

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**ANALYTICAL CHEMISTRY TECHNOLOGY**

**KNQF LEVEL 6**

**PROGRAMME ISCED CODE:** **0531 554A**

©2025

All rights reserved. No part of this Curriculum may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods without the prior written permission of QAI except in the case of brief quotations embodied in critical reviews and certain other non-commercial uses permitted by copyright law. For permission requests, write to the Council Secretary/CEO/Chief Principal at the address below:

**FOREWORD**

Provision of quality education and training is fundamental to the Government’s overall strategy for socio-economic development. Quality education and training contribute to achievement focused on Kenya’s development blueprint and sustainable development goals.

Reforms in the education and training sector are necessary for achievement of Kenya Vision 2030 and meeting the provisions the Constitution of Kenya. The education sector had to be aligned to the Constitution and this resulted in formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 1 of 2019). A key feature of this policy is the change in the design and delivery of TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery that allows for multiple entry and exit in TVET programs.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed. For trainees to build their skills on foundational hands-on activities of the occupation, units of learning are grouped in modules. This has eliminated duplication of content and streamlined exemptions based on skills acquired as a trainee progresses in the up-skilling process, while at the same time allowing trainees to be employable in the shortest time possible through the acquisition of part qualifications.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the analytical chemistry sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

Kenya Vision 2030 aims to transform Kenya into a newly industrializing middle-income country, providing high-quality life to all its citizens by the year 2030. Kenya intends to create globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through lifelong education and training. TVET has a responsibility to facilitate the process of inculcating knowledge, skills, and worker behaviour necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency-Based Education and Training (CBET).

TVET Act CAP 210A and Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya for Sustainable Development emphasized the need to reform curriculum development, assessment, and certification. This called for a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry, as well as increase the global competitiveness of the Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualifications Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes, suggested delivery methods, learning resources, and methods of assessing the trainee’s achievement. In addition, the units of learning have been grouped in modules to concretize the skills acquisition process and streamline upskilling.

I am grateful to all expert trainers and everyone who played a role in translating the Occupational Standards into this competency-based modular curriculum.

**CHAIRPERSON**

# ACKNOWLEDGEMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support were received from expert trainers, institutions and organizations.

I recognize with appreciation the role of the Analytical Chemistry National Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the industrial sector for their valuable input and everyone who participated in developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that individuals aspiring to work in the analytical sector acquire competencies to perform their work more efficiently and effectively.

**COUNCIL SECRETARY/CEO**

**QAIs**

Contents

[FOREWORD vii](#_Toc197084794)

[ACKNOWLEDGEMENT ix](#_Toc197084795)

[ABBREVIATION AND ACRONYMS xii](#_Toc197084796)

[KEY TO ISCED UNIT CODE xiv](#_Toc197084797)

[CURRICULUM OVERVIEW 1](#_Toc197084798)

[SUMMARY OF UNITS OF COMPETENCY 1](#_Toc197084799)

[ENTRY REQUIREMENTS 2](#_Toc197084800)

[INDUSTRY TRAINING 3](#_Toc197084801)

[ASSESSMENT 3](#_Toc197084802)

[MODULE I 5](#_Toc197084803)

[UNITS OF LEARNING 5](#_Toc197084804)

[MODULE I 6](#_Toc197084805)

[**CHEMICAL SAMPLES PREPARATION** 7](#_Toc197084806)

[**CHEMICAL SEPARATION** 12](#_Toc197084807)

[MODULE II 18](#_Toc197084808)

[UNITS OF LEARNING 18](#_Toc197084809)

[**MODULE II** 19](#_Toc197084810)

[**BIOCHEMICAL TECHNIQUES 20**](#_Toc197084811)

[**MATHEMATICS FOR SCIENCE** 21](#_Toc197084812)

[**ORGANIC CHEMISTRY PRINCIPLES** 30](#_Toc197084813)

[**BIOCHEMICAL TECHNIQUES** 38](#_Toc197084814)

[MODULE III 43](#_Toc197084815)

[UNITS OF LEARNING 43](#_Toc197084816)

[**MODULE III** 44](#_Toc197084817)

[**COMMUNICATION SKILLS** 45](#_Toc197084818)

[**INORGANIC CHEMISTRY PRINCIPLES** 49](#_Toc197084819)

[**CLASSICAL ANALYSIS TECHNIQUES** 57](#_Toc197084820)

[MODULE IV 63](#_Toc197084821)

[UNITS OF LEARNING 63](#_Toc197084822)

[**MODULE IV** 64](#_Toc197084823)

[**DIGITAL LITERACY** 66](#_Toc197084824)

[**PHYSICS PRINCIPLES** 83](#_Toc197084825)

[**INSTRUMENTAL ANALYSIS** 93](#_Toc197084826)

[**MODULE V** 99](#_Toc197084827)

[**UNITS OF LEARNING** 99](#_Toc197084828)

[**MODULE V** 100](#_Toc197084829)

[**WORK ETHICS AND PRACTICES** 101](#_Toc197084830)

[**PHYSICAL CHEMISTRY PRINCIPLES** 107](#_Toc197084831)

[**INDUSTRIAL CHEMISTRY ANALYSIS** 114](#_Toc197084832)

[MODULE VI 122](#_Toc197084833)

[UNITS OF LEARNING 122](#_Toc197084834)

[**MODULE VI** 123](#_Toc197084835)

[**QUALITY ASSURANCE AND CONTROL 123**](#_Toc197084836)

[**ENTREPRENEURIAL SKILLS** 124](#_Toc197084837)

[**RESEARCH METHODS** 129](#_Toc197084838)

[**QUALITY ASSURANCE AND CONTROL** 135](#_Toc197084839)

# ABBREVIATION AND ACRONYMS

ISCED International Standard Classification of Education

QAI Qualification Awarding Institutions

TVET Technical and Vocational Education and Training

CBET Competency Based Education and Training

CBETA Competency Based Education and Training Authority

NSSC National Sector Skills Committee

SOPs Standard Operating Procedures

TLC Thin Layer Chromatography

HPLC High Performance Liquid Chromatography

AAS Atomic Absorption Spectroscopy

TVETA Technical and Vocational Education and Training Authority.

ANOVA Analysis of Variance

FAES Flame Atomic Emission Spectrometer

FT-IR Fourier Transform-Infrared

GC Gas Chromatography

HPLC High Performance Liquid Chromatography

CPU Central Processing Unit

RAM Random Access Memory

CDs Compact Discs

DVDs Digital Versatile Disc

HDMI High-Definition Multimedia Interface

DVI Digital Visual Interface

VGA Video Graphics Array

USB Universal Serial Bus

TVs Televisions

URIs Uniform Resource Identifier

CV Curriculum Vitae

LED Luminous Intensity Distribution

ICH Intangible Cultural Heritage

ICT Information and Communication Technology

KCSE Kenya Certificate of Secondary Education

KNQA Kenya National Qualifications Authority

KNQF Kenya National Qualification Framework

UV-VIS Ultra-Violet Visible spectrophotometer

# KEY TO ISCED UNIT CODE



# CURRICULUM OVERVIEW

The analytical chemistry technology level 6 consists of competencies that an individual must have to effectively perform duties of an analytical chemistry technician. It involves collecting chemical samples, performing classical analysis techniques, biochemical analysis, instrumental analysis, chemical separation, quality assurance and control and industrial chemistry procedures.

This qualification consists of the following basic, common and core units of learning:

# SUMMARY OF UNITS OF COMPETENCY

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **DURATION**  **HOURS** | **CREDIT FACTOR** |
| **MODULE I** | | | |
| 0531 551 01A | CHEMICAL SAMPLE PREPARATION | **200** | **20.0** |
| 0531 551 02A | CHEMICAL SEPARATION | **200** | **20.0** |
|  | | | |
| **MODULE II** | | | |
| 0541 551 03A | MATHEMATICS FOR SCIENCE | **150** | **15.0** |
| 0531 551 04A | ORGANIC CHEMISTRY | **150** | **15.0** |
| 0531 551 05A | BIOCHEMICAL TECHNIQUES | **180** | **18.0** |
|  | | | |
| **MODULE III** | | | |
| 0031 541 06A | COMMUNICATION SKILLS | **40** | **4.0** |
| 0531 551 07A | INORGANIC CHEMISTRY | **150** | **15.0** |
| 0531 551 08A | CLASSICAL ANALYSIS TECHNIQUES | **210** | **21.0** |
|  | | | |
| **MODULE IV** | | | |
| 0611 541 09A | DIGITAL LITERACY | **40** | **4.0** |
| 0531 551 10A | PHYSICS PRINCIPLES | **150** | **15.0** |
| 0531 551 11A | INSTRUMENTAL ANALYSIS | **210** | **21.0** |
|  | | | |
| **MODULE V** | | | |
| 0417 541 12A | WORK ETHICS AND PRACTICES | **40** | **4.0** |
| 0531 551 13A | PHYSICAL CHEMISTRY | **150** | **15.0** |
| 0531 551 14A | INDUSTRIAL CHEMISTRY ANALYSES | **200** | **20.0** |
|  | | | |
| **MODULE VI** | | | |
| 0413 541 15A | ENTREPRENEURIAL SKILLS | **40** | **4.0** |
| 0542 551 16A | RESEARCH METHODS | **150** | **15.0** |
| 0531 551 17A | QUALITY ASSURANCE AND CONTROL | **180** | **18.0** |
| **SUB TOTAL** | | **2440** | **244** |
| **INDUSTRIAL TRAINING** | | **480** | **48** |
| **GRAND TOTAL** | | **2,920** | **292** |

Total number of hours is **2,920 hours** inclusive of **480** hours of industrial attachment.

# ENTRY REQUIREMENTS

An individual entering this course should have any of the following minimum requirements:

1. Kenya Certificate of Secondary Education (KCSE) mean grade C-.

**Or**

1. Equivalent qualifications as determined by TVETA.

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Possession of at least Analytical Chemistry level 7 or in related trade area;
2. Be registered by TVETA.

# INDUSTRY TRAINING

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in Analytical Chemistry sector. The industrial training may be taken after completion of all modules for those pursuing the full qualification or be distributed equally in each module for those pursuing part qualifications. In the case of dual training model, industrial training shall be as guided by the dual training policy.

