

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**INDUSTRIAL 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:

**Council Secretary/CEO/Chief Principal**

**………………………………….**

**P.O. Box …….**

**……………**

**Email:** ……….

**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 Industrial 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).

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 Industrial 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 industrial sector acquire competencies to perform their work more efficiently and effectively.

**COUNCIL SECRETARY/CEO**

**QAIs**

**TABLE OF CONTENTS**

[**FOREWORD** 3](#_Toc196838353)

[ACKNOWLEDGEMENT 5](#_Toc196838354)

[KEY TO ISCED UNIT CODE 9](#_Toc196838355)

[CURRICULUM OVERVIEW 11](#_Toc196838356)

[SUMMARY OF UNITS OF COMPETENCY 11](#_Toc196838357)

[INDUSTRY TRAINING 13](#_Toc196838358)

[ASSESSMENT 14](#_Toc196838359)

[MODULE I 16](#_Toc196838360)

[UNITS OF LEARNING 16](#_Toc196838361)

[**MODULE I** 17](#_Toc196838362)

[**MECHANICAL SCIENCE CONCEPTS** 18](#_Toc196838363)

[**UNIT OPERATIONS** 22](#_Toc196838364)

[**ANALYTICAL EQUIPMENT** 27](#_Toc196838365)

[MODULE II 31](#_Toc196838366)

[UNITS OF LEARNING 31](#_Toc196838367)

[**MODULE II** 32](#_Toc196838368)

[**MECHANICAL SCIENCE CONCEPTS** 34](#_Toc196838369)

[**MATHEMATICS FOR SCIENCE** 37](#_Toc196838370)

[**ELECTRICAL SCIENCE CONCEPTS** 40](#_Toc196838371)

[**MATERIAL ANALYSIS** 45](#_Toc196838372)

[Thermometer 49](#_Toc196838373)

[MODULE III 50](#_Toc196838374)

[UNITS OF LEARNING 50](#_Toc196838375)

[**MODULE III** 51](#_Toc196838376)

[**COMMUNICATION SKILLS** 53](#_Toc196838377)

[**CHEMICAL SCIENCE CONCEPTS** 57](#_Toc196838378)

[**MATHEMATICS FOR SCIENCE** 64](#_Toc196838379)

[**PRODUCTION QUALITY CONTROL** 70](#_Toc196838380)

[MODULE IV 75](#_Toc196838381)

[UNITS OF LEARNING 75](#_Toc196838382)

[**MODULE IV** 76](#_Toc196838383)

[**DIGITAL LITERACY** 78](#_Toc196838384)

[**CHEMICAL SCIENCE CONCEPTS** 95](#_Toc196838385)

[**INDUSTRIAL PRODUCTS** 100](#_Toc196838386)

[MODULE V 110](#_Toc196838387)

[UNITS OF LEARNING 110](#_Toc196838388)

[**MODULE V** 111](#_Toc196838389)

[INDUSTRIAL WASTES 112](#_Toc196838390)

[**WORK ETHICS AND PRACTICES** 113](#_Toc196838391)

[**LABORATORY AND MANANGEMENT PRACTICES** 119](#_Toc196838392)

[**INDUSTRIAL WASTES** 125](#_Toc196838393)

[MODULE VI 129](#_Toc196838394)

[UNITS OF LEARNING 129](#_Toc196838395)

[**MODULE VI** 130](#_Toc196838396)

[PROCESS CONTROL AND OPTIMIZATION 130](#_Toc196838397)

[**ENTREPRENEURIAL SKILLS** 132](#_Toc196838398)

[**RESEARCH METHODS** 137](#_Toc196838399)

[**PROCESS CONTROL AND OPTIMIZATION** 142](#_Toc196838400)

# ABBREVIATIONS AND ACRONYMS

ISCED International Standard Classification of Education

KNQF Kenya National Qualification Framework

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

UIPAC International Union of Pure and Applied Chemistry

AC Alternating Current

DC Direct Current

CRO Cathode Ray Oscilloscope

CPR Cardiopulmonary Resuscitation

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

GC-MS Gas Chromatography – Mass Spectroscopy

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

CV Curriculum Vitae

ICT Information and Communication Technology

UV-VIS Ultra-Violet Visible spectrophotometer

# KEY TO ISCED UNIT CODE



# CURRICULUM OVERVIEW

The Industrial Chemistry Technology level 6 consists of competencies that an individual must have to effectively perform duties of an Industrial Chemistry Technician. It involves performing unit operations, process control and optimization, production quality control, operating analytical equipment, managing industrial wastes, processing industrial products and carrying out material analysis to improve industrial process quality

Each module consists of the following units of learning:

# SUMMARY OF UNITS OF COMPETENCY

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **DURATION**  **HOURS** | **CREDIT FACTOR** |
| **MODULE I** | | | |
| 0715 551 01A | MECHANICAL SCIENCE CONCEPTS | **150** | **15.0** |
| 0711 551 02A | UNIT OPERATIONS | **200** | **20.0** |
|  | | | |
| **MODULE II** | | | |
| 0713 551 03A | ELECTRICAL SCIENCE | **100** | **10.0** |
| 0541 551 04A | MATHEMATICS FOR SCIENCE | **150** | **15.0** |
| 0711 551 05A | ANALYTICAL EQUIPMENT | **180** | **18.0** |
|  | | | |
| **MODULE III** | | | |
| 0031 541 06A | COMMUNICATION SKILLS | **40** | **4.0** |
| 0531 551 07A | CHEMICAL SCIENCE CONCEPTS | **150** | **15.0** |
| 0720 551 08A | MATERIAL ANALYSIS | **200** | **20.0** |
|  | | | |
| **MODULE IV** | | | |
| 0611 541 09A | DIGITAL LITERACY | **40** | **4.0** |
| 0711 551 10A | PRODUCTION QUALITY CONTROL | **180** | **18.0** |
| 0720 551 11A | PROCESS INDUSTRIAL PRODUCTS | **210** | **21.0** |
|  | | | |
| **MODULE V** | | | |
| 0417 541 12A | WORK ETHICS AND PRACTICES | **40** | **4.0** |
| 0711 541 13A | LABORATORY PRACTICES AND MANAGEMENT | **150** | **15.0** |
| 0712 551 14A | MANAGE INDUSTRIAL WASTES | **180** | **18.0** |
|  | | | |
| **MODULE VI** | | | |
| 0413 541 15A | ENTREPRENEURIAL SKILLS | **40** | **4.0** |
| 0500 551 16A | SCIENTIFIC RESEARCH | **100** | **10.0** |
| 0711 551 27A | PROCESS CONTROL AND OPTIMIZATION | **180** | **18.0** |
| **INDUSTRIAL TRAINING** | | **480** | **48** |
| **GRAND TOTAL** | | **2,770** | **294** |

Total number of hours is **2,770 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 Industrial 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 Industrial 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 Certificate in Industrial 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 learner requires to enable him/her to effectively apply mechanical science in performing unit operations and operate analytical equipment. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0715 551 01A | MECHANICAL SCIENCE CONCEPTS | Apply solid mechanics principles | **40** |
| Apply physics principles | **30** |
| Use mechanical systems | **40** |
| Apply fluid mechanics principles | **40** |
| 0711 551 02A | UNIT OPERATIONS | Separate production materials | **70** |
| Purify production materials | **60** |
| Mix production materials | **70** |
| **TOTAL** | **350** |

