

**REPUBLIC OF KENYA**

**COMPETENCY-BASED MODULAR CURRICULUM**

**FOR**

**SCIENCE LABORATORY TECHNOLOGY**

**KNQF LEVEL 6**

**PROGRAMME ISCED CODE:****0711 554A**

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social and economic development. Quality education and training contribute to the achievement of Kenya’s development blueprint and sustainable development goals.

Reforms in the education sector are necessary to achieve Kenya Vision 2030 and meet the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution, and this resulted in the formulation of the Policy Framework for Reforming Education and Training in Kenya (Sessional Paper No. 14 of 2012). A key feature of this policy is the radical 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 the mode of delivery allow for multiple entry and exit in TVET programmes.

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 in developing competent human resources for the Science Laboratory Sector’s growth and 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.

**CHAIRMAN OF THE COUNCIL**

# ACKNOWLEDGMENT

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 Science Laboratory 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 science laboratory technology 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 science laboratory technology sector acquire competencies to perform their work more efficiently and effectively.

**COUNCIL SECRETARY**

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# ACRONYMS

CBET : Competency-Based Education and Training

EMF : Electromotive force

ICT : Information communication technology

KNQF : Kenya National Qualification Framework

PPEs : Personal Protective Equipment

SOPs : Standard Operating Procedures

TVET : Technical and Vocational Education and Training

TVETA : Technical and Vocational Education and Training Authority

**KEY TO UNIT CODE**

**Sector / Industry**

**Sub Sector**

**Occupational Area**

**Version Control**

**Unit of Competence Number**

**ISCED level, Programme Orientation and Level of Completion**

xx

x

xxx

x

x

x

# COURSE OVERVIEW

Science Laboratory Technology Level 6 qualification consists of competencies that an individual must possess to become a Science Laboratory Technician. It involves integrating science laboratory practice, biology techniques, chemistry techniques, physics techniques, aquarium, vivarium and herbarium techniques, chemical analyses, laboratory equipment maintenance, cyto-histological and immunological techniques, test material properties, immunological and microbiological techniques, chemical instrumentation techniques and physical quantities measurement.

**Summary Of Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Name** | **Unit Duration (Hours)** | **Credit Factor** |
| **MODULE I** | | | |
| 0031 441 01A | COMMUNICATION SKILLS | 40 | 4 |
| 0588 441 02A | GENERAL SCIENCE SKILLS | 80 | 8 |
| 1022 441 03A | SCIENCE LABORATORY PRACTICE | 180 | 18 |
| 0511 441 04A | BIOLOGY TECHNIQUES | 180 | 18 |
|  | **SUB TOTAL** | **480** | **48** |
| **MODULE II** | | | |
| 0413 441 05A | DIGITAL LITERACY | 40 | 4 |
| 0541 441 06A | BASIC MATHEMATICS FOR SCIENCE | 120 | 12 |
| 1022 541 07A | LABORATORY EQUIPMENT MAINTENANCE | 80 | 8 |
| 0531 441 08A | CHEMISTRY TECHNIQUES | 180 | 18 |
|  | **SUB TOTAL** | **420** | **42** |
| **MODULE III** | | | |
| 0417 441 09A | WORK ETHICS AND PRACTICES | 40 | 4 |
| 0413 441 10A | ENTREPRENEURIAL SKILLS | 40 | 4 |
| 0588 441 11A | SCIENCE LABORATORY RESEARCH | 100 | 10 |
| 0533 441 12A | PHYSICS TECHNIQUES | 180 | 18 |
|  | **SUB TOTAL** | **360** | **36** |
| **MODULE IV** | | | |
| 0541 541 13A | MATHEMATICS FOR SCIENCE | 160 | 16 |
| 0531 541 14A | CHEMISTRY PRINCIPLES | 120 | 12 |
| 0511 5411 15A | AQUARIUM, VIVARIUM AND HERBARIUM TECHNIQUES | 80 | 8 |
| 0531 541 16A | CHEMICAL ANALYSES | 120 | 12 |
|  | **SUB TOTAL** | **480** | **48** |
| **MODULE V** | | | |
| 1022 541 17A | LABORATORY AND MANAGEMENT PRACTICES | 80 | 8 |
| 0533 541 18A | PHYSICS PRINCIPLES | 100 | 10 |
| 0511 541 19A | CYTO-HISTOLOGICAL AND IMMUNOLOGICAL TECHNIQUES | 120 | 12 |
| 0533 541 20A | TEST MATERIAL PROPERTIES | 120 | 10 |
|  | **SUB TOTAL** | **400** | **40** |
| **MODULE VI** | | | |
| 0533 541 21A | BIOLOGY PRINCIPLES | 100 | 10 |
| 0511 541 22A | MICROBIOLOGICAL TECHNIQUES | 100 | 10 |
| 0531 541 23A | CHEMICAL INSTRUMENTATION TECHNIQUES | 100 | 10 |
| 0533 541 24A | PHYSICAL QUANTITY MEASUREMENT | 100 | 10 |
|  | **SUB TOTAL** | **400** | **40** |
|  | **INDUSTRIAL ATTACHMENT** | **480** | **48** |
|  | **GRAND TOTAL** | **3020** | **302** |

**Entry Requirements**

**Science Laboratory Technology Level 6**

An individual enrolling for this course should have the following minimum requirement:

1. A Kenya Certificate of Secondary Education (KCSE) mean grade C- (minus) or KCE Division III.
2. KNQF Level 5 qualification in Science Laboratory Technology.

**Trainer Qualification**

1. Must have a minimum of a KNQF level 7 qualification in Science Laboratory Technology or its equivalent.
2. Must be licensed 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 Science Laboratory a sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Assessment**

**The course shall be assessed formatively and summatively:**

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
3. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
4. Theoretical and practical weighting for each unit of learning shall be as follows
   * 1. 30:70 for the units in module I, II and III
     2. 40:60 for units in modules in IV, V and VI
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 Kenya National TVET Certificate in Science Laboratory Technician 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 awarded upon demonstration of competence in certifiable element within a unit.

These certificates will be issued by Qualification Awarding Institution

# MODULE I UNITS OF LEARNING

# MODULE SUMMARY

The table presented below outlines the units and credit factors included in this module.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0031 441 01A | COMMUNICATION SKILLS | Apply communication channels. | 10 |
| Apply written communication skills. | 12 |
| Apply non-verbal skills. | 4 |
| Apply oral communication skills. | 4 |
| Apply group communication skills | 10 |
| **Total** | **40** |
| 1022 441 02A | SCIENCE LABORATORY PRACTICE | Perform laboratory safety procedure | 60 |
| Maintain laboratory resources | 60 |
| Prepare laboratory reagents and chemicals | 60 |
| **Total** | **180** |
| 0588 441 03A | GENERAL SCIENCE SKILLS | Apply animal anatomy and physiology concepts | 20 |
| Apply plant anatomy and physiology concepts | 20 |
| Apply inorganic chemistry concepts | 10 |
| Apply organic chemistry concepts | 10 |
| Apply physical chemistry concepts | 10 |
| Apply mechanics concept | 10 |
|  |  | **Total** | **80** |
| 0511 441 04A | BIOLOGY TECHNIQUES | Perform cytological test | 20 |
| Perform food test | 20 |
| Carry out microbiological techniques | 50 |
| Care for laboratory animals | 20 |
| Carry out herbarium techniques | 20 |
| Cary out museum techniques | 20 |
| Conduct ecological experiments | 30 |
| **Total** | **180** |
|  |  | **SUB TOTAL** | **480** |

# COMMUNICATION SKILLS

**UNIT CODE:** **0031 441 01A**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Communication Skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit encompasses the skills necessary for effective communication. It includes the utilization of various communication methods, such as written, non-verbal, oral, and group communication techniques.