# ASSESSMENT

The course will be assessed both in formative and summative as follows:

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. During summative assessment basic and common units shall be integrated in the core units.
3. Summative assessment shall involve practical assessment focusing more on critical aspects of the respective unit of competency.
4. Theoretical and practical weight shall be 40:60 respectively for each unit of learning;
5. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score

For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:

1. Obtained at least 40% in theory assessment in formative and summative assessments.
2. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
3. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
4. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be issued with KenyaNational TVET Certificate in Analytical Chemistry Technology level 6, the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. A Statement of Attainment certificate may be issued upon demonstration of competence in a certifiable element within a unit.

The certificates will be issued by the Qualification Awarding Institution

# MODULE I

# UNITS OF LEARNING

# MODULE I

This module consists of competencies that a person requires to enable him/her to effectively prepare chemical samples and perform chemical separation. This module consists of the following units of learning:

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **LEARNING OUTCOME** | **DURATION (HOURS)** |
| 0531 551 01A | CHEMICAL SAMPLES | Design sampling plan | 30 |
| Collect Chemical Sample | 90 |
| Store Chemical samples | 80 |
| 0531 551 02A | CHEMICAL SEPARATION | Carry out Extraction | 60 |
| Carry out Filtration | 30 |
| Carry out distillation | 40 |
| Chromatography | 70 |
| **TOTAL** | **400** |

## **CHEMICAL SAMPLES PREPARATION**

**UNIT CODE:** 0531 551 01A

**UNIT DURATION:**  200 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Prepare Chemical Samples.**

**Unit Description**

This unit covers the competencies required in preparing chemical samples. It involves designing sampling plan, collecting and storing chemical samples.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Design sampling plan | 30 |
| 2. | Collect Chemical Sample | 90 |
| 3. | Store Chemical samples | 80 |
| **Total** | | **200** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + 1. Design Sampling plan | 1. Sample type 2. Solids, 3. liquids 4. gases 5. Development of Sampling frame 6. Sample size identification 7. Selection of sampling tools and apparatus 8. Sampling procedure | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + 1. Collect Chemical Sample | 1. Sampling points 2. Sampling 3. Sample pretreatment 4. Size reduction, 5. Extraction 6. Digestion 7. Sample Packaging 8. Sample Labelling 9. Sample Transportation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + 1. Store Chemical samples | 1. Sample processing 2. Sample preservation techniques 3. Refrigeration 4. Oven 5. Chemical storage 6. Sample labelling and storage. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Furnace | For trainee use | 1 | 1:25 |
|  | Oven | For trainee use | 2 | 1:12 |
|  | Centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Water bath | For trainee use | 3 | 1:8 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | Sample collection apparatus | For trainee use | 25 | 1:1 |
|  | Sample storage apparatus | For trainee use | 25 | 1:1 |

## **CHEMICAL SEPARATION**

**UNIT CODE:** 0531 551 02A

**UNIT DURATION:**  200 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Chemical Separation**

**Unit Description**

This unit covers the competencies required in performing chemical separation. It involves carrying out extraction, filtration, distillation and chromatography.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Carry out Extraction | 60 |
| 2. | Carry out Filtration | 30 |
| 3. | Carry out distillation | 40 |
| 4. | Carry out chromatography | 70 |
| **Total** | | **200** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. To carry out Extraction | 1. Set up apparatus and equipment    * 1. Separating Funnel      2. Soxhlet apparatus      3. Distillation apparatus      4. Water bath      5. Heating mantle      6. TLC plates 2. Prepare extraction solvents    * 1. Ethanol      2. Chloroform      3. Acetone      4. Diethyl ether 3. Extract analytes 4. Test analytes | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To carry out Filtration | 1. Set up apparatus and equipment 2. Sample preparation 3. Filter analytes 4. Test filtered analytes | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment Third party reports |
| 1. To carry out distillation | 1. Set up apparatus and equipment 2. Sample preparation 3. Distil analyte’s 4. Test distillates | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To carry out Chromatography | 1. Set up chromatography apparatus and equipment    * 1. Paper Chromatography      2. Thin layer Chromatography      3. High Performance Chromatography      4. Gas Chromatography 2. Sample preparation 3. Separate analytes 4. Test analytes | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
| 1. **1** | Power point presentations | For trainer’s use | 1 | 1:25 |
| 1. **2** | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
| 1. **3** | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
| 1. **1** | Stationeries | For trainee use | 25 | 1:1 |
| 1. **2** | Gloves | For trainee use | 25 | 1:1 |
| 1. **3** | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
| 1. **10** | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
| 1. **11** | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
| 1. **12** | Calibration standards | For trainer and trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Water bath | For trainee use | 3 | 1:8 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | Extraction apparatus [Soxhlet extractor] | For trainer and trainee use | 5 | 1:5 |
|  | Filtration apparatus [filter funnels, conical flasks, Buchner funnel, Buchner flask, suction pump] | For trainer and trainee use | 1 | 1:25 |
|  | Distillation apparatus [distillation flask, distillation column, condenser and collection flask] | For trainer and trainee use | 1 | 1:25 |
|  | Chromatography apparatus [solvent reservoir. Injector system, columns, TLCs,] | For trainer and trainee use | 1 | 1:25 |
|  | Sample storage apparatus | For trainee use | 25 | 1:1 |

# MODULE II

# UNITS OF LEARNING

## **MODULE II**

This module consists of competencies that a learner requires to enable him/her to effectively apply mathematical concepts and organic chemistry principles to perform biochemical analyses. This module consists of the following units of learning

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **LEARNING OUTCOME** | **DURATION (HOURS)** |
| 0541 551 03A | MATHEMATICS FOR SCIENCE | Apply Basic arithmetic operations | **10** |
| Apply Algebraic equation and expression | **15** |
| Apply Indices and logarithms | **15** |
| Apply Linear and nonlinear graphs | **10** |
| Apply Binomial expansions | **15** |
| Apply matrices | **15** |
| Apply vectors | **10** |
| Apply trigonometry | **15** |
| Apply calculus | **20** |
| Apply Sequence and series | **10** |
| Apply statistics | **15** |
| 0531 551 04A | ORGANIC CHEMISTRY | Perform hydrocarbons tests | **15** |
| Perform alkyl halides tests | **15** |
| Perform alkanols tests | **15** |
| Perform carboxylic tests | **15** |
| Perform carbonyl compound tests | **15** |
| Perform amine tests | **10** |
| Prepare heterocyclic compounds | **20** |
| Conduct aromatic compound tests | **30** |
| Carry out polymerization reactions | **15** |
| 0531 551 05A | BIOCHEMICAL TECHNIQUES | Perform biochemical tests | **50** |
| Separate biomolecules | **50** |
| Prepare buffer solutions | **30** |
| Perform biochemical analyses of biomolecules | **60** |
| **TOTAL** | **480 HRS** |

**MATHEMATICS FOR SCIENCE**

**UNIT CODE:** 0541 551 03A

**Duration of Unit**: 150 HOURS

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Apply Mathematics for Science.**

**Unit Description**

This unit describes the competencies required by a science laboratory technologist in order to apply mathematics for science. It involves applying: basic arithmetic operation; algebraic equation and expression; linear and non-linear graphs; indices and logarithm; binomial expansion; matrices; vectors; trigonometry; calculus; sequence and series and statistics,

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO.** | **Learning Outcome** | **Duration (hours)** |
|  | Apply Basic arithmetic operations | **10** |
|  | Apply Algebraic equation and expression | **15** |
|  | Apply Indices and logarithms | **15** |
|  | Apply Linear and nonlinear graphs | **10** |
|  | Apply Binomial expansions | **15** |
|  | Apply matrices | **15** |
|  | Apply vectors | **10** |
|  | Apply trigonometry | **15** |
|  | Apply calculus | **20** |
|  | Apply Sequence and series | **10** |
|  | Apply statistics | **15** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply basic arithmetic operation | 1. Addition and subtraction on; 2. Natural numbers 3. Integers 4. Fractions 5. Decimals 6. Multiplication and division on; 7. Natural numbers 8. Integers 9. Fractions 10. Decimals 11. Rational and irrational numbers 12. Ratios, proportions and percentages 13. Direct proportion 14. Inverse proportion | * Observation * Third party report * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply algebraic equation and expression | 1. Solution of linear equations 2. Solution of simultaneous 3. Elimination method 4. Substitution method 5. Graphical method 6. Transposition of formula 7. Solution of quadratic equations 8. Factorization 9. Completing square method 10. Quadratic formula | * Observation * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply linear and non-linear graphs | 1. Linear and nonlinear graphs 2. Reduction of non-linear to linear graphs 3. Interpretation of graphs | * Observation * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply indices and logarithms | 1. Indices 2. Bases 3. Laws of indices 4. Indicial equations 5. Logarithms 6. Laws of logarithms 7. Logarithmic operations 8. Conversion of base of logarithms 9. Graphs of Logarithmic and exponential functions | * Observation * Written tests * Oral questioning * Portfolio of evidence |
| 1. Apply binomial expansions | 1. Roots of numbers using binomial theorem 2. Pascals triangle 3. ***Errors*** of small changes using binomial theorem 4. Absolute 5. Relative 6. Percentage 7. Permutation and combination | * Observation * Third party report * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply matrices | 1. Introduction to matrices 2. Types of matrices 3. singular 4. non-singular 5. identity 6. echelon 7. Order of matrices 8. Matrix operation 9. addition and subtraction 10. multiplication by scaler 11. compatibility 12. Matrix multiplication     1. Determinant and inverse of 2x2 matrix     2. Solution of simultaneous equations in two unknowns using matrix method     3. Eigenvalues and Eigenvectors | * Observation * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply vectors | 1. Vectors and scalar quantities in two dimensions 2. Definitions of vector and scalar quantities 3. Drawing a vector 4. Vectors operations 5. Addition 6. Subtraction 7. Scalar multiplication 8. Position of vectors 9. Modulus of a vector 10. Resolution of a vector | * Observation * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply trigonometry | 1. Pythagoras theorem 2. Trigonometric ratios 3. Trigonometry identities 4. Trigonometric equations 5. sine and cosine rule 6. Angles of elevation and depression 7. Compound angle formula 8. Double angle formula 9. Sine and cosine waves | * Observation * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply Calculus | 1. Differential Calculus 2. Functional notation 3. Standard differentiation 4. Differential equations 5. Methods of differentiation 6. Differentiation by first principle 7. Product rule 8. Quotient rule 9. Chain rule 10. Derivatives of higher order functions 11. Applications of differentiation 12. Normal and tangents 13. Stationary points 14. Maxima 15. Minima 16. Point of inflection 17. Rates of change 18. Small changes 19. Differentiation of inverse trigonometric functions 20. Integral calculus 21. Integral notation 22. Standard integration 23. Constant of integration 24. Definite and indefinite integration 25. Methods of integration 26. Algebraic substitution 27. Integration by parts 28. Integration of logarithmic functions | * Observation * Third party report * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply sequences and series | 1. Arithmetic sequence 2. arithmetic mean 3. nth term of arithmetic sequence 4. Sum of terms of arithmetic series (Arithmetic progression) 5. Geometric sequence 6. Finite geometric sequence 7. Geometric means and nth terms of a geometric sequence 8. Sum of finite and infinite geometric sequence | * Observation * Third party report * Written tests * Oral questioning * Portfolio of evidence * Interviews |
| 1. Apply statistics methods | 1. Collection of raw data 2. Ungrouped data 3. Grouped data 4. Data presentation 5. Pictograms 6. Histograms 7. Pie charts 8. Bar charts 9. Frequency polygon 10. Processing of raw data 11. Measures of central tendency 12. Mean 13. Mode 14. Median 15. Measures of dispersion 16. Range 17. Quartile 18. Variance 19. Standard deviation 20. Interpretation of processed data | * Observation * Third party report * Written tests * Oral questioning * Portfolio of evidence * Interviews |