## **MECHANICAL SCIENCE CONCEPTS**

**UNIT CODE: 0533 551 01A**

**UNIT DURATION:**  150 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply mechanical science concepts

**Unit Description**

This unit of competency provides knowledge required by an industrial chemist to apply mechanical science. It includes applying solid mechanics, applying physics principles, using mechanical systems and applying fluid mechanics principles.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| **1.** | Apply solid mechanics principles | **40** |
| **2.** | Apply physics principles | **30** |
| **3.** | Use mechanical systems | **40** |
| **4.** | Apply fluid mechanics principles | **40** |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply solid mechanics principles | * 1. States of matter   2. Phase change   3. Mechanical properties of matter   4. Vibrations   5. Displacement   6. Plasticity   7. Hooks law   8. Definition   9. Applications   10. solid dynamics       1. Vibrations       2. Displacement       3. Plasticity       4. Stress       5. Strain       6. Phase changes | * Practical Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Apply physics principles | 1. Types of mechanical forces    1. Tension    2. Compression    3. Bending    4. Shear 2. Definition of electromagnetism 3. Laws of electromagnetic induction 4. Applications of electromagnetic induction 5. Thermodynamic laws    1. First law of thermodynamics    2. Second law of thermodynamics    3. Work, energy and power 6. Definition 7. Application | * Practical Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Use mechanical systems | 1. PPEs 2. Definition of mechanical system 3. Operation of mechanical, electrical and plumbing (MEP) systems. 4. Maintenance of MEP systems 5. Applications of MEP systems    1. Elevators    2. Plumbing    3. Heating    4. Cooling | * Practical Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply fluid mechanics principles | 1. Definition of fluid mechanics 2. Phase equilibrium in thermal dynamics 3. Viscosity    1. Definition    2. Factors affecting viscosity    3. Application of viscosity 4. Vacuum systems    1. Definition    2. Working    3. Application | * Practical Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

* 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** | | | |
|  | 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** | | | |
|  | Spring | Spiral | 25 | 1:1 |
|  | Stopwatch | Accuracy of 0.01mm | 25 | 1:1 |
|  | Vibration Analyzers | Smart sensor | 5 | 1:5 |
|  | Thermocouples | Digital | 5 | 1:5 |
|  | Pressure Gauges | 0-100psi | 5 | 1:5 |
|  | Transducers |  | 25 | 1:1 |
|  | Vernier Calipers | Half divisions | 25 | 1:1 |
|  | Micrometer screw gauge | 100 divisions | 25 | 1:1 |
|  | Tachometer | Digital | 5 | 1:5 |
|  | Accelerometers | CMA | 5 | 1:5 |

## **UNIT OPERATIONS**

**UNIT CODE:** 0711 551 02A

**UNIT DURATION:** 200 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Unit Operations.**

**Unit Description**

This unit of competency covers the ability of an industrial chemist to perform unit operations. It involves separating, purifying and mixing production materials

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Separate production materials | **70** |
| 2. | Purify production materials | **60** |
| 3. | Mix production materials | **70** |
| **Total** | | **200** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Separate production materials. | 1. Identification of production material    * 1. Raw materials      2. intermediate products 2. Sample production unit 3. Test production material    * 1. physical properties      2. chemical properties 4. Production material separation    * 1. Sorting      2. Evaporation      3. Filtration      4. Distillation      5. Chromatography | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Purify production materials. | 1. Identification of production material    * 1. Raw materials      2. Intermediate products 2. Sample production unit 3. Testing of production material    * 1. Physical properties      2. Chemical properties 4. Production material purification    * 1. Chromatography         1. Gas chromatography         2. HPLC      2. Distillation      3. Fractional crystallization | * Written tests * Oral questioning/interview * Observation (practical and projects) |
| 1. Mix production materials | 1. Determination of production material ratios 2. Weigh production material    * 1. Types of weigh balances      2. Distinguish between precision and accuracy      3. Recording 3. Blend production material    * 1. Definition of blend      2. Importance of blending      3. Methods of blending      4. Types of blending equipment | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practicals
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted colour of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Cleaning agents | 5 | 5 | 1:5 |
|  | Stabilizers |  | 5 | 1:5 |
|  | Gloves | Pair | Enough | 1:1 |
|  | Hexane |  |  | 1:1 |
|  | Adsorbents |  |  | 1:1 |
|  | Buffers |  |  | 1:1 |
|  | Assorted acids |  |  | 1:1 |
|  | Purification agents (alum) |  |  | 1:1 |
|  | Drying agents |  |  | 1:1 |
|  | Sodium carbonate |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | Scoops | Sample collection | 25 | 1:1 |
|  | Bailers | Sample collection | 5 | 1:25 |
|  | Sampling tubes | Sample collection | 25 | 1:1 |
|  | Soil auger | Sample collection | 12 | 1:2 |
|  | Liquid extraction apparatus | Extraction | 25 | 1:1 |
|  | Soxhlet apparatus | Extraction | 5 | 1:5 |
|  | Khjedal apparatus | Digestion | 1 | 1:25 |
|  | Glass ware | Measuring | 25 | 1:1 |
|  | Analytical balance | Weighing | 12 | 1:2 |
|  | Desiccators | Sample holding | 5 | 1:5 |
|  | Crushers | Size reduction | 5 | 1:5 |
|  | Mixers | Homogenization | 5 | 1:5 |
|  | Fume hood |  | 2 | 1:12 |
|  | FTIR | Analysis | 1 | 1:25 |
|  | Centrifuges | Separation | 5 | 1:5 |
|  | pH meters | Measurement | 25 | 1:1 |
|  | Agitators | Homogenization | 25 | 1:1 |
|  | UV-VIS | Analysis | 1 | 1:1 |
|  | HPLC | Analysis | 1 | 1:1 |
|  | GC | Analysis | 1 | 1:1 |
|  | AAS | Analysis | 1 | 1:1 |
|  | TGA | Analysis | 1 | 1:1 |
|  | Autoclave | Sterilization | 5 | 1:5 |
|  | Distillation apparatus | Separation | 5 | 1:5 |
|  | Rotary evaporators | Separation | 5 | 1:5 |
|  | Freezers | Cooling | 1 | 1:25 |
|  | Moisture analyser | Measuring | 5 | 1:5 |
|  | Refrigerators | Cooling | 1 | 1:25 |
|  | Spectrophotometer | Analysis | 1 | 1:25 |
|  | Filtration apparatus | Filtration | 2 | 1:12 |

**KEY**

UV-VIS – Ultra-Violet Visible spectrophotometer

FTIR – Fourier Transform Infrared spectrophotometer

HPLC – High Performance Liquid Chromatography

GC – Gas Chromatography

AAS – Atomic Absorption Spectrophotometer

TGA - Thermogravimetric Analyzer

# 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, electrical concepts in carrying out material analyses. This module consists of the following units of learning

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0533 551 03A | ELECTRICAL SCIENCE CONCEPTS | Apply electrical principles | **30** |
| Applyelectrical quantities principles | **30** |
| Use electrical Equipment | **40** |
| 0541 551 04A | 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** |
| 0711 551 05A | ANALYTICAL EQUIPMENT | Set up analytical equipment | **80** |
| Calibrate analytical equipment | **50** |
| Analyze material parameters | **50** |
| **TOTAL** | **430 HRS** |