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply communication channels. | 10 |
| 2. | Apply written communication skills. | 12 |
| 3. | Apply non-verbal skills. | 4 |
| 4. | Apply oral communication skills. | 4 |
| 5 | 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 2. Principles of effective communication 3. Channels/medium/modes of communication 4. Factors to consider when selecting a channel of communication 5. Barriers to effective communication 6. Flow/patterns of communication 7. Sources of information 8. Organizational policies | * Practical assessment * Observation * Portfolio of Evidence * Oral questions * Written assessment * Third party report |
| 1. Apply written communication skills | * 1. Types of written communication   2. Elements of communication   3. Organization requirements for written communication | * Practical assessment * Observation * Portfolio of Evidence * Oral questions * Written assessment * Third party report |
| 1. Apply non-verbal communication skills | * 1. Utilize body language and Gestures   2. Apply body posture   3. Apply workplace dressing code | * Practical assessment * Observation * Portfolio of Evidence * Oral questions * Written assessment * Third party report |
| 1. Apply oral communication skills | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Workplace etiquette   4. Active listening | * Practical assessment * Observation * Portfolio of Evidence * Oral questions * Written assessment * Third party report |
| 1. Apply group discussion skills | * 1. Establishing rapport   2. Facilitating resolution of issues   3. Developing action plans   4. Group organization techniques   5. Turn-taking techniques   6. Conflict resolution techniques   7. Team-work | * Practical assessment * Observation * Portfolio of Evidence * Oral questions * Written assessment * Third party report |

**Suggested Methods of Instruction**

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

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/no.** | **Category/item** | **Description/specification** | **Quantity** | **Recommended ratio(item: trainee)** |
| 1. **Learning materials** | | | | |
|  | Case studies | Published case studies | 5 | 1:5 |
|  | Business plan templates | Standard business plan templates | 5 | 1:5 |
|  | Video clips | Digital types | 25 | 1:25 |
|  | Newspapers and Handouts | Well reputed news papers | 5 | 1:5 |
|  | Business Journals | Well reputed journals | 5 | 1:5 |
| 1. **Learning facilities and infrastructure** | | | | |
|  | Lecture/theory room | 72m2 | 1 | 1:25 |
|  | Whiteboard | 4 feet by 8 feet | 1 | 1:25 |
|  | Projector | LCD High resolution | 1 | 1:25 |
|  | Computers | RAM: 8GB | 25 | 1:25 |
|  | Printers | Ink Jet | 2 | 1:13 |
|  | Smart TV | LCD | 1 | 1:25 |
|  | Internet connection | Adequate speed |  | 1:25 |
| 1. **Consumable materials** | | | | |
|  | Stationary materials | Pens, pencils, papers | Enough for 25 | 1:25 |
|  | Assorted whiteboard markers | Non-permanent | Enough for 25 | 1:25 |

## SCIENCE LABORATORY PRACTICE

**UNIT CODE: 1022 441 02A**

**UNIT DURATION:**  180 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform Science Laboratory Practice

**Unit Description**

This unit specifies the competencies required to perform standard laboratory practices. It involves performing laboratory safety procedures, maintaining laboratory resources and preparing laboratory reagents and chemicals.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Perform laboratory safety procedure | 60 |
| 2. | Maintain laboratory resources | 60 |
| 3. | Prepare laboratory reagents and chemicals | 60 |
| **Total** | | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform laboratory safety procedure | 1. Science laboratory PPEs    * 1. Lab coats      2. Gloves      3. Overalls      4. Goggles      5. Muffs      6. Face shields      7. Helmets      8. Hair nets      9. Respirators      10. Masks 2. Laboratory hazards and risks    * 1. Chemical      2. Biological      3. Electrical      4. Radioactive      5. Musculoskeletal stresses      6. Electrical      7. Physical 3. Handling and storage of laboratory chemicals and reagents    * 1. Acids      2. Bases      3. Salts      4. Indicators      5. Distilled water 4. Laboratory waste disposal    * 1. Sharp objects      2. Glassware      3. Biological samples      4. General lab waste      5. Wipes      6. Gloves      7. Tissues      8. Chemicals      9. Radioactive materials      10. Electrical materials 5. Laboratory safety rules 6. Risk assessment in the laboratory 7. Types of laboratory related Injuries and their treatment 8. First aid procedures. 9. Development of emergency response procedures and preparedness. 10. Maintenance of records of hazards, risk assessment and control measures | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Maintain laboratory resources | * 1. Laboratory inventory maintenance   2. Maintain laboratory equipment and apparatus      1. Calibration      2. Cleaning      3. Dusting      4. Painting.   3. Storage of laboratory resources   4. Disposal of obsolete laboratory resources | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 3. Prepare laboratory reagents and chemicals | * 1. Assembly of laboratory equipment      1. Bunsen burner      2. Microscopes      3. Hot plates      4. Magnetic stirrer      5. Water baths      6. Oven      7. Freezers      8. Furnace   3.2 Assembly of laboratory of laboratory apparatus   * + 1. Balances     2. Wash bottles     3. Glass ware     4. Crucibles     5. Brushes     6. Filter papers     7. Pestle and mortar   1. Preparation of laboratory reagents and chemicals      1. Acids      2. Bases      3. Salts      4. Indicators      5. Distilled water   2. Storage of laboratory reagents and chemicals | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |

**Suggested Methods of Instruction**

* Demonstration
* Viewing of related videos
* 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 room | For trainee use | 1 | 1:25 |
|  | Standard 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** | **Apparatus 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 |

## GENERAL SCIENCE SKILLS

**UNIT CODE: 0588 441 03A**

**UNIT DURATION:**  80 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply general science principles

**Unit Description**

This unit covers the competencies required to apply general science principles. It involves applying animal anatomy and physiology concepts, plant anatomy and physiology concepts, inorganic chemistry concepts, organic chemistry concepts, physical chemistry concepts, mechanics concepts and thermodynamics concepts.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply animal anatomy and physiology concepts | 20 |
| 2. | Apply plant anatomy and physiology concepts | 20 |
| 3. | Apply inorganic chemistry concepts | 10 |
| 4 | Apply organic chemistry concepts | 10 |
| 5 | Apply physical chemistry concepts | 10 |
| 6 | Apply mechanics concept | 10 |
|  | **Total** | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply animal anatomy and physiology concepts | * 1. Animal nutrition      1. Parasitism      2. Symbiosis      3. Saprophytism      4. Holozoic nutrition   2. Animal transport system      1. Types of circulation      2. Components of the human circulatory system   3. Animal reproduction      1. Organs of the human reproductive system   4. Animal excretory system      1. Organs of the human excretory system      2. Animal gaseous exchange system   5. Organs of gaseous exchange in an insect | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |
| 1. Apply plant anatomy and physiology concepts | * 1. Plant nutrition      1. Autotropism- process of photosynthesis   2. plant transport system      1. structure of xylem tissues      2. structure of phloem tissue   3. Plant reproduction      1. Sexual reproduction      2. Asexual reproduction   4. Plant excretory system      1. Plant excretory products   5. Economic importance of plant excretory products   6. Plant gaseous exchange system      1. Mechanism of opening and closing of stomata | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |
| 1. Apply mechanics concept | * 1. Friction      1. Definition      2. Applications   2. Newton’s Law of Motion      1. Circular motion      2. Angular displacement      3. Angular velocity      4. Angular acceleration      5. Tension      6. Definition      7. Applications   3. Shear   4. Bulk modulus | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |
| 1. Apply thermodynamics concepts | * 1. Modes of heat transfer      1. Conduction      2. Convection      3. Radiation   2. Thermodynamic laws      1. First law of thermodynamics      2. Second law of thermodynamics   3. Work, energy and power   4. Definition   5. Application | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |
| 1. Apply inorganic chemistry concepts | * 1. Apply Elements classification knowledge  1. S- block elements 2. P-block elements 3. D- block elements 4. Model Chemical bonds 5. Ionic bond 6. Covalent bond 7. Metallic bond 8. Dative bond 9. Hydrogen bonding 10. Prepare Inorganic salt | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |
| 1. Apply organic chemistry concepts | * 1. Apply Organic compound classification knowledge  1. Ionic bond 2. Covalent bond 3. Metallic bond 4. Dative bond 5. Hydrogen bonding    1. Model Organic compound    2. Apply Organic reaction concept       1. Ionic bond       2. Covalent bond       3. Metallic bond       4. Dative bond    3. Hydrogen bonding | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |
| 1. Apply physical chemistry concepts | * 1. Identify Acids and bases   2. Acids      1. Hydrochloric acid      2. Sulphuric (VI) acid      3. Nitric (V) acid   3. Bases      1. Sodium hydroxide      2. Ammonia solution      3. Calcium hydroxide   4. Apply Gas law concept      1. Boyle’s Law      2. Charle’s Law      3. Daltons Law of partial pressures      4. Grahams Law of diffusion   5. Apply Electrochemistry concept.      1. Reduction      2. Oxidation      3. Electrolysis      4. Faraday’s Laws 1 and 2   6. Electrolytes | * Practical tests * Written tests * Observation * Portfolio of evidence * Third party report |

**Suggested Methods of Instruction**

* Demonstration
* Viewing of related videos
* Discussion
* Direct Instruction
* Field study