**Suggested Delivery Methods**

* Projects
* Practical
* demonstration
* group discussion
* Direct Instruction

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  |  |  |  |  |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For training | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Tools and Equipment** | | | |
|  | Computer | For trainer’s use | 1 | 1:25 |
|  | Scientific calculator | For trainee’s use | 25 | 1:1 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | SMP Mathematical table | For trainee’s use | 25 | 1:1 |
|  | White board ruler | For trainer’s use | 1 | 1:25 |
|  | White board compass | For trainer’s use | 1 | 1:25 |
|  | White board protractor | For trainer’s use | 1 | 1:25 |
|  | Geometrical set | For trainee’s use | 25 | 1:1 |
|  | Graph book | For trainee’s use | 25 | 1:1 |

## **ORGANIC CHEMISTRY PRINCIPLES**

**UNIT CODE:** 0531 551 04A

**UNIT DURATION:**  150 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Organic Chemistry Principles.**

**Unit Description**

This unit covers the competencies required in applying organic chemistry principles. It involves performing hydrocarbon tests, alkyl halide tests, alkanols tests, carboxylic acid tests, carbonyl compound tests, and amine tests preparing heterocyclic compounds and conducting aromatic compound tests.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Perform hydrocarbons tests | **15** |
|  | Perform alkyl halides tests | **15** |
|  | Perform alkanols tests | **15** |
|  | Perform carboxylic tests | **15** |
|  | Perform carbonyl compound tests | **15** |
|  | Perform amine tests | **10** |
|  | Prepare heterocyclic compounds | **20** |
|  | Conduct aromatic compound tests | **30** |
|  | Carry out polymerization reactions | **15** |
| **Total** | | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform hydrocarbon tests | 1. Classification of hydrocarbons 2. Alkanes 3. Alkenes 4. Alkynes 5. Preparation of hydrocarbons 6. Test of hydrocarbons 7. Baeyer`s test 8. Bromine test 9. Flame test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform alkyl halide tests | 1. Types of alkyl halides 2. Primary alkyl halides 3. Secondary alkyl halides 4. Tertiary alkyl halides 5. Preparation of alkyl halides 6. Chemical and physical properties of alkyl halides 7. Reactions and reaction mechanism of alkyl halides 8. Nucleophilic substitution reactions 9. Elimination reactions | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform alkanols Tests | 1. Classification of alkanol 2. Primary alkanols 3. Secondary alkanols 4. Tertiary alkanols 5. Preparation of alcohols 6. Test for alkanols 7. Luca’s test 8. Acidified KMnO4 test 9. Silver nitrate test 10. Chromic acid test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform carboxylic acid tests | 1. Classification of carboxylic acids 2. Methanoic acid 3. Ethanoic acid 4. Propanoic acid 5. Butanoic acid 6. Pentanoic acid 7. Preparation of carboxylic acids 8. Test for carboxylic acids 9. Hydrolysis of acid derivatives 10. Alcoholysis 11. Aminolysis 12. Hydroxamic acid test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform carbonyl compound tests | 1. Classification of carbonyl compound 2. Aldehydes 3. Ketones 4. Preparation of carbonyl compound 5. Test for carbonyl compound 6. Tollen`s test 7. Fehling`s test 8. Benedict`s test 9. Isomers of carbonyl compound | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform amine tests | 1. Classification of amine groups. 2. Primary amines 3. Secondary amines 4. Tertiary amines 5. Preparation of amine groups 6. Chemical reactions of amine 7. Preparation of amines 8. Classification of amine derivatives. 9. Amides 10. Amino acids 11. Aniline 12. Trimethylamine | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Prepare heterocyclic compounds | 1. Classification of heterocyclic compounds. 2. Pyridine 3. Pyrroles 4. Indoles 5. Triazole 6. Furan 7. Thiophenes 8. Draw structures of heterocyclic compounds 9. Preparation of heterocyclic compounds 10. Substitution reaction for heterocyclic compounds | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Conduct aromatic compound tests | 1. Classification of aromatic compounds. 2. Benzene 3. Phenol 4. Toluene 5. Naphthalene 6. Draw structures of aromatic compounds. 7. Preparation of aromatic compounds. 8. Test for aromatic compounds. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out Polymerization reactions | 1. Identification of polymers 2. Natural Polymers 3. Synthetic polymers 4. Condensation polymer 5. Addition polymers 6. Conversion of monomers to polymers. 7. Condensation polymerization 8. Nylon 6 9. Nylon 6’6 10. Bakelite 11. Addition polymerization. 12. Free radical Polymerization     1. Chain Initiation     2. Chain Propagation     3. Chain Termination 13. Cationic and Anionic polymerization 14. Identify monomers and polymers. 15. Substitution reaction. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals reagent [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Calibration standards | For trainer and trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Gas chromatography | For trainee use | 1 | 1:25 |
|  | Atomic force microscopy | For trainee use | 6 | 1:4 |
|  | Diode array UV-visible spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | High performance liquid chromatography | For trainer and trainee use | 1 | 1:25 |
|  | Mass spectroscopy | For trainer and trainee use | 1 | 1:25 |
|  | Infrared spectrophotometer | For trainer and trainee use | 1 | 1:25 |

## **BIOCHEMICAL TECHNIQUES**

**UNIT CODE:** 0531 551 05A

**Duration of Unit:** 180 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: apply biochemical techniques. It involves performing biochemical tests, separation and qualitative analysis of bio-molecules, and preparation of buffer. It also involves performing biochemical analyses of biomolecules.

**Unit Description**

This unit specifies the competencies required to apply biochemical techniques.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Perform biochemical tests | **50** |
|  | Separate biomolecules | **50** |
|  | Prepare buffer solutions | **30** |
|  | Perform biochemical analyses of biomolecules | **60** |
| **Total** | | **180** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform biochemical tests | 1. Collect biochemical samples    * 1. Lipids      2. Proteins      3. Carbohydrates      4. Enzymes      5. Vitamins 2. Prepare reagents   1.2.1 Buffer solutions  1.2.2 Solvents   1. Prepare biochemical samples 2. Presence absence test    * 1. Benedicts solution test      2. Burette test      3. Millon test      4. Ninhydrin test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Separate biomolecules | 1. Collect biochemical samples 2. Prepare biochemical reagents 3. Isolate biomolecules 4. Purify biomolecules | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Prepare buffer solution | 1. select buffer components 2. calculate buffer components 3. prepare buffer stock solutions 4. adjust pH of buffer solutions 5. label buffer solutions 6. store buffer solutions | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform biochemical analyses of biomolecules | 1. Collect biomolecules samples 2. Prepare biochemical reagents 3. Prepare biomolecules samples 4. Calibrate instruments 5. Documents results | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Delivery:**

1. Direct instruction
2. Field trips/site visits
3. Group discussions
4. Demonstration by trainer
5. Practice by the trainee
6. Exercises

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Computer | For trainer’s use | 1 | 1:25 |
|  | * White board markers/chalks | For trainer’s use | 1 | 1:25 |
|  | White/chalk board | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  |  |  |  |  |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture room | For trainees use | 1 | 1:25 |
|  | Fully equipped science laboratory | For trainees use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Hands Gloves | For trainees use | 25 | 1:1 |
|  | Face masks | For trainees use | 25 | 1:1 |
|  | Food tests reagents | For trainees use | 25 | 1:1 |
|  | Volumetric flasks | For trainees use | 25 | 1:1 |
|  | Protein samples | For trainees use | 25 | 1:1 |
|  | Carbohydrate samples | For trainees use | 25 | 1:1 |
|  | Lipid sample | For trainees use | 25 | 1:1 |
|  |  |  |  |  |
|  |  |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | Water baths | For trainees use | 1 | 1:25 |
|  | Calorimeter | For trainees use | 1 | 1:25 |
|  | Ovens | For trainees use | 1 | 1:25 |
|  | Gel electrophoresis equipment | For trainees use | 1 | 1:25 |
|  | Centrifuge | For trainees use | 1 | 1:25 |
|  | Bunsen burner | For trainees use | 1 | 1:25 |

# MODULE III

# UNITS OF LEARNING

## **MODULE III**

This module consists of competencies that a person requires to enable him/her to effectively apply communication skills, inorganic chemistry principles to perform classical analysis techniques. This module consists of the following units of learning:

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **LEARNING OUTCOME** | **DURATION (HOURS)** |
| 0031 541 06A | COMMUNICATION SKILLS | Apply communication channels | **10** |
| Apply written communication skills | **12** |
| Apply non-verbal communication skills | **4** |
| Apply oral communication skills | **4** |
| Apply group communication skills | **10** |
| 0531 551 07A | INORGANIC CHEMISTRY | Draw Chemical bonds | **15** |
| Classify S-block elements | **35** |
| Classify P-block elements | **40** |
| Classify D-block elements | **35** |
| Apply Nuclear chemistry principles | **25** |
| 0531 551 08A | CLASSICAL ANALYSIS TECHNIQUES | Standardize reagents | **70** |
| Carry out volumetric analysis | **60** |
| Carry out proximate analysis | **30** |
| Carry out gravimetric analysis | **50** |
| **TOTAL** | **400** |