## **ELECTRICAL SCIENCE CONCEPTS**

**UNIT CODE:** 0533 551 03A

**UNIT DURATION:**  100 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical science concepts

**Unit Description**

This unit describes the competencies required by an industrial chemist to apply electrical science concepts. It involves applying electrical principles, electrical quantities principles and using electrical Equipment

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply electrical principles | **30** |
| 2. | Applyelectrical quantities principles | **30** |
| 3. | Use electrical Equipment | **40** |
| **Total** | | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply electrical principles | * 1. definition of electrical quantities   2. types of electrical quantities      1. Voltage      2. Current      3. Charge      4. Power      5. Conductivity      6. Resistivity   3. measure electrical quantities      1. Voltage      2. Current      3. Charge      4. Power      5. Conductivity      6. Resistivity   4. calculate electrical quantities      1. Voltage      2. Current      3. Charge      4. Power      5. Conductivity      6. Resistivity   5. electrical laws      1. Ohm’s      2. Watt’s      3. Kirchhoff’s      4. Faraday’s      5. Coulomb’s      6. Lenz’      7. Henry | * Written Assessment * Oral assessment * Practical Assessment * Portfolio of Evidence |
| 1. Applyelectrical quantities principles | * 1. definition of electrical parameters   2. types of electrical parameters      1. Resistance      2. Capacitance      3. Conductance      4. Inductance   3. definition of electrical circuit   4. types of electrical circuits      1. Parallel      2. Series      3. Wheatstone bridge   5. types of electrical current      1. AC      2. DC | * Written Assessment * Oral assessment * Practical Assessment * Portfolio of Evidence |
| 1. Use electrical Equipment | 1. Electrical workshop PPEs 2. Definition of electrical equipment 3. Types of electrical equipment    * 1. Voltmeter      2. Ammeter      3. Resistors      4. Multimeter      5. Conductivity meter      6. Rheostat      7. Cathode Ray Oscilloscope (CRO) 4. Electrical equipment safety check    * 1. importance of electrical equipment      2. components of electrical safety checks         1. power cords and plugs         2. insulation resistance testing         3. earth continuity testing         4. environmental inspection (dry and moisture-free areas)      3. tools for electrical safety checks      4. compliance and standards 5. Operations of electrical equipment 6. Electrical equipment parameters    * 1. voltage      2. current      3. power      4. frequency 7. Electrical equipment calibration 8. Maintenance of electrical equipment 9. Storage of electrical equipment | * Written Assessment * Oral assessment * Practical Assessment * Portfolio of Evidence |

**Suggested Methods of Instruction**

* 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** | | | |
|  | 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 | 1:25 |
|  | Soldering Station |  | 5 | 1:5 |
|  | Power Supply | Single sockets | 10 | 2:5 |
|  |  |  |  |  |
| **c** | **Tools and Equipment** | | | |
|  | Voltmeter | 0-20V | 25 | 1:1 |
|  | Ammeter | 0-5A | 25 | 1:1 |
|  | Resistors |  | 25 | 1:1 |
|  | Multimeter | Digital | 25 | 1:1 |
|  | Conductivity meter | Portable | 5 | 1:5 |
|  | Rheostat | Single tube | 25 | 1:1 |
|  | Cathode Ray Oscilloscope (CRO) | Digital | 5 | 1:5 |
|  | Capacitors | paper | 25 | 1:1 |
|  | Breadboard | Plastic | 25 | 1:1 |
|  | Screwdrivers and Pliers |  | 25 | 1:1 |
|  | Heat Shrink Tubing and Heat Gun |  | 5 | 1:5 |
|  | Voltage Tester | Glass | 25 | 1:1 |
|  | Safety Goggles |  | 25 | 1:1 |
|  | Insulated Gloves |  | 25 | 1:1 |

**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.** | **ELEMENTS** | **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 |

## **ANALYTICAL EQUIPMENT**

**UNIT CODE:** 0711 551 05A

**UNIT DURATION:** 180 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Operate Analytical Equipment.**

**Unit Description**

This unit of competency covers the ability of an industrial chemist operate analytical equipment. It includes setting up analytical equipment, calibrating analytical equipment and analyzing material parameters.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Set up analytical equipment | **80** |
| 2. | Calibrate analytical equipment | **50** |
| 3. | Analyze material parameters | **50** |
| **Total** | | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up analytical equipment | 1. Identification of analytical equipment 2. AAS 3. FAES 4. UV -visible spectrophotometer 5. Analytical balance 6. HPLC 7. GC-MS 8. FT-IR 9. Colorimeter 10. Startup of analytical equipment     * 1. Connecting peripherals       2. Switching on       3. Calibration 11. Set of analytical equipment parameters 12. Absorbance 13. Transmittance 14. PH 15. Temperature 16. Wavelength | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Calibrate analytical equipment | * 1. Preparation of calibration standards      1. Assorted parts per million (ppm)concentrations   2. Run blank samples   3. Run calibration standards | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Analyze material parameters | 1. Preparation of samples    * 1. Definition of term sample      2. Types of samples      3. Sample preparation         1. Size reduction         2. Halving and quartering         3. Dissolution         4. Digestion 2. Analyzation of samples    * 1. Chromatography      2. Spectroscopy      3. Gravimetric      4. Volumetric      5. AAS      6. NMR 3. Data interpretation | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted color of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | * Standards | Metal ions | 5 | 1:5 |
|  | * Hard water |  | 5 | 1:5 |
|  | * Gloves | Pair | Enough | 1:1 |
|  | * Coloured water samples |  |  | 1:1 |
|  | * Blank samples |  |  | 1:1 |
|  | * Graph papers |  |  | 1:1 |
|  | * Filter papers |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | * Spatula | Sample collection | 25 | 1:1 |
|  | * Fume hood |  | 2 | 1:12 |
|  | * FTIR | Analysis | 1 | 1:25 |
|  | * Centrifuges | Separation | 5 | 1:5 |
|  | * pH meters | Measurement | 25 | 1:1 |
|  | * Agitators | Homogenization | 25 | 1:1 |
|  | * UV-VIS | Analysis | 1 | 1:1 |
|  | * HPLC | Analysis | 1 | 1:1 |
|  | * GC-MS | Analysis | 1 | 1:1 |
|  | * AAS | Analysis | 1 | 1:1 |
|  | * Distillation apparatus | Separation | 5 | 1:5 |
|  | * Rotary evaporators | Separation | 5 | 1:5 |
|  | * Freezers | Cooling | 1 | 1:25 |
|  | * Refrigerators | Cooling | 1 | 1:25 |
|  | * Spectrophotometer | Analysis | 1 | 1:25 |
|  | * Filtration apparatus | Filtration | 2 | 1:12 |