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | 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 colour of whiteboard markers | Red, blue and black | 3 | 1:25 |
|  | thermometers | Liquid in glass thermometer | 25 | 1:1 |
|  | stopwatches | Digital | 25 | 1:1 |
|  | weighing balances | Electronic balance  (0-2kg) | 5 | 1:5 |
|  | calorimeters | Copper calorimeters | 25 | 1:1 |
|  | Solid block | wooden | 25 | 1:1 |
|  | Ball bearing | One packet | 25 | 1:1 |
|  | Rollers | One packet | 25 | 1:1 |
|  | Spring | 2N/cm | 25 | 1:1 |
|  | Rubber band | Standard | 25 | 1:1 |
|  | Portable burner | 300g | 25 | 1:1 |
|  | Source of water | Taps/sinks | 10 | 2:5 |
|  | Electric sockets | Single sockets | 10 | 2:5 |
|  | pulley | single |  | 1:1 |
|  | Inclined plain | 4 |  | 1:25 |
|  |  |  |  |  |
| **B** | **Learning Facilities & infrastructure** | | | |
| 1 | standard Science laboratory |  | 1 | 1:25 |
| **2** | Ovens | For trainer’s and trainee use | 1 | 1:25 |
| **3** | Furnace | For trainer’s and trainee use | 1 | 1:25 |
| **4** | Colorimeter | For trainer’s and trainee use | 1 | 1:25 |
| **5** | Flame emission spectrophotometer | For trainer’s and trainee use | 1 | 1:25 |
| **6** | Furnace | For trainer’s and trainee use | 1 | 1:25 |
| **7** | Analytical Balance | For trainer’s and trainee use | 5 | 1:5 |
| **8** | Soxhlet extractor | For trainer’s and trainee use | 4 | 1:8 |
| **9** | Khjedhal Apparatus | For trainer’s and trainee use | 3 | 1:8 |
| **10** | Microscopes | For trainer’s and trainee use | 5 | 1:5 |

## BIOLOGICAL TECHNIQUES

**UNIT CODE: 0511 441 04A**

**UNIT DURATION:**  180 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform Biology Techniques

**Unit Description**

This unit specifies the competencies required to Perform Biology Techniques. It involves performing cytological test, performing food test, Care for laboratory animals and carrying out microbiological techniques. It also entails carrying out herbarium techniques, carrying out museum techniques and conducting ecological experiments.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Perform cytological test | 20 |
| 2. | Perform food test | 20 |
| 3. | Carry out microbiological techniques | 50 |
| 4 | Care for laboratory animals | 20 |
| 5 | Carry out herbarium techniques | 20 |
| 6 | Cary out museum techniques | 20 |
| 7 | Conduct ecological experiments | 30 |
|  | **Total** | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Perform cytological test | * 1. Identification of plant and animal cells and tissues and their structures.   2. Isolation and staining of plant and animal cells.   3. Microscopy and micrometry.   4. Types of microscopes  1. Florescent microscope 2. Bright field microscope 3. Dark ground microscope 4. Electron microscope 5. Phase contrast microscope 6. Dissecting microscope    1. Movement of substances in and out of the cell:       1. Exocytosis       2. Endocytosis    2. Preparation of solutions of various concentrations to demonstrate diffusion and osmosis    3. Active transport:       1. Primary active transport       2. Secondary active transport    4. Cell division       1. Mitosis       2. meiosis | * Practical test * Portfolio of evidence * Written tests * Third party report * Oral questioning |
| * + - 1. Perform food test | * 1. Apparatus used for food test.   2. Preparation of reagents used for food test      1. Test for reducing sugars      2. Test for non-reducing sugars      3. Test for proteins      4. Test for starch      5. Test for vitamin C (Ascorbic acid)      6. Test for lipids   3. Laboratory practical report writing. | 1. Practical test 2. Portfolio of evidence 3. Written tests 4. Third party report 5. Oral questioning |
| * + - 1. Carry out microbiological techniques | * 1. Types of microorganisms:      1. Bacteria      2. Fungi      3. Protozoa      4. Viruses   2. Aseptic techniques   3. Sterilization techniques      1. Dry heat      2. Wet heat      3. Radiation.   4. Preparation of culture media:      1. Agar      2. Broth   5. Types of culture media      1. Basal media      2. Enriched media      3. Selective media      4. Enrichment media      5. Transport media      6. Storage media   6. Culture of microorganisms   7. Preparation and observation of bacterial smears   8. Disposal of pathogenic materials. | * Practical test * Portfolio of evidence * Written tests * Third party report * Oral questioning |
| * + - 1. Care for laboratory animals | * 1. Types of laboratory animals.      1. Rats      2. Guinea pigs      3. Rabbits      4. Mongolian gerbil      5. Hamsters      6. Insects      7. Birds   2. Housing, feeding and handling of laboratory animals   3. Humane killing of laboratory animals:      1. Physical methods      2. Chemical methods      3. Electrical methods   4. Dissection of laboratory animals   5. Diseases and pests’ control in an animal house.      1. Bacterial diseases      2. Fungal diseases      3. Viral diseases      4. Protozoan diseases   6. Methods of disposal of carcasses.      1. Incineration.      2. Burying.      3. Preservation. | 1. Practical test 2. Portfolio of evidence 3. Written tests 4. Third party report 5. Oral questioning |
| * + - 1. Carry out herbarium technique | * 1. Tools for plant specimen collection:      1. Cutting tools      2. Digging tools      3. Collection bags      4. Field stationery      5. Plant press      6. Blotting papers   2. Methods of collecting of plant specimens.      1. Weeding      2. Pruning      3. Irrigation   3. Pest control      1. Planting   4. Types of herbarium specimen.      1. Leaves      2. Roots      3. Flowers      4. Fruits      5. Whole plants      6. Seeds      7. Stems   5. Preservation of plant specimens   6. Labelling, Storage and display of plant specimens | 1. Practical test 2. Portfolio of evidence 3. Written tests 4. Third party report 5. Oral questioning |
| 1. Carry out museum technique | * 1. Collection of museum specimen.   2. Tools used for museum specimen collection.  1. Museum jars 2. Killing jars 3. Pouter 4. Nets 5. Traps 6. Field stationeries 7. Collection bags 8. Pair of tongs and forceps    1. Types of museum specimen. 9. Arthropods 10. Mammals 11. Reptiles 12. Birds 13. Plants 14. Fish 15. Annelids     1. Preservation of animal specimen.     2. Labelling, Storage and display of animal specimen. | * Practical test * Portfolio of evidence * Written tests * Third party report * Oral questioning |
| 1. Conduct ecological experiments | * 1. Terminologies used in ecology  1. Species 2. Habitat 3. Population 4. Community 5. Niche 6. Ecosystem 7. Biome 8. Biosphere 9. Energy transfer in ecosystem    1. Ecological equipment 10. Quadrats 11. Nets 12. Tape measure 13. Ropes and strings 14. Marker pens 15. Instruments of measuring elements of weather     1. Use and care of ecological equipment     2. Identification of Biotic factors     3. Ecological interactions        1. Symbiosis        2. Competition        3. Parasitism        4. Commensalism        5. Predation     4. Identification of Abiotic factors.     5. Population estimation methods. | 1. Practical test 2. Portfolio of evidence 3. Written tests 4. Third party report 5. Oral questioning |

**Suggested Methods of Instruction**

* Demonstration
* Viewing of related videos
* Discussion
* Direct Instruction
* Field excursion

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Computer | For trainer’s use | 1 | 1:25 |
|  | 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 |
| **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 |
|  | Masks | For trainee use | **25** | 1:1 |
|  | laboratory animals (rats) | For trainee use | **5** | 1:5 |
|  | Dissecting kit | For trainee use | **5** | 1:5 |
|  | Dissecting board | For trainee use | **5** | 1:5 |
|  | Covers slips | For trainee use | **5** | 1:5 |
|  | Glass slides | For trainee use | **5** | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Compound light microscope | For trainee use | **5** | 1:5 |

# MODULE II UNITS OF LEARNING.

# MODULE SUMMARY

The table presented below outlines the units and credit factors included in this module.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0611 451 05A | DIGITAL LITERACY | Operate Computer Devices | **6** |
| Solve Tasks Using Office Suite | **14** |
| Manage Data and Information | **6** |
| Perform Online Communication and Collaboration | 4 |
| Apply Cybersecurity Skills | 4 |
| Perform Online Jobs | 4 |
| Apply Job Entry Techniques | 2 |
|  |  | **Total** | 40 |
| 0541 441 06A | BASIC MATHEMATICS FOR SCIENCE | Apply basic arithmetic operation | 10 |
| Apply algebraic equation and expression | 10 |
| Apply vectors | 10 |
| Apply trigonometry | 50 |
| Apply statistical methods | 40 |
|  | **Total** | **120** |
| 1022 541 07A | LABORATORY EQUIPMENT MAINTENANCE | Perform pre-use checks on laboratory equipment | **20** |
| Perform calibration checks on laboratory equipment | **25** |
| Perform equipment cleaning | **25** |
| **Total** | **70** |
| 0533 441 07A | CHEMISTRY TECHNIQUES | Carry out pH measurement | 60 |
| Analyse chemical sample | 60 |
| Carry out separation technique | 60 |
| **Total** | 180 |
|  |  | **Grand Total** | **340** |

