 Precautions

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

XII Actual procedure followed

(A)……
……..
(B)……
……..
(C)……
……

XIII Resources used (with major specifications)

.....
.....

XIV Precautions followed

.....
.....

XV Observations

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

XVI Results

a) Emulsion Time for Lubricant A ……

b) Emulsion Time for Lubricant B ……

c) Emulsion Time for Lubricant C ……

XVII Interpretation of results

.....

.....

.....

XVIII Conclusions and Recommendations (if any)

.....

.....

.....

XIX 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?

XX 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	O. P. Vermani, A. K. Narula	New age International. Publication, New Delhi, 2005, ISBN: 8122408141
4	Practical Chemistry	Dr.N.K.Verma	Laxmi publication New Delhi 81-7008-594-2
5	Engineering Chemistry	Shashi Chawla	S.Chand. Publication, New Delhi, 2013, ISBN: 1234567155036
	Engineering Chemistry	Shashi Chawla	S.Chand. Publication, New Delhi, 2013, ISBN: 1234567155036

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(60%)
1	Process for operation of stop watch	20%
2	Process for adding steam in lubricant	20%
3	Process for shaking of tubes	10%
4	Process for producing steam	10%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Identification of SEN	40%

List of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Experiment No. 14: 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 Relevant Program Outcomes (POs) and PSOs

PO3 Experiments and practice
PO10 Life-long learning

III Relevant Course Outcomes

g) Use paints, varnishes and relevant engineering materials in industry.

IV Practical Learning Outcome

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

V Practical Skills

Measurement skill: Adjustment of thermometer and test flame.

VI Relevant Affective domain related Outcomes

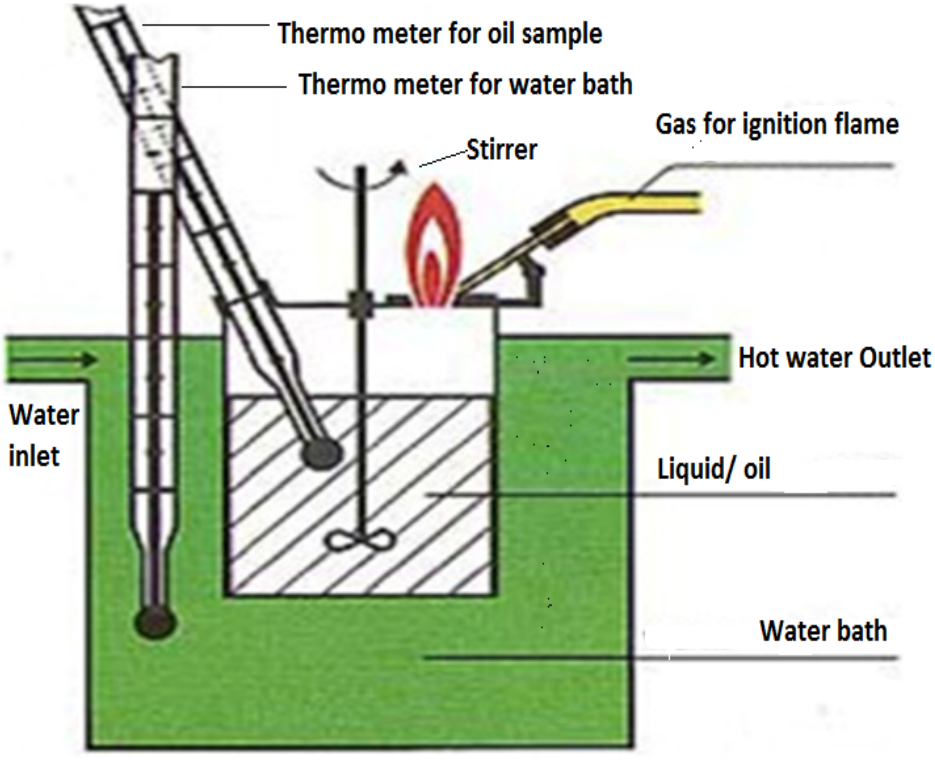
1. Maintain tools and equipments
2. Follow safety practices.