**KEY**

UV-VIS – Ultra-Violet Visible spectrophotometer

FTIR – Fourier Transform Infrared spectrophotometer

HPLC – High Performance Liquid Chromatography

GC – Gas Chromatography

AAS – Atomic Absorption Spectrophotometer

# MODULE III

# UNITS OF LEARNING

## **MODULE III**

This module consists of competencies that a learner requires to enable him/her to effectively apply communication skills and chemical concepts to perform material analyses. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **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 | CHEMICAL SCIENCE CONCEPTS | Apply physical chemistry principles | **30** |
| Apply organic chemistry principles | **30** |
| Apply inorganic chemistry principles | **30** |
| Apply biochemistry principles | **30** |
| Apply industrial microbiological principles | **30** |
| 0720 551 08A | MATERIAL ANALYSES | Analysis of material structure concepts | **50** |
| Analysis of material Properties | **40** |
| Assessment of material chemical composition | **60** |
| Synthesize industrial material | **50** |
| **TOTAL** | **400 HRS** |

## **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 |  |  |

## **CHEMICAL SCIENCE CONCEPTS**

**UNIT CODE:** 0531 551 07A

**UNIT DURATION:** 150 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Chemical Science Concepts.**

**Unit Description**

This unit describes the competencies required by an industrial chemist to apply chemical science concepts. It includes applying physical chemistry, organic chemistry, inorganic chemistry, biochemistry and industrial microbiology principles.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply physical chemistry principles | **30** |
|  | Apply organic chemistry principles | **30** |
|  | Apply inorganic chemistry principles | **30** |
|  | Apply biochemistry principles | **30** |
|  | Apply industrial microbiological principles | **30** |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply physical chemistry properties | 1. Apply gas law 2. Boyle’s 3. Charles’ 4. Avogadro’s 5. Gay-Lussac’s 6. Combined 7. pH and buffer solutions    * 1. define pH      2. types of pH meter      3. pH calculation         1. strong acids and bases         2. weak acids and bases         3. polyprotic acids e.g. H2SO4      4. definition of buffers      5. types of buffers         1. acidic buffer         2. basic buffer      6. uses of buffers in laboratory      7. Henderson-Hasselbalch equation derivation      8. Buffer solution pH calculation      9. Preparation of buffer solutions.         1. acidic buffer         2. basic buffer 8. Apply chemical kinetics    * 1. definition of terms      2. reactions rates      3. order of reaction      4. reaction mechanism      5. temperature and reaction rates      6. radioactive decay 9. Apply surface and colloids chemistry   **Surface chemistry**   * + 1. adsorption     2. catalysis     3. surface tension     4. surface modification   **colloid chemistry**   * + 1. types of colloidal systems        1. sol        2. gel        3. foam        4. emulsion        5. aerosol     2. preparation of colloids   **methods**   * + - 1. condensation       2. dispersion   **purification**   * + - 1. dialysis       2. ultrafiltration     1. stability of colloids        1. factors     2. colloids properties        1. optical        2. kinetic        3. electrical     3. application of surface and colloids chemistry  1. Apply electrochemistry principles    * 1. definition of electrochemistry      2. types electrochemical cells         1. electrolytic         2. galvanic      3. redox reactions         1. definition of oxidation and rection processes            1. electron transfer            2. oxidation number            3. oxygen transfer            4. hydrogen transfer         2. oxidizing and reducing agent         3. oxidation number calculation         4. balancing redox equation      4. electrode potentials         1. types of electrodes         2. electrode potential table      5. half cells      6. calculation of emf      7. application of electrochemistry 2. Apply phase equilibrium 3. Apply chemical thermodynamics principles | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Apply organic chemistry principles | 1. Classify organic compounds 2. Hydrocarbons 3. Carboxylic acids 4. Aldehydes 5. Esters 6. Ketones 7. Halo alkanes 8. Alcohols 9. Carbonyl compounds 10. Apply organic compound reaction     * 1. substitution reactions       2. addition reactions       3. elimination reactions 11. Uses of organic compounds | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Apply inorganic chemistry principles | 1. Classification of organic elements 2. S-block 3. P-block 4. D-block 5. Metals 6. Non-metals 7. Metalloids 8. Atomic structure and bonding 9. Chemical reactivity 10. Volumetric analysis     * 1. acid-base       2. redox       3. complexometric       4. precipitation | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Apply biochemistry principles | 1. Classification of biomolecules 2. Carbohydrates 3. Proteins 4. Lipids 5. Vitamins 6. Physical properties of biomolecules 7. Structure 8. Colour 9. Shape 10. Chemical properties of biomolecules 11. Activity 12. Acidity 13. Basicity 14. Hydrophilicity 15. Hydrophobicity 16. Biomolecules products 17. Glycerol 18. Amino acids 19. Fatty acids 20. Sugars 21. Starch 22. Enzymes | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Apply industrial microbiological principles | 1. Isolate microorganisms 2. Fungi 3. Bacteria 4. Virus 5. Archaea 6. Introduction of microorganisms in production process 7. Monitoring microbial activity 8. Record microbial activity | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practical
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted color of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | * Hydrogen peroxide | 5 | 5 | 1:5 |
|  | * Liquid nitrogen |  | 5 | 1:5 |
|  | * Gloves | Pair | Enough | 1:1 |
|  | * Metal electrode |  |  | 1:1 |
|  | * Benedict’s reagents |  |  | 1:1 |
|  | * Biuret reagents |  |  | 1:1 |
|  | * Ninhydrin |  |  | 1:1 |
|  | * Sudan III |  |  | 1:1 |
|  | * Agar media |  |  | 1:1 |
|  | * Sodium hypochlorite |  |  | 1:1 |
|  | * Culture media |  |  | 1:1 |
|  | * Antifoaming agents |  |  | 1:1 |
|  | * Sucrose |  |  | 1:1 |
|  | * Staining reagents |  |  | 1:1 |
|  | * Fluorescent dyes |  |  | 1:1 |
|  | * Enzymes substrates |  |  | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | * 25 Gas syringes | Sample collection | 5 | 1:25 |
|  | * 25 Pressure sensors | Measuring pressure | 25 | 1:1 |
|  | * 25 Gas collection tubes | Sample collection | 25 | 1:1 |
|  | * Glassware | Measuring and holding solutions | 25 | 1:1 |
|  | * Filtration apparatus |  | 25 | 1:1 |
|  | * 25 Agar plates |  | 25 | 1:1 |
|  | * 25 Inoculating loops and needles |  | 25 | 1:1 |
|  | * 25 Sterile pipettes | Measuring | 25 | 1:1 |
|  | * 25 Sterile swabs | Collection | 25 | 1:1 |
|  | * Hot plate | Heating | 5 | 1:5 |
|  | * Water bath | Heating | 5 | 1:5 |
|  | * Electrochemical cells |  | 12 | 1:2 |
|  | * Fume hood |  | 2 | 1:12 |
|  | * FTIR |  | 1 | 1:25 |
|  | * Centrifuges |  | 5 | 1:5 |
|  | * pH meters |  | 25 | 1:1 |
|  | * Microscope |  | 25 | 1:1 |
|  | * Autoclave |  | 5 | 1:5 |
|  | * Refrigerators |  | 1 | 1:25 |
|  | * Spectrophotometer |  | 1 | 1:25 |
|  | * Bioreactors |  | 1 | 1:25 |
|  | * Incubator |  | 2 | 1:12 |