## **COMMUNICATION SKILLS**

**UNIT CODE:** 0031 541 06A

**UNIT DURATION:** 40 hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Communication Skills

**Unit Description**

This unit covers the competencies required to apply communication skills. It involves applying communication channels, written, non-verbal, oral, and group communication skills.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply communication channels | **10** |
|  | Apply written communication skills | **12** |
|  | Apply non-verbal communication skills | **4** |
|  | Apply oral communication skills | **4** |
|  | Apply group communication skills | **10** |
| **Total** | | **40** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply communication channels | * 1. Communication process      1. Principles of effective communication   2. Channels/medium/modes of communication      1. Factors to consider when selecting a channel of communication      2. Barriers to effective communication   3. Flow/patterns of communication      1. Sources of information      2. Organizational policies | * Observation * Portfolio of Evidence * Practical assessment * Oral questions * Written assessment |
| 1. Apply written communication skills | * 1. Types of written communication   2. Written communication needs   3. Organization requirements for written communication | * Observation * Portfolio of Evidence * Practical assessment * Oral assessment * Written assessment |
| 1. Apply non-verbal communication skills | * 1. Utilization of body language and gestures   2. Identification of body posture   3. Identification of workplace dressing code | * Observation * Portfolio of Evidence * Practical assessment * Oral assessment   Written assessment |
| 1. Apply oral communication skills | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Oral communication pathways   4. Review oral communication pathway   5. Maintain oral communication pathway   6. Workplace etiquette | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment |
| 1. Apply group discussion skills | * 1. Group communication strategies      1. Language switch      2. Comprehension check      3. Repetition      4. Asking confirmation      5. Paraphrasing      6. Clarification request      7. Translation      8. Restructuring      9. Generalization   2. Establishment of rapport   3. Facilitation of resolution of issues   4. Develop action plans   5. Group organization techniques   6. Use of questing listening and non-verbal techniques   7. Turn-taking techniques   8. Conflict resolution techniques   9. Team-work   10. Group communication challenges | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment |

**Suggested Methods of Instruction**

* Discussion
* Roleplaying
* Simulation
* Direct instruction
* Demonstration
* Field trips

**Recommended Resources for 25 Trainees**

|  |  |  |
| --- | --- | --- |
| **General Resources** | **Tools and Equipment** | **Materials and Supplies** |
| * 25 Desktop computers/laptops | Mobile phones | Flashcards |
| * Internet connection |  | Flip charts |
| * 1 Projector * 1 Printer |  | 2 packets of assorted colors of whiteboard marker pens |
| * 1 Whiteboard |  | Printing papers |
| * Report writing templates |  |  |

## **INORGANIC CHEMISTRY PRINCIPLES**

**UNIT CODE:** 0531 551 07A

**UNIT DURATION:**  150 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Inorganic Chemistry Principles.**

**Unit Description**

This unit covers the competencies required in applying inorganic chemistry principles. It involves drawing chemical bonds, classifying s block. p block, d Block elements and applying nuclear chemistry principles.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Draw Chemical bonds | **15** |
|  | Classify S-block elements | **35** |
|  | Classify P-block elements | **40** |
|  | Classify D-block elements | **35** |
|  | Apply Nuclear chemistry principles | **25** |
| **Total** | | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Draw chemical bonds | 1. Atomic structure 2. Discovery of Atoms experiments 3. Discovery of electron experiments 4. Discovery of Neutron experiments 5. s,p,d,f notation of Atoms 6. Electronic configuration 7. Chemical bonds 8. Covalent 9. Ionic 10. Dative 11. Hydrogen 12. Intermolecular forces 13. Dipole-dipole attractions 14. Relative atomic mass 15. Hybridization 16. Sp1 hybridization 17. sp2 hybridization 18. sp3 hybridization 19. sp3d hybridization 20. sp3d2 hybridization | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Classify S block elements | 1. History of periodic table 2. Dobereiners Triads 3. John Newlands Law of Octaves 4. Lother Meyers Concept 5. Mendeleevs Law of the Periodic table 6. Modern Law of the Periodic Table 7. Group elements 8. Determine valence electrons 9. Electronic configuration 10. Elements classification 11. Arrange elements on periodic table 12. Chemistry of s block elements 13. Chemical and physical properties 14. Physical properties 15. Anomalous behavior 16. Melting and boiling points 17. Valence 18. Ionization energy 19. Atomic radius 20. Metal character 21. Chemical properties 22. Solubility | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Classify p block elements | 1. Group P block elements group 2. P block valence electrons 3. Electronic configuration 4. Classification of Elements 5. Arrangement of Elements 6. Chemistry of group elements 7. Chemical and physical properties 8. Physical properties 9. Anomalous behaviour 10. Melting and boiling points 11. Valence 12. Ionization energy 13. Atomic radius 14. Metal character 15. Chemical properties 16. Solubility | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Classify D block elements | 1. d block elements groupings 2. Gold 3. Copper 4. Lead 5. Chromium 6. Iron 7. D block valence electrons 8. Electronic configuration 9. Element classification 10. Elements are arranged 11. Chemistry of group elements 12. Chemical and physical properties 13. Physical properties 14. Anomalous behaviour 15. Melting and boiling points 16. Valence 17. Ionization energy 18. Atomic radius 19. character 20. Chemical properties 21. Solubility 22. Extraction of D-block elements | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply nuclear chemistry principles. | 1. Nuclear reactions 2. Nuclear fission 3. Nuclear fusion 4. Radioactive decay 5. Neutron capture 6. Selection of reactive materials, target and reaction conditions 7. Nuclear radiation 8. Alpha 9. Beta 10. Gamma     1. Radioactive decay of radioisotopes | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Calibration standards | For trainer and trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | X-ray fluorescence spectrometers | For trainee use | 1 | 1:25 |
|  | Alpha-beta counters | For trainee use | 6 | 1:4 |
|  | Alpha spectrometers | For trainer and trainee use |  |  |
|  | Beta spectrometers | For trainer and trainee use |  |  |
|  | Colorimetric | For trainer and trainee use | 1 | 1:25 |
|  | Ultraviolet -Visible spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Fourier Transform-Infrared spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Atomic Absorption spectrophotometer | For trainer and trainee use | 1 | 1:25 |

## **CLASSICAL ANALYSIS TECHNIQUES**

**UNIT CODE:** 0531 551 08A

**UNIT DURATION:**  210 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Classical Analysis Techniques**

**Unit Description**

This unit covers the competencies required in performing classical analysis techniques. It involves standardizing reagents, carrying-out volumetric analysis, gravimetric analysis and proximate analysis.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Standardize reagents | **70** |
|  | Carry out volumetric analysis | **60** |
|  | Carry out proximate analysis | **30** |
|  | Carry out gravimetric analysis | **50** |
| **Total** | | **210** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Standardize reagents | 1. Assemble laboratory apparatus 2. Select laboratory reagents 3. Calculate reagents concentration 4. Measure reagents accurately 5. Prepare reagent solutions 6. Label reagent solution | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out volumetric analysis | 1. Assemble volumetric analysis apparatus 2. Standard solutions 3. Buffer solutions 4. Working standards. 5. Stock solutions 6. Perform different types of titrations 7. Acid base 8. Redox 9. Complexometric 10. Precipitation 11. Determine unknown concentration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out gravimetric analysis   . | 1. Assemble gravimetric analysis apparatus 2. Gravimetric process 3. Sample weighing 4. Precipitation 5. Filtration 6. Washing 7. Drying and ignition 8. Types of precipitates 9. Crystalline 10. colloidal 11. Solubility constant and product 12. Gravimetric calculations | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out proximate analysis | 1. Set up apparatus and equipment 2. Collect biological samples    * 1. Carbohydrates      2. Lipids      3. Proteins 3. Prepare samples 4. Select required reagents 5. Test samples 6. Write test reports | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Water bath | For trainee use | 3 | 1:8 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | Proximate analysis apparatus [Soxhlet extractor, Khjedal apparatus, crucible, desiccators.] | For trainee use | 5 | 1:5 |
|  | Titration apparatus [ burette, pipette, lamp and stand, conical flasks, white tile] | For trainee use | 25 | 1:1 |
|  | Sample storage apparatus | For trainee use | 25 | 1:1 |
|  | Magnetic stirrers | For trainee use | 5 | 1:5 |
|  | Atomic absorption spectroscopy | For trainers and trainee use | 1 | 1:25 |

# MODULE IV

# UNITS OF LEARNING

## **MODULE IV**

This module consists of competencies that a person requires to enable him/her to effectively apply digital literacy skills and physics principles to perform and instrumental analysis. This module consists of the following units of learning:

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **LEARNING OUTCOME** | **DURATION (HOURS)** |
| 0611 541 09A | DIGITAL LITERACY | Operate computer devices | **6** |
| Solve tasks using Office suite | **14** |
| Manage data and information | **6** |
| Perform online communication and collaboration | **4** |
| Apply cyber security skills | **4** |
| Perform online jobs | **4** |
| Apply job entry techniques | **2** |
| 0531 551 10A | PHYSICS PRINCIPLES | Apply dynamics | **20** |
| Apply principles of thermodynamics | **20** |
| Apply principles of optics | **15** |
| Apply friction principles | **14** |
| Apply pressure principles | **15** |
| Apply principles of electromagnetism | **20** |
| Apply electrostatic and electrical principles | **15** |
| Apply semiconductor device principles | **15** |
| Apply principles of nuclear physics | **16** |
| 0531 551 11A | INSTRUMENTAL ANALYSIS | To perform colorimetric analysis | **35** |
| To perform UV-VIS analysis | **35** |
| To perform FT-IR analysis | **35** |
| To conduct AES analysis | **25** |
| To perform AAS analysis | **50** |
| To perform conductometric analysis | **30** |
| **SUB TOTAL** | **400** |