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. If the liquid is having flash point less than 60^0C, they are called flammable liquid and those with flash point above 60^0C 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 79^0C.
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 1^0Cper min. and the application of the test flame is done after every 1^0C rise in

temperature of oil. At certain temperature the oil will ignite and continue to burn for a period of at least 5 sec.

VIII Experimental set-up



IX Resources required (In tabular form)

Sr. No	Name of resource	Specification	Quantity	Remark
1	Cleveland's open cup apparatus		05	
2	Thermometer		05	
3	Lubricating oil		As per requirement	

X Procedure (Step wise)

1. Fill the cup with the oil in such a way that, the oil level is exactly upto 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^{o}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.

XI 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.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations

Table-1

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

XVI Results

Given lubricating oil gives no flash up to……^{0}C

Given lubricating oil gives flash up to……..^{0}C

Given lubricating oil gives fire point up to…… .^{0}C

XVII Interpretation of results

1. The flash point of given sample determined by Cleveland's open cup apparatus is found to be…….^{0}C
2. The fire point of given sample determined by Cleveland's open cup apparatus is found to be…….^{0}C.

XVIII Conclusions and Recommendations

.....
.....
.....

XIX 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. How to mount thermometer in the oil cup.
4. At what rate oil should be heated.

XX 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	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 Delhi 81-7008-594-2

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(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 assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Identification of flash point	20%
2.	Identification of fire point	20%

List of Student Team Members

1. …….
2. …….
3. …….
4. ……..

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

[Space to Write Answers]

Experiment No. 15: 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 49^0 C.

II Relevant Program Outcomes (POs).

PO3 Experiments and practice
PO4 Engineering tools

III Relevant Course Outcomes

f) Use paints, varnishes and relevant engineering materials in industry.

IV Practical Learning Outcome

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

V Practical Skills

Measurement skill

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

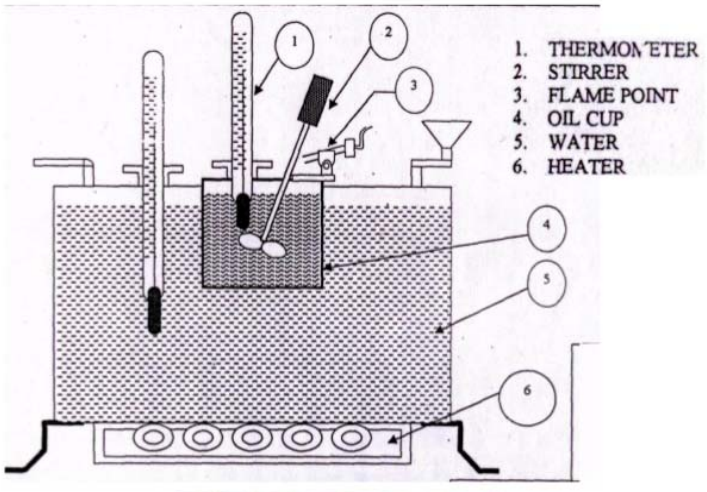
VI Relevant Affective domain related Outcomes

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 an 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 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 to 1.5^0C 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.

XI 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 discernible.
3. Use the correct range of thermometer.
4. Temperature of oil should be increases at the rate of 1 to 1.5^{0}C.

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

XV Observations

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

XVI Results

1) Given lubricating oil gives no flash up to…….^{0}C.
2) Given lubricating oil gives flash up to…….^{0}C.

XVII Interpretation of results

The flash point of given sample determined by Abel's closed cup apparatus is found to be…….^{0}C

XVIII Conclusions and Recommendations (if any)

Given lubricating oil can be use up to……working temperature

XIX Practical Related Questions

1. Write the precautions while performing the practical.

2. Give the limitations of Able's close cup.
3. Explain the significant of fire & flash point.
4. Name the apparatus used for flash point & fire point determination.

XX 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	Experiments and calculations in engineering chemistry	Dr.S.S.Dara	S.Chand. Publication, New Delhi, 2011, ISBN: 8121908647
4	Applied Chemistry: Theory and Practice	O. P. Vermani, A. K. Narula	New age International. Publication, New Delhi, 2005, ISBN: 8122408141

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(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 assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Identification of flash point	40%

List of Student Team Members

1. …….
2. ……..
3. ……..
4. ……

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

[Space to Write Answers]

Experiment No. 16: 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 Relevant Program Outcomes (POs).