## DIGITAL LITERACY

**UNIT CODE: 0611 451 05A**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Digital Literacy

**Duration of Unit:** 40 Hours

**Unit Description**

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

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Operate computer devices | **6** |
| 2. | Solve tasks using office suite | **14** |
| 3. | Manage data and information | **6** |
| 4 | Perform online communication and collaboration | 4 |
| 5 | Apply cybersecurity skills | 4 |
| 6 | Perform online jobs | 4 |
| 7 | 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 Hardware      1. The System Unit E.g. Motherboard, CPU, casing      2. Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices.      3. Output Devices e.g. hardcopy output and softcopy output      4. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives      5. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc.   6. Classification of computer software   7. Operating system functions   8. Procedure for turning/off a computer   9. Mouse use techniques   10. Keyboard Parts and Use Techniques   11. Desktop Customization   12. File and Files Management using an operating system   13. Computer Internet Connection Options       1. Mobile Networks/Data Plans       2. Wireless Hotspots       3. Cabled (Ethernet/Fiber)       4. Dial-Up   1.14 Satellite  1.15 Computer external devices management   1. Device connections 2. Device controls (volume controls and display properties) | * 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/preferences 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. Document Print setup   2.9.1 Page layout,  2.9.2 Margins set up  2.9.3 Orientation.   1. Word Document Printing 2. Meaning & Importance of electronic spreadsheets 3. Components of Spreadsheets 4. Application areas of spreadsheets 5. Using spreadsheet application 6. Parts of Excel screen: ribbon, formula bar, active cell, name box, column letter, row number, Quick Access Toolbar. 7. Cell Data Types 8. Block operations 9. Arithmetic operators (formula bar (-, +, 10. Cell Referencing 11. Data Manipulation 12. Using Functions (Sum, Average, SumIF, Count, Max, Max, IF, Rank, Product, mode etc) 13. Using Formulae 14. Sorting data 15. Filtering data 16. Visual representation using charts 17. Worksheet printing     1. Electronic Presentations     2. Meaning and Importance of electronic presentations     3. Examples of Presentation Software     4. Using the electronic presentation application 18. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars). 19. Open and close presentations 20. Creating Slides (Insert new slides, duplicate, or reuse slides.) 21. Text Management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check). 22. Use magnification/zoom tools 23. Apply or change a theme. 24. Save a presentations 25. Switch between open presentations     1. Developing a presentation 26. Presentation views 27. Slides 28. Master slide     1. Text 29. Editing text 30. Formatting 31. Tables     1. Charts 32. Using charts 33. Organization charts     1. Graphical objects 34. Insert, manipulate 35. Drawings     1. Prepare outputs 36. Applying slide effects and transitions     1. Check and deliver 37. Spell check a presentation 38. Slide orientation 39. 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    10. Web browsing concepts    11. Key concepts    12. Security and safety    13. Web browsing    14. Using the web browser    15. Tools and settings    16. Clearing Cache and cookies    17. URIs    18. Bookmarks    19. Web outputs    20. Web based information    21. Search    22. Critical evaluation of information    23. Copyright, data protection    24. Downloads Management    25. Performing Digital Data Backup (Online and Offline)    26. Emerging issues in internet | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform online communication and collaboration | 1. Netiquette principles 2. Communication concepts    1. Online communities    2. Communication tools    3. Email concepts 3. Using email    1. Sending email    2. Receiving email    3. Tools and settings    4. Organizing email 4. Digital content copyright and licenses 5. 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) 6. Preparation for online collaboration    1. Common setup features    2. Setup 7. Mobile collaboration    1. Key concepts    2. Using mobile devices    3. Applications    4. 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**

* + Practical
  + Projects
  + Demonstrations
  + Group discussions
  + 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 |
|  | Sample CVs | For trainee’s use | 5 | 1:5 |
|  | * Sample job applications | For trainee’s use | 5 | 1:5 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room |  | 1 | 1:25 |
|  | Computers with OS (Windows/Linux/Mac), Microsoft Office, Google Workspace, Antivirus | For trainee’s use | 25 | 1:1 |
|  | Internet connection | For trainees and trainer’s use | 1 connection | 1:25 |
|  | Whiteboard | For trainer’s use | 1 | 1:25 |
|  | Smartboard/Smart TV (Where applicable) | 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 |
|  | External storage media | For trainer and trainee use | Varies | 1:1 or 1:5 depending on need |
|  | Projector | For trainer’s use | 1 | 1:25 |

## BASIC MATHEMATICS FOR SCIENCE

**UNIT CODE: 0541 441 06A**

**UNIT DURATION:**  120 Hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Basic Mathematics for science.

**Unit Description**

This unit specifies the competencies required to apply fundamental mathematical techniques. It involves applying basic arithmetic operations, solving algebraic equations and expressions, performing vector operations, using trigonometric principles, and applying statistical methods.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply basic arithmetic operation | 10 |
| 2. | Apply algebraic equation and expression | 10 |
| 3. | Apply vectors | 10 |
| 4 | Apply trigonometry | 50 |
| 5 | Apply statistical methods | 40 |
|  | Total | 120 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply basic arithmetic operation | 1. Addition and subtraction on;    * 1. Natural numbers      2. Integers      3. Fractions      4. Decimals 2. Multiplication and division on;    * 1. Natural numbers      2. Integers      3. Fractions      4. Decimals 3. Ratios, proportions and percentages    * 1. Direct proportion      2. Inverse proportion 4. Indices    * 1. Bases      2. Laws of indices      3. Indicial equations | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Apply algebraic equation and expression | * 1. Solution of linear equations   2. Solution of simultaneous      1. Elimination method      2. Substitution method      3. Graphical method   3. Linear graphs      1. Co-ordinates      2. Plotting of points      3. Graphs of straight lines   4. Solution of quadratic equations      1. Factorization      2. Completing square method      3. Quadratic formula | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Apply vectors | 1. Introduction to vectors 2. Definition of vectors 3. Vector quantities 4. Scalar quantity 5. Vectors addition 6. Vectors subtraction 7. Vectors multiplication 8. Position of vectors 9. Modulus of a vector | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Apply trigonometry | 1. Pythagoras theorem 2. Trigonometric ratios    * 1. Sine      2. Cosine      3. tangent 3. Trigonometric operations    * 1. Trigonometric identities      2. Trigonometric equations      3. Sine rule      4. cosine rule      5. Tangent rule 4. Angles of elevation and depression | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Apply statistical methods | * 1. Collection of raw data  1. Ungrouped data 2. Grouped data    1. Data presentation 3. Pictograms 4. Histograms 5. Pie charts 6. Bar charts 7. Frequency polygon    1. Processing of raw data    2. Measures of central tendency       * 1. Mean         2. Mode         3. Median | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |

**Suggested Delivery Methods**

* Practical
* projects
* Group discussions
* Demonstration
* 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 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 |
|  | Graph book | For trainee’s use | 25 | 1:1 |
|  | 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 |

## LABORATORY EQUIPMENT MAINTENANCE

**UNIT CODE: 1022 541 07A**

**Duration of Unit:** 80 Hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Maintain laboratory equipment.

**Unit Description**

This unit of competency covers the ability of a laboratory technologist to perform pre-use checks on laboratory equipment, perform calibration checks on laboratory equipment and perform equipment cleaning.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Perform pre-use checks on laboratory equipment | **20** |
|  | Perform calibration checks on laboratory equipment | **25** |
|  | Perform equipment cleaning | **25** |
|  | **Total** | **70** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform pre-use checks on laboratory equipment. | 1. Parts of laboratory equipment 2. Functions of laboratory equipment | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform calibration checks on laboratory equipment. | 1. Calibration of laboratory equipment 2. Operation procedures of laboratory equipment | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform equipment cleaning. | 1. Maintenance of laboratory equipment 2. Dusting and cleaning 3. Lubrication 4. Overhaul maintenance 5. Calibration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Delivery Methods**

* + Practical
  + Projects
  + Demonstrations
  + Group discussions
  + 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 |
|  | Computer | For trainer’s use | 1 | 1:25 |
|  | Projector |  | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | **1** | 1:25 |
|  | Flip charts | For trainer’s use | **1** | 1:25 |
|  | Stationeries | For trainee use | **25** | 1:1 |
| **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** | | | |
| **1.** | Disinfectant | For trainee use | **25** | 1:1 |
|  | Gloves | For trainee use | **25** | 1:1 |
|  | Laboratory coats | For trainee use | **25** | 1:1 |
|  | Face Masks | For trainee use | **25** | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Projector |  | 1 | 1:25 |
|  | First aid kit | For trainee use | **1** | 1:25 |
|  | Goggles | For trainee use | **25** | **1:1** |
|  | Safety boots | For trainee use | **25** | **1:1** |