## **DIGITAL LITERACY**

**UNIT CODE:** 0611 541 09A

**UNIT DURATION:** 40 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Digital Literacy**

**Unit Description**

This unit covers the competencies required to demonstrate digital literacy. It involves operating computer devices, solving tasks using the Office suite, managing data and information, performing online communication and collaboration, applying cybersecurity skills, and performing jobs online.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Operate computer devices | **6** |
|  | Solve tasks using Office suite | **14** |
|  | Manage data and information | **6** |
|  | Perform online communication and collaboration | **4** |
|  | Apply cyber security skills | **4** |
|  | Perform online jobs | **4** |
|  | Apply job entry techniques | **2** |
| **Total** | | **40** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Operate computer devices | * 1. Meaning and importance of digital literacy   2. Functions and Uses of Computers   3. Classification of computers   4. Components of a computer system   5. Computer devices      1. Desktops      2. Laptops      3. Smartphones      4. Tablets      5. Smartwatches   6. Computer Hardware   1.7.1 The System Unit E.g. Motherboard, CPU, casing  1.7.2 Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices.  1.7.3 Output Devices e.g. hardcopy output and softcopy output  1.7.4 Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives  1.7.5 Computer Ports e.g. HDMI, DVI, VGA, USB type C etc.  1.8 Classification of computer software  1.8.1 System software e.g. Operating System (Windows, Macintosh, Linux, Android, iOS)  1.8.2 Application Software e.g. Word Processors, Spreadsheets, Presentations etc.  1.8.3 Utility Software e.g. Antivirus programs  1.9 Operating system functions  1.9.1 Procedure for turning/off a computer  1.10 Mouse use techniques  1.10.1 Clicking  1.10.2 Double-clicking  1.10.3 Right-clicking  1.10.4 Drag and drop  1.11 Keyboard Parts and Use Techniques  1.12 Desktop Customization  1.13 File and Files Management using an operating system  1.14 Computer Internet Connection Options   * + 1. Mobile Networks/Data Plans     2. Wireless Hotspots     3. Cabled (Ethernet/Fiber)     4. Dial-Up     5. Satellite     6. ISDN (Integrated Services Digital Network)   1.15 Computer external devices management   1. Printers 2. Projectors 3. Smart Boards 4. Speakers 5. External storage drives 6. Digital/Smart TVs | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Solve tasks using Office suite | 1. Meaning and Importance of Word Processing 2. Examples of Word Processors 3. Working with word documents 4. Open and close word processor 5. Create a new document 6. Save a document 7. Switch between open documents 8. Enhancing productivity 9. Set basic options/preference 10. Help resources 11. Use magnification/zoom tools 12. Display, hide built-in tool bar 13. Using navigation tools 14. Typing Text 15. Document editing (copy, cut, paste commands, spelling and Grammar check) 16. Document formatting 17. Formatting text 18. Formatting paragraph 19. Formatting styles 20. Alignment 21. Creating tables 22. Formatting tables 23. Graphical objects 24. Insert object (picture, drawn object) 25. Select an object 26. Edit an object 27. Format an object 28. Saving word document     * 1. save       2. Save as 29. Document Print setup   2.9.1 Page layout,  2.9.2 Margins set up  2.9.3 Orientation.   1. Word Document Printing   **Work sheet**   1. Meaning & Importance of electronic spreadsheets 2. Components of Spreadsheets 3. Application areas of spreadsheets 4. Using spreadsheet application 5. Parts of Excel screen: ribbon, formula bar, active cell, name box, column letter, row number, Quick Access Toolbar. 6. Cell Data Types 7. Block operations 8. Arithmetic operators (formula bar (-, +, 9. Cell Referencing 10. Data Manipulation 11. Using Functions (Sum, Average, SumIF, Count, Max, Max, IF, Rank, Product, mode etc) 12. Using Formulae 13. Sorting data 14. Filtering data 15. Visual representation using charts 16. Worksheet printing     1. Electronic Presentations     2. Meaning and Importance of electronic presentations     3. Examples of Presentation Software     4. Using the electronic presentation application 17. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars). 18. Open and close presentations 19. Creating Slides (Insert new slides, duplicate, or reuse slides.) 20. Text Management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check). 21. Use magnification/zoom tools 22. Apply or change a theme. 23. Save a presentation 24. Switch between open presentations     1. Developing a presentation 25. Presentation views 26. Slides 27. Master slide     1. Text 28. Editing text 29. Formatting 30. Tables     1. Charts 31. Using charts 32. Organization charts     1. Graphical objects 33. Insert, manipulate 34. Drawings     1. Prepare outputs 35. Applying slide effects and transitions     1. Check and deliver 36. Spell check a presentation 37. Slide orientation 38. Slide shows, navigation   2.26 Print presentations (slides and handouts) | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Manage Data and Information | 1. Meaning of Data and information 2. Importance and Uses of data and information 3. Types of internet services    1. Communication Services    2. Information Retrieval Services    3. File Transfer    4. World Wide Web Services    5. Web Services    6. Automatic Network Address Configuration    7. News Group    8. Ecommerce    9. Types of Internet Access Applications       1. Browsers       2. Email Apps       3. e-commerce Apps   **internet search**   * 1. Web browsing concepts   2. Key concepts   3. Security and safety   4. Web browsing   5. Using the web browser   6. Tools and settings   7. Clearing Cache and cookies   8. URIs   9. Bookmarks   10. Web outputs   11. Web based information   12. Search   13. Critical evaluation of information   14. Copyright, data protection   15. Downloads Management   16. Performing Digital Data Backup (Online and Offline)   17. Emerging issues in internet | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform online communication and collaboration | * Netiquette principles * Communication concepts   1. Online communities   2. Communication tools   3. Email concepts * Using email   1. Sending email   2. Receiving email   3. Tools and settings   4. Organizing email * Digital content copyright and licenses * Online collaboration tools   1. Online Storage (Google Drive)   2. Online productivity applications (Google Docs & Forms)   3. Online meetings (Google Meet/Zoom)   4. Online learning environments   5. Online calendars (Google Calendars)   6. Social networks (Facebook/Twitter - Settings & Privacy) * Preparation for online collaboration   1. Common setup features   2. Setup * Mobile collaboration   1. Key concepts   2. Using mobile devices   3. Applications   Synchronization | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply cybersecurity skills | 1. Data protection and privacy    1. Confidentiality of data/information    2. Integrity of data/information    3. Availability of data/information    4. Internet security threats    5. Malware attacks    6. Social engineering attacks    7. Distributed denial of service (DDoS)    8. Man-in-the-middle attack (MitM)    9. Password attacks    10. IoT Attacks    11. [Phishing Attacks](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#phishing-attacks)    12. [Ransomware](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#ransomware)    13. Computer threats and crimes    14. Cybersecurity control measures 2. Physical Controls 3. Technical/Logical Controls (Passwords, PINs, Biometrics) 4. Operational Controls    1. Laws governing protection of ICT in Kenya 5. The Computer Misuse and Cybercrimes Act No. 5 of 2018 6. The Data Protection Act No. 24 Of 2019 | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform Online Jobs | 1. Introduction to online working 2. Types of online Jobs 3. Online job platforms    1. Remotask    2. Data annotation tech    3. Cloud worker    4. Upwork    5. Oneforma    6. Appen 4. Online account and profile management 5. Identifying online jobs/job bidding 6. Online digital identity 7. Executing online tasks 8. Management of online payment accounts. | * + Observation   + Oral assessment   + Portfolio of evidence   + Third party report   + Written assessment |
| 1. Apply job entry techniques | * Types of job opportunities  1. Self-employment 2. Service provision 3. product development 4. salaried employment  * Sources of job opportunities * Resume/ curriculum vitae  1. What is a CV 2. How long should a CV be 3. What to include in a CV 4. Format of CV 5. How to write a good CV 6. Don’ts of writing a CV    1. Job application letter 7. What to include 8. Addressing a cover letter 9. Signing off a cover letter    1. Portfolio of Evidence 10. Academic credentials 11. Letters of commendations 12. Certification of participations 13. Awards and decorations     1. Interview skills 14. Listening skills 15. Grooming 16. Language command 17. Articulation of issues 18. Body language 19. Time management 20. Honesty     1. Generally knowledgeable in current affairs and technical area | * + Observation   + Oral assessment   + Portfolio of evidence   + Written assessment |

**Suggested Methods Instruction**

* + Instructor-led facilitation using active learning strategies
  + Demonstration
  + Practical work by trainees
  + Viewing of related videos
  + Group discussions
  + Project
  + Role play
  + Case study

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| A | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Report writing templates | Trainees | 5 | 1:5 |
| B | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For Trainer/trainee’s use | 1 | 1:25 |
|  | Computers with OS | Trainees | 25 | 1:1 |
|  | Internet connection | Trainees and Trainers | 1 connection | 1:25 |
|  |  |  |  |  |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
| C | **Consumable materials** | | | |
|  | Printing papers | For trainer and trainee use | Varies | Varies |
|  | Assorted whiteboard markers | For trainer’s use | Varies | Varies |
| D | **Tools and Equipment** | | | |
|  | Printers | For trainer’s use | 2 | 1:12 |
|  | Mobile phones | For trainer’s use | 25 | 1;1 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | External storage media | For trainer and trainee use | Varies | 1:1 or 1:5 depending on need |