## **MATERIAL ANALYSIS**

**UNIT CODE:** 0720 551 08A

**UNIT DURATION:** 200 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Carry Out Material Analysis.**

**Unit Description**

This unit specifies the competencies required by an Industrial Chemist to carry out material analysis. It involves analyzing material structure, analyzing material properties, assessing material chemical composition and synthesizing industrial materials.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Analysis of material structure concepts | **50** |
| 2. | Analysis of material Properties | **40** |
| 3. | Assessment of material chemical composition | **60** |
| 4. | Synthesize industrial material | **50** |
| **Total** | | **200** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Analyze material structure concepts | 1. Determination of material crystal structure 2. Monoclinic 3. Cubic 4. Tetragonal 5. Rhombic 6. Triclinic 7. Orthorhombic 8. Hexagonal 9. Octahedron 10. Determination of material grain structure 11. Examination of material defects 12. Dislocation 13. Voids 14. Inclusions 15. Impurities 16. Distortion 17. Grain boundary 18. Establishment of material property structure relationship | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Analyse material properties | 1. Sample materials for analysis 2. Analysis of material properties 3. Thermal 4. Mechanical 5. Optical 6. Magnetic 7. X-ray diffraction 8. Electrical 9. Characterization of material property | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Assess material chemical composition | 1. Carry out material elemental analysis 2. Carry out spectroscopic analysis 3. Carry out mass spectrometry analysis 4. Carry out chromatographic analysis 5. Carry out microscopic analysis | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Synthesize industrial materials | 1. Selection of industrial raw materials 2. Conduct industrial raw materials preparation 3. Mix industrial raw materials 4. Blend industrial raw materials 5. Carry out industrial raw materials heat treatment 6. Conduct industrial product quality control 7. Carry out industrial products storage 8. Dispatch industrial production waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted color of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
|  |  | For trainer’s use |  |  |
|  |  | For trainer’s use |  |  |
| **C** | **Consumable materials** | | | |
|  | * Distilled water | washing | Enough |  |
|  | * Potassium alum | Crystal growth | 500g | 1:1 |
|  | * Rhombic | Crystal samples | 500g | 1:1 |
|  | * Sweeteners | Taste | 500g | 1:1 |
|  | * Vinegar | Pickling | 500g | 1:1 |
|  | * Antioxidants | Preservation | 500g | 1:1 |
|  | * Caramel Colour | Coloring | 500g | 1:1 |
|  | * Synthetic Food Colours | Coloring | 500g | 1:1 |
|  | * Spices and Herbs | Aroma | 500g | 1:1 |
|  | * Gloves | pack | Enough | 1:1 |
|  | * Thinner | Diluting | 500g | 1:1 |
|  | * Primers | Pre-coating | 500g | 1:1 |
|  | * Pigments | Dying | 500g | 1:1 |
|  | * Sodium hydroxide | Saponification | 500g | 1:1 |
|  | * Fragrances | Perfuming | 1L | 1:1 |
|  | * Ethanol | Dispersion | 5L | 1:1 |
|  | * Addictive’s | Exfoliation | 1L | 1:1 |
|  | * Emulsifying wax | Binding | 1L | 1:1 |
|  | * Thickener | Thickening | 1L | 1:1 |
|  | * Glycerine | Hydration | 1L | 1:1 |
|  | * Beeswax | Adding structure | 1L | 1:1 |
|  | * Oils | Moisturizing | Enough | 1:1 |
|  | * Zinc oxide | UV protection |  | 1:1 |
|  | * Naphtha | Reforming |  |  |
|  | * Catalysts |  |  |  |
|  | * Butane |  |  |  |
|  | * Isobutene |  |  |  |
|  | * Brine solution |  |  |  |
|  |  |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | * Scoops | 25 | 25 | 1:1 |
|  | * Refrigerator | Cooling | 1 | 1:25 |
|  | * sampling tubes | Carrying | 25 | 1:1 |
|  | * sampling containers |  | 1 | 1:25 |
|  | * Granular | Granulation | 5 | 1:5 |
|  | * Crushers | Crushing | 1 | 1:25 |
|  | * Mixers | Mixing | 1 | 1:25 |
|  | * Analytical balance | Weighing | 12 | 1:2 |
|  | * pH meter | pH measurement | 12 | 1:2 |
|  | * agitators | Agitation | 5 | 1:5 |
|  | * cold boxes | Cooling | 12 | 1:2 |
|  | * freezers | Freezing | 1 | 1:25 |
|  | * fume hood |  | 2 | 1:12 |
|  | * Automatic labelling machine | Labelling | 1 | 1:25 |
|  | * Fractionating unit | Distillation | 5 | 1:25 |
|  | Thermometer | Temperature | 25 | 1:25 |

# MODULE IV

# UNITS OF LEARNING

## **MODULE IV**

This module consists of competencies that a learner requires to enable him/her to effectively apply digital skills to perform production quality control and process industrial products. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **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** |
| 0711 551 10A | PRODUCTION QUALITY CONTROL | Sample production materials | **50** |
| Inspect production materials | **50** |
| Control nonconforming products | **40** |
| Sorting and packaging of production materials | **40** |
| 0720 551 11A | INDUSTRIAL PRODUCTS | Process food products | **30** |
| Process agrochemical products | **30** |
| Process petroleum products | **30** |
| Process pharmaceutical products | **30** |
| Process coating products | **30** |
| Process cosmetics products | **30** |
| Process chemical products | **30** |
| **TOTAL** | **440 HRS** |

## **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 | 1. Types of job opportunities 2. Self-employment 3. Service provision 4. product development 5. salaried employment 6. Sources of job opportunities 7. Resume/ curriculum vitae 8. What is a CV 9. How long should a CV be 10. What to include in a AC 11. Format of CV 12. How to write a good CV 13. Don’ts of writing a CV     1. Job application letter 14. What to include 15. Addressing a cover letter 16. Signing off a cover letter     1. Portfolio of Evidence 17. Academic credentials 18. Letters of commendations 19. Certification of participations 20. Awards and decorations     1. Interview skills 21. Listening skills 22. Grooming 23. Language command 24. Articulation of issues 25. Body language 26. Time management 27. 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 |