PO1 Basic knowledge
PO3 Experiments and practice
PO8 Individual and team work
PO9 Communication
PO10 Life-long learning

III Relevant Course Outcomes

f) Use paint, varnishes and relevant engineering materials in industry.

IV Practical Learning Outcome:

Determine thinner content in oil paint**.**

V Practical Skills

Measurement skill: Weighing skill

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. A 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

NA

IX Resources required

Sr. No.	Resources	Specifications	Quantity	Remark
1	Crucible	Silica	10	
2	Electric Oven	Electric oven inner size 18''x18''x18''; temperature range 100 to 250^0 C. with the capacity of 40 lt.	01	
3	Chemical balance	scale range of 0.001g to 500gm pan size 100 mm; response time 3-5 sec.: power requirement 90-250 V, 10 watt	01	
4	Desiccators		10	
5	$CaCO_3$	Crystals		
6	Oil Paint			

X Procedure

1. Weigh approximately 1g (W) of paint on an electronic weighing balance in a porcelain dish.
2. Keep the porcelain dish in a previously heated electric oven at 120^0c 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.

XI Precautions

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

XII Actual procedure followed

.....

.....

XIII Resources used (with major specifications)

.....

.....

XIV Precautions followed

.....

.....

.....

XV Observations and Calculations

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

Calculations

Calculate percentage of thinner content

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

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

$$100\text{gm paint contain} = \frac{\ldots\ldots. \times 100}{\ldots\ldots\ldots..}\% \text{ of thinner}$$

The paint contain =……. %of thinner

XVI Results

Thinner content of paint is……%

XVII Interpretation of results

.....

.....

XVIII Conclusions and Recommendations (if any)

.....

.....

XIX Practical Related Questions:

1. Why weight of paint decreases after heating?
2. What is the use of Desiccator?
3. Why the oven should be previously heated.
4. What is the role of $CaCO_3$ in desiccator?
5. At what temperature paint is heated?

XX 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	Fundamental of electrochemistry	Bagotsky,V.S.	Wiley International N. J.,2005, ISBN: 9780471700586
4	Experiments and calculations in engineering chemistry	Dr.S.S.Dara	S.Chand. Publication, New Delhi, 2011, ISBN: 8121908647
5	Engineering Chemistry	A.D. Sharma, V. Thakur	Wiley International N. J.,2012, ISBN: 9788126537419
6	Engineering Chemistry	Shashi Chawla	S.Chand. Publication, New Delhi, 2013, ISBN: 1234567155036

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(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 assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Percentage of thinner content in oil paint	40%

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

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

[Space to Write Answers]

List Of Laboratory Manuals Developed by MSBTE

First Semester:

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

Second Semester:

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

Third Semester:

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

Fourth Semester:

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

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

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

Pharmacy Lab Manual

First Year:

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

Second Year:

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

HEAD OFFICE

Secretary,
Maharashtra State Board of Technical Education
49, Kherwadi, Bandra (East), Mumbai - 400 051
Maharashtra (INDIA)
Tel: (022)26471255 (5 -lines)
Fax: 022 - 26473980
Email: -secretary@msbte.com
Web -www.msbte.org.in

REGIONAL OFFICES:

MUMBAI

Deputy Secretary (T),
Mumbai Sub-region,
2nd Floor, Govt. Polytechnic Building,
49, Kherwadi, Bandra (East)
Mumbai - 400 051
Phone: 022-26473253 / 54
Fax: 022-26478795
Email: rbtemumbai@msbte.com

PUNE

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
412-E, Bahirat Patil Chowk,
Shivaji Nagar, Pune
Phone: 020-25656994 / 25660319
Fax: 020-25656994
Email: rbtepn@msbte.com

NAGPUR

Deputy Secretary (T),
M.S. Board of Technical Education
Regional Office,
Mangalwari Bazar, Sadar, Nagpur - 440 001
Phone: 0712-2564836 / 2562223
Fax: 0712-2560350
Email: rbteng@msbte.com

AURANGABAD

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
Osmanpura, Aurangabad -431 001.
Phone: 0240-2334025 / 2331273
Fax: 0240-2349669
Email: rbteau@msbte.com