## **PHYSICS PRINCIPLES**

**UNIT CODE :** 0533 551 10A

**UNIT DURATION:**  150 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency**: Apply physics principles**

**Unit Description**

This unit specifies the competencies required to apply physics principles. It involves applying: dynamics principles; principles of thermodynamics; principles of optics; friction principles; work, energy and power principles; pressure principles; principles of electromagnetism; electrostatic and electrical principles; semiconductor device principles and principles of nuclear physics.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply dynamics | **20** |
|  | Apply principles of thermodynamics | **20** |
|  | Apply principles of optics | **15** |
|  | Apply friction principles | **14** |
|  | Apply pressure principles | **15** |
|  | Apply principles of electromagnetism | **20** |
|  | Apply electrostatic and electrical principles | **15** |
|  | Apply semiconductor device principles | **15** |
|  | Apply principles of nuclear physics | **16** |
| **Total** | | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply dynamics principles | 1. Static forces 2. Velocity, speed and acceleration 3. Laws of motion 4. Law of inertia 5. Law of momentum 6. Law of interaction 7. Motion graphs 8. Newton’s laws of motion 9. Equations of linear and circular motion 10. Demonstration of Uniform circular motion 11. Angular displacement, angular velocity, angular acceleration and centripetal force 12. Applications of uniform circular motion | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply principles of thermodynamics | 1. Heat energy 2. Heat capacity 3. Specific heat capacity 4. Latent heat 5. Latent heat of fusion 6. Latent heat of vaporization 7. Latent heat of sublimation 8. Determination of Specific heat capacity 9. Determination of specific Latent heats of fusion, vaporization and sublimation. 10. Thermodynamic processes 11. Adiabatic changes 12. Isothermal processes 13. Isobaric changes 14. Isochoric changes 15. Thermodynamic quantities 16. Pressure 17. Volume 18. Temperature | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply principles of optics | 1. Propagation of light 2. Light properties    * 1. Reflection      2. Total internal reflection      3. Refraction 3. Laws of reflection. 4. Total internal reflection 5. Image formation by curved mirrors 6. Focal lengths, object distances, image distances and magnification calculation using mirror formula. 7. Image formation by lenses 8. Laws of refraction. 9. Focal lengths, object distances, image distances and magnification calculation using lens formula 1/f= 1/u+ 1/vc 10. Refractive index, critical angle and total internal reflection. 11. Optical instruments | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply friction principles | 1. Definition of friction 2. Source of friction 3. Laws of friction 4. Resultant forces 5. Coefficient of friction 6. Applications of friction 7. Methods of reducing friction | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply pressure principles | 1. Definition of pressure 2. Pressure in solids, liquids and gases 3. Transmission of pressure in liquids 4. Hydraulics 5. Measurements of pressure 6. Atmospheric pressure 7. Applications of pressure | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply principles of electromagnetism | 1. Types of magnets 2. Properties of Magnets    * 1. Lines of force      2. Magnetic flux patterns      3. Flux density 3. Lines of force 4. Magnetic flux patterns 5. Flux density 6. Properties of magnetic field lines 7. Magnetic field pattern 8. Electromagnetism 9. Quantities and units 10. Stationery Geld moving conductor 11. Fleming’s right led rule 12. Faradays and Lenz’s cork screw rule 13. Grip rule 14. Self-inductance 15. Mutual inductance 16. Induction due to current charge in another circuit 17. Storage of magnets 18. Applications of electromagnetism | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply electrostatic and electrical principles | 1. Types of charges 2. Electrostatic devices    * 1. Capacitor      2. Van de Graff generator      3. Electroscope 3. Factors affecting capacitance of parallel plate capacitors 4. Applications of capacitors 5. Mains Electricity sources 6. Electrical quantities 7. Electrical Circuits 8. Electrical measuring instruments 9. Ohm’s law 10. Electrical energy sources   7.10.1 Renewable sources  7.10.2 Non-renewable sources   1. Electromagnetic induction 2. self-induction 3. mutual induction | * Practical Assessment * Project-Based * Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply semiconductor device principles | 1. Energy band theory 2. Semi-conductor devices 3. diode 4. transistor 5. LED 6. Rectification 7. Half-wave 8. Full wave 9. Semi-conductor diode 10. Forward and backward biasing of semi-conductor diodes 11. Application of semi-conductor diodes -rectification 12. Types of transistors 13. Connection of transistors 14. Transistor characteristics 15. Uses of transistors | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply principles of nuclear physics | 1. Production of X-rays 2. Types of X-rays 3. Application of X-rays 4. Types of radioactivity 5. Elements of radioactivity 6. Thorium 7. Uranium 8. Carbon 14 9. Properties of radio-active materials 10. Types of radioactive radiations 11. Alpha particles 12. Beta particles 13. Gamma radiation 14. Background radiations 15. Half-lives of radioactive elements. 16. Uses of radioactivity 17. Hazards associated with radioactive material 18. Safety precautions on X-rays and radio-active elements. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Demonstration
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Field study

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Internet connection | Wi-Fi |  | 1:25 |
|  | Projector |  | 1 | 1:25 |
|  | Whiteboard | 4 x 8 ft | 1 | 1:25 |
|  | Assorted color of whiteboard markers | Red, blue and black | 3 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | standard Science laboratory |  | 1 |  |
| **C** | **Tools and Equipment** | | | |
|  | Vernier calipers | Half division | 25 | 1:1 |
|  | Micrometer screw gauge | Accuracy of 0.01mm | 25 | 1:1 |
|  | Tape measure | 5m | 25 | 1:1 |
|  | Pressure gauge | 20psi | 5 | 1:5 |
|  | Barometer | Mercury | 5 | 1:5 |
|  | Bunsen burner | 500g | 25 | 1:1 |
|  | Capacitors | paper | 25 | 1:1 |
|  | Meter rule | Wooden | 25 | 1:1 |
|  | Diodes | PnP | 25 | 1:1 |
|  | Transistors | 3 terminals | 25 | 1:1 |
|  | Electroscope | Gold leaf | 25 | 1:1 |
|  | Van de Graff generator |  | 2 | 2:25 |
|  | Mirror | Plain and curved | 25 | 1:1 |
|  | Lenses | Perspex | 25 | 1:1 |
|  | Glass block | Rectangular | 25 | 1:1 |
|  | Optical pins | 2 inches | 100 | 4:1 |
|  | Transformers | 12volts |  |  |
|  | thermometers | -100c to 1000c | 25 | 1:1 |
|  | stopwatches | Digital | 25 | 1:1 |
|  | weighing balances | 0 to 2kg | 5 | 1:5 |
|  | calorimeters | Copper | 25 | 1:1 |
|  | ammeters | 0 to 2A | 25 | 1:1 |
|  | voltmeters | 0 to 5A | 25 | 1:1 |
|  | Variable Resistors | 0 to 100 ohms | 25 | 1:1 |
|  | Connecting wires | Wires with crocodile clips | 200 | 8:1 |
|  | Dry cells | D size | 50 | 2:1 |
|  | Galvanometer | Zero centred | 25 | 1:1 |
|  | Magnets | Bar magnets | 25 | 1:1 |

## **INSTRUMENTAL ANALYSIS**

**UNIT CODE:** 0531 551 11A

**UNIT DURATION:**  210 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Instrumental Analysis.**

**Unit Description**

This unit covers the competencies required in performing instrumental analysis. It involves performing colorimetric analysis, UV-Vis analysis, FT-IR analysis, AES analysis, AAS analysis and conductometric analysis

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | To perform colorimetric analysis | **35** |
|  | To perform UV-VIS analysis | **35** |
|  | To perform FT-IR analysis | **35** |
|  | To conduct AES analysis | **25** |
|  | To perform AAS analysis | **50** |
|  | To perform conductometric analysis | **30** |
| **Total** | | **210** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. To perform colorimetric analysis | 1. Set up colorimetric instrument 2. Prepare standard solution    * 1. Buffer solutions      2. Working standards.      3. Stock solutions 3. Calibrate colorimeter 4. Prepare samples 5. Analyse samples and standards 6. Quantify analyte concentration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To perform UV-VIS | 1. Set up UV–VIS spectrometer 2. Prepare standard solution 3. Calibrate UV-VIS spectrometer 4. Prepare samples solutions 5. Measure absorbance of sample and standards 6. Quantify analyte concentration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To perform FT-IR analysis | 1. Set up FT-IR spectrometer 2. Prepare standard solution 3. Calibrate FT-IR spectrometer 4. Prepare samples 5. Measure molecular vibration 6. Stretching 7. Bending 8. Identify functional groups | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To conduct AES analysis | 1. Set up AES spectrometer 2. Prepare standard solution 3. Calibrate AES spectrometer 4. Prepare samples solutions 5. Measure emission of samples and standards 6. Quantify analyte concentration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To perform AAS analysis | 1. Set up AAS spectrometer 2. Prepare standard solution 3. Calibrate AAS spectrometer 4. Prepare samples solutions 5. Measure absorbance of samples and standards 6. Quantify analyte concentration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To perform conductometric analysis | 1. Set up Conductometer. 2. Prepare standard solution 3. Calibrate Conductometer 4. Prepare samples solutions 5. Prepare electrolytes. 6. Prepare buffers 7. Quantify analyte conductance | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
|  | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
|  | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Calibration standards | For trainer and trainee use | enough | 1:1 |
|  | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Water bath | For trainee use | 3 | 1:8 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | colorimetric | For trainer and trainee use | 1 | 1:25 |
|  | Ultraviolet -Visible spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Fourier Transform-Infrared spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Atomic Emission spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Atomic Absorption spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Conductometer | For trainer and trainee use | 1 | 1:25 |
|  | Sample storage apparatus | For trainee use | 25 | 1:1 |
|  | Magnetic stirrers | For trainee use | 5 | 1:5 |

**MODULE V**

**UNITS OF LEARNING**

**MODULE V**

This module consists of competencies that a learner requires to enable him/her to effectively apply work ethics skills and physical chemistry principles to perform industrial analyses. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **LEARNING OUTCOME** | **DURATION (HOURS)** |
| 0417 541 12A | WORK ETHICS AND PRACTICES | Apply self-management skills | **10** |
| Promote ethical work practices and values | **4** |
| Promote Team work | **10** |
| Maintain professional and personal development | **10** |
| Apply Problem solving skills | **4** |
| Promote Customer Care | **2** |
| 0531 551 13A | PHYSICAL CHEMISTRY | Apply ionic equilibrium | **20** |
| Apply chemical equilibrium | **20** |
| Apply reaction kinetics | **20** |
| Apply kinetic theory of gases | **20** |
| Apply electrochemistry principles | **25** |
| Apply thermodynamics principles | **20** |
| Apply thermochemistry principles | **25** |
| 0531 551 14A | INDUSTRIAL CHEMISTRY ANALYSES | To perform water and waste water | **35** |
| To perform soap and detergents | **30** |
| To perform agrochemicals | **30** |
| Perform petroleum analysis | **25** |
| Perform cement analysis | **25** |
| Perform sugar and allied analysis | **30** |
| Perform paper and allied analysis | **25** |
| **TOTAL** | **390 HRS** |