## **PRODUCTION QUALITY CONTROL**

**UNIT CODE:** 0711 551 10A

**UNIT DURATION:** 180 HOURS

**Relationship to Occupational Standards**

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

**Unit Description**

This unit of competency covers the ability of an industrial chemist to perform production quality control. It involves sampling production materials, inspecting production materials, controlling nonconforming products and sorting and packaging production materials.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Sample production materials | **50** |
|  | Inspect production materials | **50** |
|  | Control nonconforming products | **40** |
|  | Sorting and packaging of production materials | **40** |
| **Total** | | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Sample production materials | 1. Collect production material samples 2. Label production material samples 3. Carry out production material sample treatment 4. Drying 5. Grinding and milling 6. Weighing 7. Decomposition 8. Dissolution 9. Digestion 10. Storage 11. Carry out production material sample storage 12. Cold storage 13. Dark storage 14. Open air storage 15. Air tight containers | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Inspection production materials | 1. Assemble quality control inspection tools 2. Safety gear 3. Score cards 4. Checklist 5. Testing meters 6. Gauges 7. Laboratory testing tools 8. Conduct production material inspection 9. Visual 10. Destructive testing 11. Nondestructive testing 12. Mechanical testing 13. Chemical testing 14. Record quality deviations | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Control nonconforming products | 1. Segregate and label production and nonconforming products 2. Carry out production nonconformity root cause analysis 3. Initiation of production nonconformity corrective measures 4. Replacing the product 5. Scrapping 6. Adjustments 7. Recycling 8. Reworking 9. Root cause analysis | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Sorting and packaging of production materials | 1. Carry out production material grading 2. Purity 3. Physical and chemical properties 4. Stability and shelf life 5. Sort out production materials 6. Packaging of production materials | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted color of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | * Cleaning agents | 1L |  |  |
|  | * Solvents | 1L |  |  |
|  | * Acids and bases | 1L |  |  |
|  | * Gloves | pack | Enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | * Scoops | 25 | 25 | 1:1 |
|  | * 1 Bailers |  | 1 | 1:25 |
|  | * sampling tubes |  | 25 | 1:1 |
|  | * sampling containers |  | 1 | 1:25 |
|  | * Soil auger |  | 5 | 1:5 |
|  | * Crushers |  | 1 | 1:25 |
|  | * Mixers |  | 1 | 1:25 |
|  | * Analytical balance |  | 12 | 1:2 |
|  | * pH meters |  | 12 | 1:2 |
|  | * Agitators |  | 5 | 1:5 |
|  | * cold boxes |  | 12 | 1:2 |
|  | * Freezers |  | 1 | 1:25 |
|  | * fume hood |  | 2 | 1:12 |
|  | * Automatic labelling machine |  | 1 | 1:25 |
|  | * score cards |  | 25 | 1:1 |
|  | * checklist |  | 25 | 1:1 |
|  | * testing meters |  | 25 | 1:1 |
|  | * gauges |  | 5 | 1:5 |
|  | * laboratory testing tools |  | 1 | 1:25 |
|  | * Sorting machine |  | 1 | 1:25 |
|  | * Packaging machine |  | 1 | 1:25 |

## **INDUSTRIAL PRODUCTS**

**UNIT CODE:** 0720 551 11A

**UNIT DURATION:** 210 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Process Industrial Products.**

**Unit Description**

This unit specifies the competencies required by an Industrial Chemist to process various industrial products which will include processing food, agrochemical, petroleum, pharmaceutical, coating, cosmetic and chemical products.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Process food products | **30** |
|  | Process agrochemical products | **30** |
|  | Process petroleum products | **30** |
|  | Process pharmaceutical products | **30** |
|  | Process coating products | **30** |
|  | Process cosmetics products | **30** |
|  | Process chemical products | **30** |
| **Total** | | **210** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Process food products | 1. Wear personal protective equipment 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Carry out food raw material inspection 8. Setting stage 9. Documentation review 10. Inspection criteria 11. Onsite inspection 12. Conduct raw materials preparation 13. Washing 14. Mixing 15. Chopping 16. Refining 17. Separation 18. Refrigeration 19. Thawing 20. Mix raw materials 21. Conduct food value addition 22. Fortification 23. Enriching 24. Flavouring 25. Preservation 26. Colouring 27. Conduct production quality control 28. Carry out sorting and grading 29. Dispatch production waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Process agrochemical products | 1. Ware PPEs 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Carry out agrochemical raw material inspection 8. Setting stage 9. Documentation review 10. Inspection criteria 11. Onsite inspection 12. Conduct agrochemical raw materials preparation 13. Washing 14. Mixing 15. Chopping 16. Refining 17. Separation 18. Refrigeration 19. Thawing 20. Carry out agrochemical products compounding 21. Conduct production quality control 22. Dispatch production waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Process petroleum products | 1. Ware PPEs 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Petroleum raw material inspection 8. Setting stage 9. Documentation review 10. Inspection criteria 11. Onsite inspection 12. Crude oil refining 13. Distillation 14. Cracking 15. Reforming 16. Hydro processing 17. Isomerization n 18. Alkylation 19. Desalination 20. Fractionation 21. Incorporation of chemical treatment and additives 22. Production quality control 23. Storage of petroleum products 24. Dispatch production waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Process pharmaceutical products | 1. Ware PPEs 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Pharmaceutical raw material inspection 8. Setting stage 9. Documentation review 10. Inspection criteria 11. Onsite inspection 12. Pharmaceutical raw materials preparation 13. Washing 14. Mixing 15. Chopping 16. Refining 17. Separation 18. Refrigeration 19. Thawing 20. Pharmaceutical products compounding 21. Granulation 22. Capsulation 23. Production quality control 24. Pharmaceutical products storage and package 25. Dispatch production waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Process coating products | 1. Ware PPEs 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Assemble coating products raw materials 8. Paint 9. Dyes 10. Inks 11. Vanishes 12. Lacquers 13. Coating products raw material inspection  * Setting stage * Documentation review * Inspection criteria * Onsite inspection  1. Mix coating products raw materials 2. Mill coating products raw materials 3. Blend coating products 4. Coating products quality control 5. Package coating products 6. Dispatch coating products waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Process cosmetics products | 1. Ware PPEs 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Assemble cosmetic products raw materials 8. Perfume 9. Soap 10. Creams 11. Ointments 12. Sunscreen 13. Nail polish 14. Cosmetic products raw material inspection 15. Setting stage 16. Documentation review 17. Inspection criteria 18. Onsite inspection 19. Mix coating products raw materials 20. Cosmetic products quality control 21. Package cosmetic products 22. Dispatch cosmetic products waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Process chemical products | 1. Ware PPEs 2. Eye protection 3. Head protection 4. Face protection 5. Body protection 6. Foot protection 7. Assemble chemical products raw materials 8. Cement 9. Ceramics 10. Polymers 11. Salts 12. Acids 13. Chemical products raw material inspection 14. Setting stage 15. Documentation review 16. Inspection criteria 17. Onsite inspection 18. Chemical product raw materials preparation 19. Washing 20. Mixing 21. Chopping 22. Refining 23. Separation 24. Refrigeration 25. Thawing 26. Chemical product processing 27. Chemical products quality control 28. Package coating products 29. Dispatch chemical products waste for disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted colour of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | * Distilled water | Washing | Enough |  |
|  | * Assorted vitamins | Nutritional | 500g | 1:1 |
|  | * Wheat gluten | Enriching | 500g | 1:1 |
|  | * Sweeteners | Taste | 500g | 1:1 |
|  | * Vinegar | Pickling | 500g | 1:1 |
|  | * Antioxidants | Preservation | 500g | 1:1 |
|  | * Caramel Colour | Colouring | 500g | 1:1 |
|  | * Synthetic Food Colours | Colouring | 500g | 1:1 |
|  | * Spices and Herbs | Aroma | 500g | 1:1 |
|  | * Gloves | Pack | Enough | 1:1 |
|  | * Thinner | Diluting | 500g | 1:1 |
|  | * Primers | Pre-coating | 500g | 1:1 |
|  | * Pigments | Dying | 500g | 1:1 |
|  | * Sodium hydroxide | Saponification | 500g | 1:1 |
|  | * Fragrances | Perfuming | 1L | 1:1 |
|  | * Ethanol | Dispersion | 5L | 1:1 |
|  | * Addictive’s | Exfoliation | 1L | 1:1 |
|  | * Emulsifying wax | Binding | 1L | 1:1 |
|  | * Thickener | Thickening | 1L | 1:1 |
|  | * Glycerine | Hydration | 1L | 1:1 |
|  | * Beeswax | Adding structure | 1L | 1:1 |
|  | * Oils | Moisturizing | Enough | 1:1 |
|  | * Zinc oxide | UV protection |  | 1:1 |
|  | * Naphtha | Reforming |  |  |
|  | * Catalysts |  |  |  |
|  | * Butane |  |  |  |
|  | * Isobutene |  |  |  |
|  | * Brine solution |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | * Scoops | 25 | 25 | 1:1 |
|  | * Refrigerator | Cooling | 1 | 1:25 |
|  | * sampling tubes | Carrying | 25 | 1:1 |
|  | * sampling containers |  | 1 | 1:25 |
|  | * Granular | Granulation | 5 | 1:5 |
|  | * Crushers | Crushing | 1 | 1:25 |
|  | * Mixers | Mixing | 1 | 1:25 |
|  | * Analytical balance | Weighing | 12 | 1:2 |
|  | * pH meter | pH measurement | 12 | 1:2 |
|  | * agitators | Agitation | 5 | 1:5 |
|  | * cold boxes | Cooling | 12 | 1:2 |
|  | * freezers | Freezing | 1 | 1:25 |
|  | * fume hood |  | 2 | 1:12 |
|  | * Automatic labelling machine | Labelling | 1 | 1:25 |
|  | * Fractionating unit | Distillation | 5 | 1:25 |
|  | * Thermometer | Temperature | 25 | 1:25 |