## CHEMISTRY TECHNIQUES

**UNIT CODE: 0531 441 08A**

**UNIT DURATION**: 180 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Chemistry Techniques**

**Unit Description**

This unit specifies the competencies required to perform chemistry techniques. It involves carrying out pH measurements, analyzing chemical samples and carrying out separation techniques.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Carry out Ph measurement | 60 |
| 2. | Analyse chemical sample | 60 |
| 3. | Carry out separation technique | 60 |
|  | **Total** | 180 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out pH measurement | * 1. Assemble pH apparatus and equipment  1. Indicator papers 2. Glassware 3. Glassware 4. Hot plates 5. Burettes 6. Pipettes 7. Magnetic stirrer plates 8. Bunsen burners 9. Spatulas 10. Crucibles 11. Tripod stand 12. Clamp and stand 13. Test tube racks 14. Tongs     1. Measurement Sample pH 15. Distilled water 16. pH indicator solutions 17. Organic solvents 18. Inorganic solvents 19. Reported sample pH result | * Practical * Projects * Demonstrations * Group discussion * Direct Instructions * Written tests |
| 1. Analyse chemical sample | * 1. Assemble chemical analysis apparatus and equipment      1. Glassware  1. Hot plates 2. Burettes 3. Pipettes 4. Magnetic stirrer plates 5. Bunsen burners 6. Spatulas 7. Crucibles 8. Tripod stand 9. Clamp and stand 10. Test tube racks 11. Tongs 12. Analytical balances 13. Ovens 14. Karl Fischer titrators     1. Prepare chemical samples and reagents 15. Alcoholic beverages 16. Food substances 17. Petroleum products 18. Soil 19. Gases 20. Metal ores 21. Mineral salts 22. Organic acids 23. Inorganic acids 24. Organic bases 25. Inorganic bases 26. Polar solvents 27. Non-polar solvents     1. Perform chemical analysis 28. Volumetric 29. Gravimetric 30. Flame photometry 31. Colorimetry     1. Reported chemical analysis results | * Practical * Projects * Demonstrations * Group discussion * Direct Instructions * Written tests |
| 1. Carry out separation technique | * 1. Assemble Separation technique apparatus and equipment  1. Glassware 2. Pestle and mortar 3. Water bath 4. Separating funnel 5. Hot plates 6. Magnetic stirrer plates 7. Bunsen burners 8. Spatula 9. Crucibles 10. Tripod stand 11. Filter paper 12. Clamp and stand 13. Chromatography paper 14. Thin layer chromatography development chamber 15. Tongs 16. Distillation apparatus 17. Soxhlet apparatus 18. Analytical balance 19. Oven 20. Furnace 21. Fridge     1. Prepare chemical sample and separation reagent        1. Organic solvents        2. Distilled water        3. Inorganic solvents     2. Perform sample separation        1. Distillation        2. Evaporation        3. Paper chromatography        4. Decantation        5. Extraction        6. Filtration        7. Crystallization     3. Report separation result | * Practical * Projects * Demonstrations * Group discussion * Direct Instructions * Written tests |

**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** | | | |
|  | Desktop computer/laptop | For trainer’s use | 2 | 1:12 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Standard laboratory manuals | 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 |
|  | Separation technique apparatus | For trainee use | 5 | 1:5 |
|  | Assorted chemical samples | For trainee use | 5 | 1:5 |
| **B** | **Learning Facilities & infrastructure** | | | |
| 1. | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
| 2. | Standard Science laboratory | For trainee use | 1 | 1:25 |
| 3. | Internet connection | For trainee use | Enough |  |
| 4. | 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 Glassware | For trainee use | enough | 1:1 |
|  | Assorted equipment | For trainee use | enough | 1:5 |
|  | Pestle and mortars | For trainee use | 12 | 1:2 |
|  | Desiccators | For trainee use | 4 | 1:8 |
| 1. **10** | Droppers/teat pipettes | For trainee use | 25 | 1:1 |
| 1. **11** | Assorted chemicals [acids, bases, solvents, salts] | For trainee use | enough | 1:1 |
|  | Calibration standards | For trainer and trainee use | enough | 1:1 |
| **D** | **Tools and Equipment** | | | |
| **1.** | Analytical balances | For trainee use | 5 | 1:5 |
| **2.** | First aid kit | For trainee use | 5 | 1:25 |
| **3.** | Muffle Furnace | For trainee use | 1 | 1:25 |
| **4** | oven | For trainee use | 2 | 1:12 |
| **5** | centrifuges | For trainee use | 4 | 1:6 |
| **6** | refrigerator/freezer | For trainee use | 1 | 1:25 |
| **7** | Desiccators | For trainee use | 4 | 1:8 |
| **8** | Water bath | For trainee use | 3 | 1:8 |
| **9** | hot plate | For trainee use | 6 | 1:4 |
| **10** | Magnetic stirrer | For trainee use | 4 | 1:6 |
| **11** | colorimetric | For trainer and trainee use | 1 | 1:25 |
| **12** | Atomic Emission spectrophotometer | For trainer and trainee use | 1 | 1:25 |
| **13** | Soxhlet extractor | For trainee use | 5 | 1:5 |
| **12** | pH meter | For trainee use | 5 | 1:5 |
| **13** | pH testing pens | For trainee use | 5 | 1:5 |
| **14** | Buffer solutions | For trainee use | 5 | 1:5 |
| **15** | Sample storage apparatus | For trainee use | 25 | 1:1 |
| **16** | Magnetic stirrers | For trainee use | 5 | 1:5 |
| **19** | Titration apparatus | For trainee use | 25 | 1:1 |
| **17** | Separation technique apparatus | For trainee use | 5 | 1:5 |

# MODULE III UNITS OF LEARNING

# MODULE SUMMARY

The table presented below outlines the units and credit factors included in this module.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0417 441 08A | 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** |
| **Total** | **40** |
| 0413 441 09A | ENTREPRENEURIAL SKILLS | Apply financial literacy skills | **6** |
| Apply the entrepreneurial concept | **4** |
| Identify entrepreneurship opportunities | **6** |
| Apply business legal aspects | **6** |
| Innovate business strategies | **6** |
| Develop a business plan | **12** |
|  |  | **Total** | **40** |
| 0588 441 10A | SCIENCE LABORATORY RESEARCH | Prepare science laboratory research data collection tools | **30** |
| Carry out science laboratory research data collection | **40** |
| Carry out science laboratory research data analysis | **30** |
| Prepare Scientific Research Proposal | **30** |
| Apply Scientific Research Methods | **30** |
| Analyze Scientific Research Findings | **30** |
| Total | **100** |
| 0533 441 11A | PHYSICS TECHNIQUES | Measure physical quantities | **20** |
| Perform pressure experiment | **20** |
| Measure heat capacity | **30** |
| Conduct wave experiment | **20** |
| Perform optical experiment | **20** |
| Conduct electrical experiment. | **20** |
| Carry out electromagnetism experiment | **30** |
| Perform particulate nature of matter experiment | **20** |
| **Total** | **180** |
|  |  | **GRAND TOTAL** | **360** |

## WORK ETHICS AND PRACTICES

**UNIT CODE:** 0417 441 09A

**Relationship to Occupational Standards**

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

**Duration of Unit:** 40 hours

**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**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply self-management skills | **10** |
| 2. | Promote ethical work practices and values | **4** |
| 3. | Promote team work | **10** |
| 4 | Maintain professional and personal development | **10** |
| 5 | Apply problem solving skills | **4** |
| 6 | 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. Self-awareness 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   7. Qualities of a team player  1. Leading a team 2. Team performance and evaluation 3. Conflicts and conflict resolution 4. Gender and diversity mainstreaming 5. Developing Healthy workplace relationships 6. Adaptability and flexibility 7. 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
  + Projects
  + Demonstrations
  + Group discussions
  + 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 |
|  | Charts | For trainees and Trainer’s use | 6-10 | 1:5 pr 1:10 |
|  | * Video clips | For trainees and Trainer’s use | Varies | Varies |
|  | Audio tapes | For trainees and Trainer’s use | Varies | Varies |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | For Trainer/trainee’s use | 1 | 1:25 |
|  | Computers | For trainee’s use | 25 | 1:1 |
|  | Radio sets | For trainee’s use | 3-5 | 1:5 or 1:10 |
|  | TV sets | For trainee’s use | 3-5 | 1:5 or 1:10 |
| **C** | **Consumable materials** | | | |
|  | Stationery | For trainees and trainer’s use | Varies | Varies |
| **D** | **Tools and Equipment** | | | |
|  | LCD projectors | For trainer’s use | 1 | 1:25 |