**WORK ETHICS AND PRACTICES**

**UNIT CODE:** 0417 541 12A

**UNIT DURATION:** 40 hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply work ethics and practices.**

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves the ability to: conduct self-management, promote ethical work practices and values, promote teamwork, manage workplace conflicts, maintain professional and personal development, apply problem-solving, and promote customer care.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply self-management skills | **10** |
|  | Promote ethical work practices and values | **4** |
|  | Promote Team work | **10** |
|  | Maintain professional and personal development | **10** |
|  | Apply Problem solving skills | **4** |
|  | Promote Customer Care | **2** |
| **Total** | | **40** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply Self-Management Skills | 1. Personal vision mission and goals    * 1. definition of terms      2. develop a personal vision, mission and goal 2. Formulating personal vision, mission, and goals 3. Healthy lifestyle practices 4. Strategies for overcoming work challenges 5. Emotional intelligence 6. Coping with Work Stress. 7. Assertiveness versus aggressiveness and passiveness 8. Developing and maintaining high self-esteem 9. Developing and maintaining positive self-image 10. Time management 11. Setting performance targets 12. Monitoring and evaluating performance targets | * Observation * Portfolio of evidence * Project * Practical * Written assessment * Oral assessment |
| 1. Promote Ethical Work Practices and Values | * 1. Integrity   2. Core Values, ethics and beliefs   3. Patriotism   4. Professionalism   5. Organizational codes of conduct   6. Industry policies and procedures | * Portfolio of evidence * Project * Practical * Observation * Written assessment * Oral assessment |
| 1. Promote Teamwork | * 1. Types of teams   2. Team building   3. Individual responsibilities in a team   4. Determination of team roles and objectives   5. Team parameters and relationships   6. Benefits of teamwork   3.7 Qualities of a team player  3.8 Leading a team  3.9 Team performance and evaluation  3.10 Conflicts and conflict resolution  3.11 Gender and diversity mainstreaming  3.12 Developing Healthy workplace relationships  3.13 Adaptability and flexibility  3.14 Coaching and mentoring skills | * Observation * Written assessment * Oral assessment * Portfolio of evidence * Project * Practical |
| 1. Maintain Professional and Personal Development | 1. Personal vs professional development and growth 2. Avenues for professional growth 3. Recognizing career advancement 4. Training and career opportunities 5. Assessing training needs 6. Mobilizing training resources 7. Licenses and certifications for professional growth and development 8. Pursuing personal and organizational goals 9. Managing work priorities and commitments 10. Dynamism and on-the-job learning | * Project * Practical * Observation * Written assessment * Oral assessment * Portfolio of evidence |
| 1. Apply Problem-Solving Skills | 1. Causes of problems 2. Methods of solving problems 3. Problem-solving process 4. Decision making 5. Creative thinking and critical thinking process in development of innovative and practical solutions | * Observation * Project * Portfolio of evidence * Practical * Written assessment * Oral assessment |
| 1. Promote Customer Care | 1. Identifying customer needs 2. Qualities of good customer service 3. Customer feedback methods 4. Resolving customer concerns 5. Customer outreach programs 6. Customer retention | * Observation * Project * Practical * Portfolio of evidence * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

* Practical
* Demonstrations
* Project
* Group discussion
* Direct instruction

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | PowerPoint presentations | For trainer’s use |  |  |
|  | Case studies |  | 5 | 1:5 |
|  | Business plan templates |  | 5 | 1:5 |
|  | Newspapers and Handouts |  | 5 | 1:5 |
|  | Business Journals |  | 5 | 1:5 |
|  | Video clips | Assorted | 5 sets | 3:5 |
|  | Audio tapes | Assorted | 5 sets | 3:5 |
|  | Whiteboard |  | 1 | 1:25 |
|  | Rolls flip charts |  | 1 | 1:25 |
|  | Assorted color of whiteboard markers | For trainers Use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Printing papers |  | enough | - |
|  | Stationery |  | 25 pcs | 1:1 |
|  | Printing ink cartilages | assorted | - | - |
|  | Internet |  | 200mbps | - |
| **D** | **Tools and Equipment** |  |  |  |
|  | Computers | For trainer’s use |  |  |
|  | Printer | For trainer’s use |  |  |
|  | LCD Overhead projector | For trainer’s use |  |  |

## **PHYSICAL CHEMISTRY PRINCIPLES**

**UNIT CODE:** 0531 551 13A

**UNIT DURATION:**  150 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Physical Chemistry Principles**.

**Unit Description**

This unit covers the competencies required in applying physical chemistry principles. It involves ionic equilibrium, chemical equilibrium, kinetic theory of gases, electrochemistry principles, and thermodynamics principles and thermochemistry principles.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply ionic equilibrium | **20** |
|  | Apply chemical equilibrium | **20** |
|  | Apply reaction kinetics | **20** |
|  | Apply kinetic theory of gases | **20** |
|  | Apply electrochemistry principles | **25** |
|  | Apply thermodynamics principles | **20** |
|  | Apply thermochemistry principles | **25** |
| **Total** | | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply ionic equilibrium | 1. Hydrolysis constant 2. Precipitation of sparingly soluble salts 3. Salt hydrolysis 4. Ionization constant | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + - 1. Apply chemical equilibrium | 1. Equilibrium constant 2. Le Chateliers principles 3. Law of mass action. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + - 1. Apply reaction kinetics | 1. Order of reactions 2. Zero order 3. First order 4. Second order 5. Rate of reactions 6. Half-life of a chemical reaction 7. Activation energy | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + - 1. Apply kinetic theory of gases | 1. Kinetic energy equation 2. Charles law 3. Boyles law 4. Grahams law 5. Avogadro’s law 6. Ideal gas law 7. Van der Waals equations. 8. Heat capacities 9. Molar heat capacity 10. Latent heat capacity | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + - 1. Apply electrochemistry principles. | 1. Kohlrausch’s law 2. Molar conductivity 3. Strong electrolytes 4. Weak electrolytes 5. Infinite dilutions 6. Electromotive force 7. Standard electrodes 8. Electrochemical cells 9. Salt bridge 10. Faradays law 11. Faradays first law 12. Faradays second law 13. Polarograms 14. Half wave potential 15. Decomposition voltage 16. Back emf 17. Dropping mercury electrode 18. Nernst equation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + - 1. Apply thermodynamics principles. | 1. First law of thermodynamics 2. Second law of thermodynamics 3. Entropy change 4. Gibbs free energy | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * + - 1. Apply thermochemistry principles. | 1. Hess’s law 2. Enthalpy changes 3. Enthalpy of combustion 4. Enthalpy of solutions 5. Enthalpy of neutralization 6. Bond energies 7. Bond dissociation 8. Bond formation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | 25 | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Assorted electrodes | For trainee use | enough | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Electrochemical cells | For trainer and trainee use | 5 | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | Conductivity meters | For trainee use | 4 | 1:6 |
|  | Potentiostats | For trainee use | 5 | 1:5 |
|  | Mult-parameter meters | For trainee use | 5 | 1:5 |
|  | Dissolved oxygen meters | For trainee use | 5 | 1:5 |
|  | Stopped-flow analyzers | For trainee use | 5 | 1:5 |
|  | UV-Vis spectrophotometer | For trainee use | 1 | 1:25 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | Calorimeters | For trainer and trainee use | 1 | 1:25 |
|  | Thermo-chemical elemental analyzers | For trainer and trainee use | 1 | 1:25 |
|  | Conductometer | For trainer and trainee use | 5 | 1:5 |
|  | Sample storage apparatus | For trainee use | 25 | 1:1 |

## **INDUSTRIAL CHEMISTRY ANALYSIS**

**UNIT CODE:** 0531 551 14A

**UNIT DURATION:**  200 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Industrial Chemistry Analysis.**

**Unit Description**

This unit covers the competencies required in performing industrial chemistry. It involves performing water and waste water analysis, carrying out soap and detergents analysis, performing agrochemical analysis, petroleum analysis, cement analysis, sugar and allied analysis and pulp analysis.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | To perform water and waste water | **35** |
|  | To perform soap and detergents | **30** |
|  | To perform agrochemicals | **30** |
|  | Perform petroleum analysis | **25** |
|  | Perform cement analysis | **25** |
|  | Perform sugar and allied analysis | **30** |
|  | Perform paper and allied analysis | **25** |
| **Total** | | **200** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * 1. To perform water and waste water analysis | 1. Collect water and waste water sample 2. Measure water biological parameters 3. Nutrients 4. Bacteria 5. Algae 6. Protozoa 7. Virus 8. Measure water physical parameters 9. Turbidity 10. Odor 11. Density 12. Taste 13. Temperature 14. Color 15. Electric conductivity 16. Measure water chemical parameters 17. pH 18. Dissolved oxygen 19. Hardness 20. Biological oxygen demand 21. Total soluble solids 22. Total dissolved solids | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * 1. To carry out soap and detergents analysis | 1. Test free fatty acids 2. Test acid value 3. Measures moisture content 4. Test foam stability test hardness 5. Calculate saponification values | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * 1. To perform agrochemical analysis | 1. Test solubility test of agrochemicals 2. Vapour pressure test 3. Photo stability test 4. Shelf-life test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * 1. Perform petroleum analysis | 1. Calculate octane number 2. Calculate cetane number 3. Determine flash point 4. Measure specific gravity | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * 1. Perform cement analysis | 1. Fineness test 2. Setting time test 3. Chemical test 4. Unsoundness test 5. Compressive strength test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * 1. Perform sugar and allied analysis | 1. Brix test 2. Crystal size test 3. Moisture content 4. Colour test 5. Ash test 6. Polarisation test 7. pH measurement | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| * 1. Perform paper and allied analysis | 1. Calculate copper number 2. Calculate kappa number 3. Viscosity test 4. Starch test | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Calibration standards | For trainer and trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Water bath | For trainee use | 3 | 1:8 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | Water and waste water analysis instruments [colorimeter, turbid meter, spectrophotometer, pH meter, Conductometer…] | For trainer and trainee use | 1 | 1:25 |
|  | soap and detergents analysis instruments [pH meter, AAS, refractive index meter] | For trainer and trainee use | 1 | 1:25 |
|  | agrochemical analysis instruments [mass spectrometer, UV spectrophotometry, liquid chromatography, HPLC] | For trainer and trainee use | 1 | 1:25 |
|  | petroleum analysis instruments [Flash Point Tester, distillation tester, viscometer, combustion analyzer] | For trainer and trainee use | 1 | 1:25 |
|  | cement analysis instruments [Vicat apparatus, Le Chartelier mold, air permeability apparatus] | For trainer and trainee use | 1 | 1:25 |
|  | sugar and allied analysis instruments [refractometer, hydrometer, sucrolyser, UV-Vis spectrophotometer, glucometer, HPLC] | For trainer and trainee use | 1 | 1:25 |
|  | paper and allied analysis instruments [refractometer, hydrometer, Cob sizing tester] | For trainer and trainee use | 1 | 1:25 |