# 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, laboratory and management practices to manage industrial waste. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **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** |
| 0711 551 13A | LABORATORY AND MANAGEMENT PRACTICES | Maintain safe work environment | **20** |
| Manage workplace accidents and incidents | **20** |
| Manage laboratory waste products | **30** |
| Maintain science laboratory equipment | **20** |
| Prepare laboratory reagents | **30** |
| Manage laboratory material resources | **30** |
| 0712 551 14A | INDUSTRIAL WASTES | Sort industrial waste | **40** |
| Carry out industrial waste management 4Rs | **40** |
| Treat industrial waste | **50** |
| Dispose industrial waste | **50** |
| **TOTAL** | **370 HRS** |

## **WORK ETHICS AND PRACTICES**

**UNIT CODE:** 0417 541 13A

**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 |  |  |

## **LABORATORY AND MANANGEMENT PRACTICES**

**UNIT CODE:** 0711 551 13A

**Duration of Unit:** 150 hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply laboratory and management practices

**Unit Description**

This unit of competency provides knowledge required by an Industrial Chemist to apply laboratory and safety management practices. It involves maintaining safe work environment, managing workplace accidents and incidents, managing laboratory waste products, preparing laboratory reagents and managing laboratory material resources.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Maintain safe work environment | **20** |
|  | Manage workplace accidents and incidents | **20** |
|  | Manage laboratory waste products | **30** |
|  | Maintain science laboratory equipment | **20** |
|  | Prepare laboratory reagents | **30** |
|  | Manage laboratory material resources | **30** |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Maintain safe work environment | 1. Identification of laboratory hazards and risks    * 1. Chemical      2. Mechanical      3. Biological      4. Electrical      5. Flames 2. Sources of hazards and risks 3. Laboratory safety procedures 4. Good house keeping 5. PPEs 6. Labelling and storage of laboratory chemicals 7. Safe handling of laboratory reagents and chemicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Manage workplace accidents and incidents | 1. Laboratory related injuries and their treatment    * 1. Burns      2. Bruises      3. Cuts      4. Fractures      5. Sprains      6. Dislocations      7. Suffocation 2. First aid treatment    * 1. definition of first aid      2. types of first aid         1. Cleaning         2. CPR         3. Dressing         4. Ointment application 3. Reporting of accidents | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Manage laboratory waste products | * 1. PPEs   2. Segregation of laboratory waste      1. types of laboratory waste         1. Broken glassware         2. Used reagents         3. Expired chemicals         4. waste paper         5. Biohazardous wastes         6. Polythene bags         7. Sharp objects         8. Liquid spillages         9. Microscopic slides   3. Decontamination of work area      1. Disinfection/sanitization      2. Stain removal      3. Removing solid waste      4. Floor scrubbing   4. Waste disposal      1. Incineration      2. Recycling      3. Reusing      4. Burning      5. Evaporation      6. Burying in pit      7. Land filling      8. Composting | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Maintain science laboratory equipment | 1. Identification of laboratory equipment    * 1. Cleaning      2. Oiling and greasing      3. Sterilization      4. Calibration 2. Maintenance of laboratory equipment 3. Storage of laboratory equipment | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Prepare laboratory reagents | 1. PPEs 2. Determine laboratory reagents ratios 3. Preparation of laboratory reagents   **Types**   * + 1. Acids     2. Bases     3. Indicators\     4. Standard solutions     5. Solvents     6. Salts   **Preparation**   * + 1. Weighing     2. Dissolving     3. Diluting     4. Standardization  1. Labelling and storage of laboratory reagents | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |
| 1. Manage laboratory material resources | * 1. Preparation of laboratory requisitions   2. Maintenance of laboratory inventories   3. Stock taking   4. Dispatchment of expired laboratory chemicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Third Party Reports * Written Assessment |

**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** | | | |
|  | Computer | 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 |
|  | White /black board | For trainer’s use | **1** | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | **Lecture/theory room** |  |  |  |
|  | Fully equipped science laboratory | For trainee use | **1** | 1:25 |
|  | Lecture room | For 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 |
|  | Goggles | For trainee use | **25** | 1:1 |
|  | Face masks | For trainee use | **25** | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Compound light microscope | For trainee use | **5** | 1:5 |
|  | Safety boot | For trainee use | **25 pairs** | 1:1 |
|  | Laboratory coats | For trainee use | **25** | 1:1 |

## **INDUSTRIAL WASTES**

**UNIT CODE:** 0712 551 14A

**UNIT DURATION:** 180 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Manage Industrial Wastes.**

**Unit Description**

This unit of competency covers the ability of an Industrial Chemist to manage industrial waste. It includes sorting industrial waste, carrying out industrial waste, treating industrial waste and disposal of industrial waste.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Sort industrial waste | **40** |
| 2. | Carry out industrial waste management 4Rs | **40** |
| 3. | Treat industrial waste | **50** |
| 4. | Dispose industrial waste | **50** |
| **Total** | | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Sort industrial waste | 1. Collection of industrial waste 2. Liquid waste 3. Hazardous 4. Solid 5. Organic 6. Biological 7. Testing of industrial waste 8. Segregation industrial waste | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Carry out industrial waste management 4Rs | 1. Reduce industrial waste 2. Reuse industrial waste 3. Recover industrial waste 4. Recycle industrial waste | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Treat industrial waste | 1. Assemble industrial waste treatment tools 2. Industrial waste treatment 3. Separation of treated industrial waste 4. Testing of treated industrial waste 5. Chemical analysis 6. Toxicity levels 7. Physical properties analysis 8. Leachability 9. Environmental impact assessment test | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Dispose industrial waste | 1. Segregation of treated industrial waste 2. Dispatchment of industrial waste to waste disposal site 3. Industrial waste disposal | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practicals
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted colour of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
|  |  | For trainer’s use |  |  |
|  |  | For trainer’s use |  |  |
| **C** | **Consumable materials** | | | |
|  | * Color-coded Waste Bags | 5 | 5 | 1:5 |
|  | * Waste Labels or Markers |  | 5 | 1:5 |
|  | * Gloves | Pair | Enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | * Sorting bins |  | 5 | 1:25 |
|  | * Tongs |  | 25 | 1:1 |
|  | * Sifting screens and sieves |  | 25 | 1:1 |
|  | * Magnet |  | 25 | 1:1 |
|  | * Filtration units |  | 5 | 1:5 |
|  | * Centrifuges |  | 5 | 1:5 |
|  | * Incinerators |  | 1 | 1:25 |
|  | * Clarifiers |  | 1 | 1:25 |
|  | * Autoclave |  | 5 | 1:5 |
|  | * Shredders |  | 5 | 1:5 |
|  | * Waste Compactors |  | 1 | 1:25 |
|  | * Scrubbers |  | 1 | 1:25 |
|  | * Oil & Water Separators |  | 5 | 1:5 |