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** 0413 441 10A

**Relationship to occupational standards**

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

**Duration of unit:** 40 hours

**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**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply financial literacy skills | **6** |
| 2. | Apply the entrepreneurial concept | **4** |
| 3. | Identify entrepreneurship opportunities | **6** |
| 4 | Apply business legal aspects | **6** |
| 5 | Innovate business strategies | **6** |
| 6 | Develop a 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 | * Practical * Portfolio of evidence * Project * Observation * Written assessment * Oral assessment * Third party reports * Interviews |
| 2.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 * Third party report |
| 3.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 * Third party report |
| 4.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 * Third party report |
| 5.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 * Third party report |
| 6.Develop Business Plan | * 1. Business description   2. Marketing plan   3. Organizational/Management   4. plan   5. Production/operation plan   6. Financial plan   7. Executive summary   8. Business plan presentation   9. Business idea incubation | * Observation * Written assessment * Project * Oral assessment * Third party report |

**Suggested Methods of Instruction**

* Direct instruction with active learning strategies
* Project (Business plan)
* Case studies
* Field trips
* Group Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training
* Guest speakers

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/no.** | **Category/item** | **Description/specification** | **Quantity** | **Recommended ratio(item: trainee)** |
| 1. **Learning materials** | | | | |
|  | Report writing templates | Digital report template | 5 | 1:5 |
|  | Flashcards | Educational flash cards | 5 | 1:5 |
|  | Flip charts | Educational flip charts | 5 | 1:5 |
| 1. **Learning facilities and infrastructure** | | | | |
|  | Lecture/theory room | 72m2 | 1 | 1:25 |
|  | Whiteboard | 4 feet by 8 feet | 1 | 1:25 |
|  | Projector | LCD High resolution | 1 | 1:25 |
|  | Computers | RAM: 8GB | 25 | 1:25 |
|  | Printers | Ink Jet | 2 | 1:13 |
| 1. **Consumable materials** | | | | |
|  | Printing Papers | A4 | Enough for 25 | 1:25 |
|  | Assorted whiteboard markers | Non-permanent | Enough for 25 | 1:25 |
| 1. **Tools and equipment** | | | | |
|  | Mobile phones | Functioning smart phone | Enough for 25 | 1:25 |

## SCIENCE LABORATORY RESEARCH

**UNIT CODE:** 0588 441 11A

**UNIT DURATION:**  100 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Science Laboratory research.

**Unit Description**

This unit outlines the necessary competencies for performing research in a science laboratory. It includes the preparation of tools for data collection, the execution of data collection in the laboratory, and the analysis of the collected research data, preparing for science laboratory research, carrying out science laboratory research and analyzing the science laboratory research findings. It also includes documenting and disseminating science laboratory research findings

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Prepare science laboratory research data collection tools | **30** |
| 2. | Carry out science laboratory research data collection | **40** |
| 3. | Carry out science laboratory research data analysis | **30** |
| 4 | Prepare Scientific Research Proposal | **30** |
| 5 | Apply Scientific Research Methods | **30** |
| 6 | Analyze Scientific Research Findings | **30** |
|  | **Total** | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare science laboratory research data collection tools. | 1. Project topics 2. Literature review 3. Study site 4. Sample size determination 5. Materials and methods 6. Ethical considerations 7. Data collection tools:    * 1. Questionnaires      2. Photography      3. Videos tapes      4. Google forms | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Carry out science laboratory research data collection. | * 1. Data collection methods      1. Interviews      2. Surveys      3. Observations   2. Experiments   3. Secondary data sources   4. Direct measurements | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Carry out science laboratory research data analysis | 1. Data organization    * 1. Data formatting      2. Data cleaning      3. Data coding    1. Data analysis methods    2. Compiling of research report.       1. Results       2. Discussion       3. Conclusion       4. Recommendations       5. References\       6. Appendices    3. Submission of the research report | * Practical * Project * Third party report * Portfolio of evidence * Written test * Oral test |
| 1. Prepare for science laboratory research | * 1. Introduction to research methods   2. Ethics in research   3. Research topics and study site   4. Research problem   5. Research objectives   6. Designing research questions   7. Development of conceptual framework   8. Establishment of research theoretical framework   9. Proposal writing procedures | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out science laboratory research | 1. Scientific study design 2. Sampling techniques    * 1. Probability      2. Non-probability 3. Sample size 4. Research instruments 5. Piloting of research instruments 6. Data collection | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Analyze science laboratory research findings | 1. Standard data analysis methods 2. Validity and reliability of analytical methods 3. Research ethical considerations 4. Data analysis techniques 5. ANOVA 6. Measures of central tendency 7. Measures of dispersal 8. Data presentation 9. Statistical packages e.g., SPSS, Excel 10. Documentation of research processes 11. Recommendations of research study 12. Compiling research report | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

* Demonstration
* Viewing of related videos
* 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 |
|  | 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 |
|  | Stationeries | For trainee use | **25** | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | **Lecture/theory room** |  |  |  |
|  | Standard science laboratory | For trainee use | **1** | 1:25 |
|  | Lecture room | For trainee use | **1** | 1:25 |
| **C** | **Consumable materials** | | | |
| **1.** | Disinfectant | For trainee use | **25** | 1:1 |
|  | Gloves | For trainee use | **25** | 1:1 |
|  | Laboratory coats | For trainee use | **25** | 1:1 |
|  | Face Masks | For trainee use | **25** | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | First aid kit | For trainee use | **1** | 1:25 |
|  | Goggles | For trainee use | **25** | **1:1** |
|  | Safety boots | For trainee use | **25** | **1:1** |

## PHYSICS TECHNIQUES

**UNIT CODE: 0533 441 12A**

**UNIT DURATION:**  180 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform Physics Techniques

**Unit Description**

This unit specifies the competencies required to perform physics techniques. It involves measuring physical quantities, performing pressure experiment, measuring heat capacity, conducting wave experiment, performing optical experiment, conducting electrical experiment, carrying out electromagnetism experiment and performing particulate nature of matter experiment.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Measure physical quantities | **20** |
| 2. | Perform pressure experiment | **20** |
| 3. | Measure heat capacity | **30** |
| 4 | Conduct wave experiment | **20** |
| 5 | Perform optical experiment | **20** |
| 6 | Conduct electrical experiment. | **20** |
| 7 | Carry out electromagnetism experiment | **30** |
| 8 | Perform particulate nature of matter experiment | **20** |
|  | **Total** | **180** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Measure physical quantities | 1. Basic and derived physical quantities 2. SI units 3. Conversion of units 4. Measuring instruments 5. Measuring physical quantities 6. Archimedes principle 7. Upthrust 8. Law of floatation 9. Density and Relative density | * Practical Assessment * Written * Oral * Observation * Third party |
| 1. Perform pressure experiment | * 1. Definition of pressure   2. Pressure in solids, liquids and gases   3. Transmission of pressure in liquids      1. Hydraulics   4. Measurements of pressure   5. Atmospheric pressure   6. Applications of pressure | * Practical Assessment * Written * Oral * Observation * Third party |
| 1. Measure heat capacity | 1. Definition of heat, heat transfer and thermal equilibrium 2. Temperature scales 3. Modes of heat transfer 4. Change of states 5. Application of heat on matter 6. Thermal expansivity 7. Heat capacities 8. Latent heat | * Practical Assessment * Written * Oral * Observation * Third party |
| 1. Conduct wave experiment | * 1. Types of waves      1. characteristics of wave motion      2. wavelength      3. frequency      4. period      5. speed      6. amplitude   2. Properties of waves   3. Reflection   4. Refraction   5. Diffraction   6. Interference | 1. Practical Assessment 2. Written 3. Oral 4. Observation 5. Third party |
| 1. Perform optical experiment | * 1. Nature of light   2. Propagation of light   3. Laws of reflection   4. Polarisation   5. Image formation by plain & curved mirrors   6. Laws of refraction.   7. Distances, sizes of object/images, magnification and focal lengths are determined as per the mirror and lens formula   Refractive index, critical angle and total internal reflection.   * 1. Image formation by lenses   2. Optical instruments | * Practical Assessment * Written * Oral * Observation * Third party |
| 1. Conduct electrical experiment | * 1. Electrical quantities  1. Current 2. Resistance 3. Voltage 4. Electromotive force (emf) 5. Potential Difference (pd)    1. Electrical Circuits 6. Series 7. parallel    1. Electrical measuring instruments    2. Ohm’s law    3. Factors affecting resistance       1. Length       2. Cross section area       3. Temperature       4. Nature of the material/resistivity    4. Resistor networks       1. Parallel       2. series | * Practical Assessment * Written * Oral * Observation * Third party |
| 1. Carry out electromagnetism experiment | * 1. Types of magnets   2. Properties of Magnetism   3. Magnetization and de-magnetization methods   4. Uses of magnets   5. Laws of electromagnetism   6. Applications of electromagnetism | * Practical Assessment * Written * Oral * Observation * Third party |
| 1. Perform particulate nature of matter experiment | * 1. States of matter   2. Properties of matter.   3. Brownian motion | * Practical Assessment * Written * Oral * Observation * Third party |