# MODULE VI

# UNITS OF LEARNING

**MODULE VI**

This module consists of competencies that a learner requires to enable him/her to effectively apply enetreptreneurial skills and research methods to perform quality assurance and control. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **LEARNING OUTCOME** | **DURATION (HOURS)** |
| 0413 541 15A | ENTREPRENEURIAL SKILLS | Apply Financial Literacy Skills | **6** |
| Apply entrepreneurial concept | **4** |
| Identify entrepreneurial opportunities | **6** |
| Apply business legal aspects | **6** |
| Innovate Business strategies | **6** |
| Develop Business Plan | **12** |
| 0542 551 16A | RESEARCH METHODS | Develop research project proposal | **30** |
| Carry out sampling and data collection | **30** |
| Apply methods of data analysis | **30** |
| Carry out presentation and interpretation of data | **30** |
| Perform project writing and presentation | **30** |
| 0531 551 17A | QUALITY ASSURANCE AND CONTROL | To conduct quality control | **45** |
| To conduct quality assurance | **45** |
| To conduct quality audit | **45** |
| To conduct method validation | **45** |
|  |  | **TOTAL** | **370** |

## **ENTREPRENEURIAL SKILLS**

**UNIT CODE:** 0413 541 15A

**UNIT DURATION:** 40 hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Entrepreneurial skills.

**Unit Description:**

This unit covers the competencies required to demonstrate an understanding of entrepreneurship. It involves demonstrating an understanding of financial literacy, applying entrepreneurial concepts identifying entrepreneurship opportunities, applying business legal aspects, and developing business innovative strategies and business plans.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply Financial Literacy Skills | **6** |
|  | Apply entrepreneurial concept | **4** |
|  | Identify entrepreneurial opportunities | **6** |
|  | Apply business legal aspects | **6** |
|  | Innovate Business strategies | **6** |
|  | Develop Business Plan | **12** |
| **Total** | | **40** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply Financial Literacy | 1. Personal finance management 2. Balancing between needs and wants 3. Budget Preparation 4. Saving management 5. Factors to consider when deciding where to save 6. Debt management 7. Factors to consider before taking a loan 8. Investment decisions 9. Types of investments 10. Factors to consider when investing money 11. Insurance services 12. Insurance products available in the market 13. Insurable risks | * Observation * Project * Written assessment * Oral assessment * Interviews |
| 1. Apply Entrepreneurial Concept | 1. Difference between Entrepreneurs and Business persons 2. Types of entrepreneurs 3. Ways of becoming an entrepreneur 4. Characteristics of Entrepreneurs 5. Salaried employment and self-employment 6. Requirements for entry into self-employment 7. Roles of an Entrepreneur in an enterprise 8. Contributions of Entrepreneurship | * Observation * Project * Written assessment * Oral assessment |
| 1. Identify Entrepreneurship Opportunities | 1. Sources of business ideas 2. Factors to consider when evaluating business opportunity 3. Business life cycle | * Observation * Project * Written assessment * Oral assessment |
| 1. Apply Business Legal Aspects | 1. Forms of business ownership 2. Business registration and licensing processing 3. Types of contracts and agreements 4. Employment laws 5. Taxation laws | * Observation * Project * Written assessment * Oral assessment |
| 1. Innovate Business Strategies | 1. Creativity in business 2. Innovative business strategies 3. Entrepreneurial Linkages 4. ICT in business growth and development | * Observation * Project * Written assessment * Oral assessment |
| 1. Develop Business Plan | 1. Business description 2. Marketing plan 3. Organizational/Management   plan   1. Production/operation plan 2. Financial plan 3. Executive summary 4. Business plan presentation 5. Business idea incubation | * Observation * Written assessment * Project * Oral assessment |

**Suggested Methods of Instruction**

* Practical
* Demonstrations
* Project
* Group discussion
* Direct instruction
* Guest speakers

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | Overhead Projector | LCD | 1 | 1:25 |
|  | Case studies |  | 5 | 1:5 |
|  | Business plan templates |  | 5 | 1:5 |
|  | Newspapers and Handouts |  | 5 | 1:5 |
|  | Business Journals |  | 5 | 1:5 |
|  | Video clips | Assorted | 25 sets | 1:1 |
|  | Whiteboard |  | 1 | 1:25 |
|  | Rolls flip charts | For trainer’s use | - | - |
|  | Assorted color of whiteboard markers | For trainers Use |  |  |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Printing papers |  | enough |  |
|  | Printing ink cartilages | assorted | - | - |
|  | Internet |  | 200mbps | - |
| **D** | **Tools and Equipment** |  |  |  |
|  | Computers | For trainer’s use |  |  |
|  | Printer | For trainer’s use |  |  |

## **RESEARCH METHODS**

**UNIT CODE:** 0542 551 16A

**UNIT DURATION:**  150 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Research Methods**.

**Unit Description**

This unit covers the competencies required in applying research methods. It involves developing research project proposal, carrying out sampling and data collection, applying methods of data analysis concepts, carrying out presentation and interpretation of data, and performs project report writing and presentation.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Develop research project proposal | **30** |
|  | Carry out sampling and data collection | **30** |
|  | Apply methods of data analysis | **30** |
|  | Carry out presentation and interpretation of data | **30** |
|  | Perform project writing and presentation | **30** |
| **Total** | | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Develop research project proposal | 1. Develop research design 2. Study survey 3. Experimental 4. Quantitative survey 5. Qualitative survey 6. Literature review 7. Develop research proposal | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out sampling and data collection | 1. Sampling plan 2. Sources of data 3. Primary sources 4. Secondary sources 5. Types of data | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply methods of data analysis concepts | 1. Measures of central tendency 2. Mean 3. Mode 4. Median 5. Measures of dispersion 6. Standard deviation 7. Variance 8. Probability calculations 9. Correlation calculations | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out presentation and interpretation of data | 1. Data tabulation 2. Data classification 3. Statistical data presentation 4. Tabulation 5. Graphical 6. Pie charts 7. Data interpretation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform project report writing and presentation | 1. Findings documentation 2. Report conclusion 3. Recommendations 4. Project report presentation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | aprons | For trainee use | 25 | 1:1 |
|  | Specimen containers | For trainee use | 25 | 1:1 |
|  | Assorted laboratory reagents | For trainee use | 25 | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 25 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | incubators | For trainee use | 5 | 1:5 |
|  | Assorted samplers [ladles, buckets, stir bars] | For trainee use | 1 | 1:25 |
|  | Laboratory mills | For trainee use | 6 | 1:4 |
|  | Lab grinders | For trainee use | 2 | 1:12 |
|  | Jaw crushers | For trainee use | 2 | 1:12 |
|  | Laboratory digestion systems | For trainer and trainee use | 1 | 1:25 |
|  | Moulds for sample preparation | For trainer and trainee use | 5 | 1:5 |
|  | Assorted sieves | For trainer and trainee use | 5 | 1:5 |
|  | Sample concentrators | For trainer and trainee use | 5 | 1:5 |

## **QUALITY ASSURANCE AND CONTROL**

**UNIT CODE:** 0531 551 17A

**UNIT DURATION:**  180 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Quality Assurance and Control.**

**Unit Description**

This unit covers the competencies required in performing quality assurance and control of analytical chemistry laboratory procedures. It involves conducting quality control, quality assurance, quality audits, and method validation.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | To conduct quality control | **45** |
|  | To conduct quality assurance | **45** |
|  | To conduct quality audit | **45** |
|  | To conduct method validation | **45** |
| **Total** | | **180** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. To conduct quality control | 1. Sample collection 2. Run blank samples 3. Run quality control samples 4. Run blind samples 5. Run chemical standards    * 1. Standard solution      2. Analytical reagents      3. Reference standard 6. Run repeat samples 7. Document results    * 1. Reports      2. Graphs      3. Filling | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To conduct quality assurance | 1. Sample collection 2. Run certified reference material 3. Run chemical standards 4. Run inter-laboratory samples    * 1. Independent certified laboratory      2. Compliance laboratories 5. Evaluate uncertainty | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To conduct quality audit | 1. Select quality audits    * 1. Safety      2. Quality management systems      3. Product quality      4. Quality operations      5. Pollution 2. Develop audit plan 3. Conduct pre-audit review 4. Conduct on-site audit 5. Generate audit findings 6. Report audit findings | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. To conduct method validation | 1. Validate method selectivity (ICH 2003) 2. Validate method precision (ICH 2003) 3. Validate method accuracy (ICH 2003) 4. Validate method bias (ICH 2003) 5. Validate measurement range (ICH 2003)    * 1. Accuracy      2. Selectivity      3. Detection limits | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | 1 | 1:25 |
|  | Flip charts | For trainer’s use | 1 | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Assorted reference materials | For trainer’s and trainee use | 5 | 5:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
|  | standard Science laboratory | For trainee use | 1 | 1:25 |
|  | Internet connection | For trainee use | Enough |  |
|  | Assorted analytical instruments | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Stationeries | For trainee use | 25 | 1:1 |
|  | Gloves | For trainee use | 25 | 1:1 |
|  | Laboratory coats | For trainee use | 25 | 1:1 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Assorted whiteboard markers | For trainer’s | enough |  |
|  | Assorted Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
|  | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Calibration standards | For trainer and trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | International quality standards manuals | For trainer and trainee use | 5 | 1:5 |
|  | Quality control charts | For trainer and trainee use | 5 | 1:5 |
|  | Analytical balances | For trainee use | 5 | 1:5 |
|  | First aid kit | For trainee use | 5 | 1:25 |
|  | Muffle Furnace | For trainee use | 1 | 1:25 |
|  | oven | For trainee use | 2 | 1:12 |
|  | centrifuges | For trainee use | 4 | 1:6 |
|  | refrigerator/freezer | For trainee use | 1 | 1:25 |
|  | Water bath | For trainee use | 3 | 1:8 |
|  | hot plate | For trainee use | 6 | 1:4 |
|  | colorimetric | For trainer and trainee use | 1 | 1:25 |
|  | Ultraviolet -Visible spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Fourier Transform-Infrared spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Atomic Emission spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Atomic Absorption spectrophotometer | For trainer and trainee use | 1 | 1:25 |
|  | Standard Operating Procedures (SOPs) | For trainer and trainee use | 5 | 1:5 |