# 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, conduct scientific research to perform process control and optimization. This module consists of the following units of learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **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** |
| 0500 551 16A | SCIENTIFIC RESEARCH | Prepare scientific research proposal | **30** |
| Apply scientific research methods | **40** |
| Analyze scientific research finding | **30** |
| 0711 551 17A | PROCESS CONTROL AND OPTIMIZATION | Conduct manufacturing process and product audit | **50** |
| Carry out process statistical control | **50** |
| Carry out manufacturing process validation | **40** |
| Monitor manufacturing production control system | **40** |
|  |  | **TOTAL** | **340** |

## **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:** 0500 551 16A

**UNIT DURATION:** 100 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)** |
|  | Prepare scientific research proposal | **30** |
|  | Apply scientific research methods | **40** |
|  | Analyze scientific research finding | **30** |
| **Total** | | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare scientific research proposal | 1. Identification of scientific research problem 2. Development of research objectives 3. Designing of research question 4. Development of research proposal    * 1. Explain the meaning of research proposal      2. Types of research proposal      3. Importance of research proposal      4. Components of a research proposal         1. Preliminaries         2. Introduction         3. Statement of problem         4. Objectives of the study         5. Research questions         6. Rationale         7. Literature review         8. Design and methodology         9. References         10. Appendices      5. Identification of appropriate research title | * Written tests * Oral questioning/interview * Observation (practical and projects) |
| 1. Apply scientific research methods | 1. Determination of scientific study design 2. Qualitative designs 3. Quantitative designs 4. Determination of sample size 5. Determination of sampling techniques 6. Probability 7. Non-probability 8. Determination of ethical considerations 9. Identification of research material 10. Collection of data 11. Types of data 12. Sources of data | * Written tests * Oral questioning/interview * Observation (practical and projects) |
| 1. Analyze scientific research findings | 1. Identification of data analysis methods 2. ANOVA 3. Measures of central tendency 4. Measures of dispersal 5. Data analysis    * 1. Coding and editing      2. Data classification      3. Presentation of data in various forms      4. Data analyses      5. Data interpretation 6. Preparation of research report | * Written tests * Oral questioning/interview * Observation (practical and projects) |

**Suggested Methods of Instruction**

* Practicals
* Projects
* Demonstrations
* Group discussion
* 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 |
|  | 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 |
| 1. **11** | 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 |

## **PROCESS CONTROL AND OPTIMIZATION**

**UNIT CODE:** 0711 551 17A

**UNIT DURATION:** 180 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Process Control and Optimization.**

**Unit Description**

This unit of competency covers the ability of an industrial chemist to perform process control and optimization. It involves conducting manufacturing process and product audit, carrying out process statistical control, carrying out manufacturing process validation and monitoring manufacturing production control system.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Conduct manufacturing process and product audit | **50** |
|  | Carry out process statistical control | **50** |
|  | Carry out manufacturing process validation | **40** |
|  | Monitor manufacturing production control system | **40** |
| **Total** | | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct manufacturing process and product audit | 1. Manufacturing process inspection 2. Calcining 3. Casting 4. Moulding 5. Labelling 6. Packaging 7. Assembling 8. Manufacturing products inspection 9. Validation of manufacturing process parameters 10. Temperature 11. pH 12. Machine speed 13. Viscosity 14. Pressure 15. Feed low 16. Voltage time 17. Chemical concentrations 18. Torque 19. Preparation of audit reports     * 1. Purpose of an audit report       2. Types of audit report       3. Components of an audit report       4. Steps of preparing an audit report       5. Qualities of an effective audit report | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Carry out process statistical control | 1. Establishment manufacturing process control units 2. Assembly lines 3. Quality inspection stations 4. Packaging and labelling 5. Mixing and blending 6. Storage 7. Manufacturing process variation review 8. Measuring of manufacturing performance 9. Preparation of manufacturing process control charts 10. Variable control charts 11. Attributes control charts | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Carry out manufacturing process validation | 1. Establishment of manufacturing process design 2. Manufacturing process qualification 3. Development of manufacturing process verification protocols 4. Manufacturing process uncertainty assessment | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |
| 1. Monitor manufacturing production control system | 1. Monitoring of manufacturing production performance 2. Initiation of corrective adjustment 3. Manufacturing operations control 4. Planning and scheduling 5. Quality control and assurance 6. Inventory management | * Written tests * Oral questioning/interview * Observation (practical and projects) * Third party report |

**Suggested Methods of Instruction**

* Practicals
* Projects
* Demonstrations
* Group discussion
* Direct Instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | 10 Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | WIFI | 1 | 1:25 |
|  | 1 Projectors | For trainer’s use | 1 | 1:25 |
|  | 1 Whiteboard | For trainer’s use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s use | 1 | 1:25 |
|  | Assorted colour of whiteboard markers | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For trainer’s use | 1 | 1:25 |
|  | Laboratory | For trainer’s use | 1 | 1:25 |
|  |  | For trainer’s use |  |  |
|  |  | For trainer’s use |  |  |
| **C** | **Consumable materials** | | | |
|  | * Thermal fluids | Metal ions | 5 | 1:5 |
|  | * Pressure sensitive pads |  | 5 | 1:5 |
|  | * pH buffers |  |  |  |
|  | * Assorted acids |  |  |  |
|  | * Thermocouple wire spools |  |  |  |
|  | * Data markers and tags |  |  |  |
|  | * Catalyst pellets |  |  |  |
|  | * pH test strips |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | * Quality and regulatory document for references | Sample collection | 25 | 1:1 |
|  | * Template for audit plan, checklists and report |  | 2 | 1:12 |
|  | * Simulation software | Analysis | 1 | 1:25 |
|  | * Sensors | Measure | 5 | 1:5 |
|  | * pH meters | Measurement | 25 | 1:1 |
|  | * Thermometers |  |  |  |
|  | * Pressure gauges |  |  |  |
|  | * Agitators | Homogenization | 25 | 1:1 |
|  | * Calibration tools | Calibrate | 1 | 1:1 |
|  | * Production counter and timers | Measure | 1 | 1:1 |
|  | * Data analysis software | Analysis | 1 | 1:1 |
|  | * Filtration apparatus | Filtration | 2 | 1:12 |