**Suggested Methods of Instruction**

* Demonstration
* Viewing of related videos
* Discussion
* Direct Instruction
* Field study

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Internet connection | wifi |  | 1:25 |
|  | Projector |  | 1 | 1:25 |
|  | Whiteboard | 4 x 8 ft | 1 | 1:25 |
|  | Assorted colour of whiteboard markers | Red, blue and black | 3 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | standard Science laboratory |  | 1 |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **c** | **Tools and Equipment** | | | |
|  | Vernier calipers | Half division | 25 | 1:1 |
|  | Micrometer screw gauge | Accuracy of 0.01mm | 25 | 1:1 |
|  | Tape measure | 5m | 25 | 1:1 |
|  | Pressure gauge | 20psi | 5 | 1:5 |
|  | Barometer | Mercury | 5 | 1:5 |
|  | Bunsen burner | 500g | 25 | 1:1 |
|  | Ripple tank | Perspex cover | 5 | 1:5 |
|  | Meter rule | Wooden | 25 | 1:1 |
|  | Slinky Spring | 1m | 25 | 1:1 |
|  | Resonance tube | Complete kit | 10 | 2:5 |
|  | Tuning forks | 2 harmonics | 25 | 1:1 |
|  | Sonometer | 20 KHz | 25 | 1:1 |
|  | Mirror | Plain and curved | 25 | 1:1 |
|  | Lenses | Perspex | 25 | 1:1 |
|  | Glass block | Rectangular | 25 | 1:1 |
|  | Optical pins | 2 inchs | 100 | 4:1 |
|  | thermometers | -100c to 1000c | 25 | 1:1 |
|  | stopwatches | Digital | 25 | 1:1 |
|  | weighing balances | 0 to 2kg | 5 | 1:5 |
|  | calorimeters | Copper | 25 | 1:1 |
|  | ammeters | 0 to 2A | 25 | 1:1 |
|  | voltmeters | 0 to 5A | 25 | 1:1 |
|  | Variable Resistors | 0 to 100 ohms | 25 | 1:1 |
|  | Connecting wires | Wires with crocodile clips | 200 | 8:1 |
|  | Dry cells | D size | 50 | 2:1 |
|  | Galvanometer | Zero centred | 25 | 1:1 |
|  | Magnets | Bar magnets | 25 | 1:1 |
|  | Smoke cell | With glass cover | 5 | 1:5 |
|  | Beakers | 250ml | 25 | 1:1 |
|  | Potassium permanganate crystals | 500grams tin | 25grams | 1:1 |
|  | Glass tube | Clear | 25 | 1:1 |

# MODULE IV UNITS OF LEARNING.

# MODULE SUMMARY

The table presented below outlines the units and credit factors included in this module.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0541 541 13A | MATHEMATICS FOR SCIENCE | Apply linear and non-linear graphs | **10** |
| Apply Indices and Logarithm | **10** |
| Apply binomial expansion | **20** |
| Apply trigonometry | **20** |
| Apply differential calculus | **20** |
| Apply integral calculus | **20** |
| Apply sequences and series | **20** |
| Apply statistics methods | **20** |
| Apply matrices | **20** |
|  |  | **Total** | **160** |
| 0531 541 14A | CHEMISTRY PRINCIPLES | Apply physical chemistry concepts. | **25** |
| Apply organic chemistry concepts. | **25** |
| Apply inorganic chemistry concepts. | **25** |
| Apply biochemistry concepts | **45** |
|  |  | **Total** | **120** |
| 0511 541 15A | AQUARIUM, VIVARIUM AND HERBARIUM TECHNIQUES | Carry out herbarium techniques | **40** |
| Carry out museum techniques | **40** |
| Carry out aquarium techniques | **25** |
|  |  | **Total** | **80** |
| 0531 541 16A | CHEMICAL ANALYSES | Conduct chemical sampling | **25** |
| Prepare chemical reagents | **25** |
| Conduct volumetric analysis | **25** |
| Conduct gravimetric analysis | **45** |
|  |  | **Total** | **120** |
|  |  | **Grand Total** | **480** |

## MATHEMATICS FOR SCIENCE

**UNIT CODE:** 0541 541 13A

**Duration of Unit**: 160 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 Technician in order to apply mathematics for science. It involves applying: linear and non-linear graphs; indices and logarithm; binomial expansion.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply linear and non-linear graphs | **10** |
| 2. | Apply Indices and Logarithm | **10** |
| 3. | Apply binomial expansion | **20** |
| 4 | Apply trigonometry | **20** |
| 5 | Apply differential calculus | **20** |
| 6 | Apply integral calculus | **20** |
| 7 | Apply sequences and series | **20** |
| 8 | Apply statistics methods | **20** |
| 9 | Apply matrices | **20** |
|  | **Total** | **160** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply linear and non-linear graphs | * 1. Linear and nonlinear graphs   2. Reduction of non-linear to linear graphs   3. Interpretation of graphs | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply indices and logarithms | 2.1 Indices  2.1.1. Laws of indices  2.1.2. Indicial equations  2.2. Logarithms  2.2.1Laws of logarithms  2.2.2Logarithmic operations  2.3. Conversion of base of logarithms  2.4. Graphs of Logarithmic and exponential functions | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply binomial expansions | 3.1. Roots of numbers using binomial theorem  3.1.1. Pascals triangle  ***3.2. Errors*** of small changes using binomial theorem  3.2.1. Absolute  3.2.2. Relative  3.2.3. Percentage  3.3. Permutation and combination | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply trigonometry | 1. Pythagoras theorem 2. Trigonometric ratios    * 1. Trigonometry identities      2. Trigonometric equations      3. sine and cosine rule    1. Angles of elevation and depression    2. Compound angle formula    3. Double angle formula    4. Sine and cosine waves | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply Differential Calculus | 1. Differential Calculus 2. Functional notation 3. Standard differentiation 4. Differential equations    1. Methods of differentiation 5. Differentiation by first principle 6. Product rule 7. Quotient rule 8. Chain rule    1. Derivatives of higher order functions    2. Applications of differentiation       1. Normal and tangents       2. Stationary points          1. Maxima          2. Minima          3. Point of inflection       3. Rates of change       4. Small changes    3. Differentiation of inverse trigonometric functions | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply Integral Calculus | 1. Integral calculus    * 1. Integral notation      2. Standard integration      3. Constant of integration      4. Definite and indefinite integration 2. Methods of integration 3. Algebraic substitution 4. Integration by parts 5. Integration of logarithmic functions | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 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. um of finite and infinite geometric sequence | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply statistics methods | 1. Processing of raw data 2. Measures of central tendency    * + 1. Mean        2. Mode        3. Median    1. Measures of dispersion       1. Range       2. Quartile       3. Variance       4. Standard deviation   8.3 Interpretation of processed data | * Practical assessment * Portfolio of evidence * Oral assessment * Written tests |
| 1. Apply matrices | * 1. Introduction to matrices      1. Types of matrices         1. singular         2. non-singular         3. identity         4. echelon      2. Order of matrices      3. Matrix operation         1. addition and subtraction         2. multiplication by scaler         3. compatibility         4. Matrix multiplication   2. Determinant and inverse of 2x2 matrix   3. Solution of simultaneous equations in two unknowns using matrix method   4. Eigenvalues and Eigenvectors | * Practical assessment * Portfolio of evidence * Oral assessment   Written tests |

**Suggested Delivery Methods**

* + Practical
  + Projects
  + Demonstrations
  + Group discussions
  + 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 |

## CHEMISTRY PRINCIPLES

**UNIT CODE: 0531 541 14A**

**UNIT DURATION: 120 hours**

**Relationship to Occupational Standards**

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

**Unit Description**

This unit of competency provides knowledge required by a science laboratory technologist to apply chemistry principles. The principles include applying physical chemistry, organic chemistry, inorganic chemistry and biochemistry concepts.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply physical chemistry concepts. | **25** |
| 2. | Apply organic chemistry concepts. | **25** |
| 3. | Apply inorganic chemistry concepts. | **25** |
| 4 | Apply biochemistry concepts | **45** |
|  | **Total** | **120** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply physical chemistry concepts. | 1. Ionic equilibrium 2. Electrochemistry principles 3. Chemical kinetics 4. Chemical thermodynamics | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Assessment |
| 1. Apply organic chemistry concepts. | 2.1 Aldehydes  2.2 Synthesize organic compounds   * 1. Purify synthesized compounds   2. Characterize purified compounds | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply inorganic chemistry concepts. | 1. Identify elements 2. Classify elements   3.2.4Group I-VIII   1. Determine chemical bonds (VSPER)theory   3.3.1Covalent  3.3.2Electrovalent  3.3.3Coordinate  3.3.5Hydrogen   1. Test inorganic salts | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply biochemistry concepts. | 1. Identify biochemical molecules    1. Carbohydrates    2. Lipids    3. Nucleic acids    4. Carry out biochemical reactions 2. Reduction- Oxidation 3. Hydrolysis 4. Condensation 5. Neutralization    1. Determine biochemical processes   Photosynthesis   1. Fermentation 2. Glycolysis 3. Respiration | * 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** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | For trainer’s and trainee use | 1 | 1:25 |
|  | Projectors | For trainer’s and trainee use | 1 | 1:25 |
|  | 1 Projectors | For trainer’s and trainee use | 1 | 1:25 |
|  | 1 roll Flip Charts | For trainer’s and trainee use | 1 | 1:25 |
|  | Assorted colour of whiteboard markers | For trainer’s and trainee use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| **1** | Lecture/theory room | For trainer’s and trainee use | 1 | 1:25 |
| **2** | Fully equipped chemistry laboratory | For trainer’s and trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Hydrogen peroxide | 1L | 25 | 1:1 |
|  | Assorted acids | 1L each | 25 | 1:1 |
|  | Liquid nitrogen | 1L | 25 | 1:1 |
|  | Calcium sulphate | 500g | 25 | 1:1 |
|  | Silver chloride | 500g | 25 | 1:1 |
|  | Lead chloride | 500g | 25 | 1:1 |
|  | Potassium nitrate | 500g | 25 | 1:1 |
|  | Sodium chloride | 500g | 25 | 1:1 |
|  | Metal electrodes | Zinc, copper, platinum rhodium | 25 | 1:1 |
| 1. s | Sulphuric acid | 1L | 25 | 1:1 |
|  | Ethanol | 1L | 25 | 1:1 |
|  | Bromobutane | 1L | 25 | 1:1 |
|  | Benzene | 1L | 25 | 1:1 |
|  | Ethanol | 1L | 25 | 1:1 |
|  | Hexane | 1L | 25 | 1:1 |
|  | Acetone | 1L | 25 | 1:1 |
|  | Water | Enough | 25 | 1:1 |
|  | Chloroform | 1L | 25 | 1:1 |
|  | Anhydrous sodium sulphate | For trainee use | 25 | 1:1 |
|  | Calcium chloride | For trainee use | 25 | 1:1 |
|  | Iodine solution | 1L | 25 | 1:1 |
|  | Benedicts reagents | 1L | 25 | 1:1 |
|  | Sodium hydroxide | 1L | 25 | 1:1 |
|  | Copper (II) sulphate | 1L | 25 | 1:1 |
|  | Biuret reagents | 1L | 25 | 1:1 |
|  | Ninhydrin | 1L | 25 | 1:1 |
|  | Sudan III | 1L | 25 | 1:1 |
|  | Ethanol | 1L | 25 | 1:1 |
|  | Glucose | 1L | 25 | 1:1 |
|  | Sucrose | 1L | 25 | 1:1 |
|  | Amino acids | 1L | 25 | 1:1 |
|  | Lipids | 1L | 25 | 1:1 |
|  | Amylase | 1L | 25 | 1:1 |
|  | Protease | 1L | 25 | 1:1 |
|  | DNAase and RNAase |  | 25 | 1:1 |
|  | Iodine solution | 1L | 25 | 1:1 |
|  | Benedicts reagents | 1L | 25 | 1:1 |
|  | Ninhydrin | 500g | 25 | 1:1 |
|  | pH 7 buffer | pH 4, 7, 10 | 25 | 1:1 |
|  | hydrogen peroxide | 1L | 25 | 1:1 |
|  | Glucose | 1L | 25 | 1:1 |
|  | Sucrose | 1L | 25 | 1:1 |
|  | Amino acids | 250g each type | 25 | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Gas syringes | Sample collection | 25 | 1:1 |
|  | Pressure sensors | Measurement | 25 | 1:1 |
|  | Gas collection tubes | Collection | 25 | 1:1 |
|  | Hot plate | Heating | 5 | 1:5 |
|  | Water bath | Heating | 5 | 1:5 |
|  | 1 Projectors | For trainer’s and trainee use | 1 | 1:25 |
|  | Ice bath | Cooling | 5 | 1:5 |
|  | Measuring cylinder | Measuring | 25 | 1:1 |
|  | Electro -chemical cell | Analysis | 25 | 1:1 |
|  | Battery | Power supply | 25 | 1:1 |
|  | Voltmeter | Measurement | 25 | 1:1 |
|  | recrystallization set up |  | 25 | 1:1 |
|  | Column chromatography | Analysis | 25 | 1:1 |
|  | FT-IR | Analysis | 1 | 1:25 |
|  | Fume hood |  | 2 | 1:12 |
|  | pH meters | Measuring | 25 | 1:1 |
|  | Spectrophotometer | Analysis | 1 | 1:25 |
|  | TLC plates | Separation | 25 | 1:1 |
|  | gel electrophoresis | Analysis | 12 | 1:2 |
|  | Microscopes | Observation | 25 | 1:1 |
|  | Incubator | Incubation | 1 | 1:25 |

### **AQUARIUM, VIVARIUM AND HERBARIUM TECHNIQUES**

**UNIT CODE:** 0511 541 15A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: perform herbarium, museum and aquarium

**Duration of Unit:** 80 Hours

**Unit Description**

This unit specifies the competencies required to perform herbarium techniques, museum techniques and Aquarium techniques.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Carry out herbarium techniques | **40** |
| 2. | Carry out museum techniques | **40** |
| 3. | Carry out aquarium techniques | **25** |
|  | **Total** | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out herbarium techniques | 1. Collection of specimens 2. Drying of specimens 3. Preservation of specimens 4. Mounting of specimens 5. Classification of plant specimens 6. Labeling of specimens 7. Filing of plant specimens | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out museum techniques | 1. Identification of specimen 2. Specimen collection 3. Specimen preparation 4. Specimen preservation 5. Classification of museum specimens 6. Arthropods 7. Bones 8. Plants 9. Mammals 10. Birds 11. Reptiles 12. Fish | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out aquarium techniques | 1. Components of an aquarium 2. Filter 3. Pump 4. Thermometer 5. Aquatic plants 6. Decoration 7. Construction of a fish pond 8. Fish feeding 9. Fish breeding 10. Fish harvesting 11. Fish diseases and management 12. Construction of vivarium 13. Vivarium diseases 14. Management of vivarium | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Delivery:**

* + Practical
  + Projects
  + Demonstrations
  + Field trips
  + Direct instruction
  + Group discussion

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  **(Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Computer | For trainer’s use | 1 | 1:25 |
|  | Standard manuals/SOPs | For trainer’s use | **1** | 1:25 |
|  | Flip charts | 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 |
|  | Masks | For trainee use | **25** | 1:1 |
|  | Covers slips | For trainee use | **5** | 1:5 |
|  | Glass slides | For trainee use | **5** | 1:5 |
|  | Mounting sheets | For trainee use | **12** | 1:2 |
|  | Petri Dishes | For trainee use | **12** | 1:2 |
|  | Scalpels and Blades | For trainee use | **25** | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Projector |  | 1 | 1:25 |
| 1. **1.** | Dissecting microscope | For trainee use | **5** | 1:5 |
| 1. **2.** | First aid kit | For trainee use | **5** | 1:25 |
| 1. **3.** | Plant press | For trainee use | **12** | 1:2 |
| 1. **4.** | Digital Camera | For trainee use | **1** | 1:25 |
| 1. **5.** | Tweezers and Forceps | For trainee use | **25** | 1:1 |
| 1. **6.** | Precision Scales | For trainee use | **1** | 1:25 |
| 1. **8.** | Plant press or vasculum | For trainee use | **12** | 1:12 |
| 1. **9.** | Fishpond | For trainee use | **1** | 1:25 |
| 1. **10.** | Aquarium | For trainee use | **1** | 1:25 |
| 1. **11.** | Caliper | For trainee use | **1** | 1:25 |
| 1. **12.** | Magnifying Glasses | For trainee use | **12** | 1:2 |

## CHEMICAL ANALYSES

**UNIT CODE:** **0531 541 16A**

**UNIT DURATION: 120 hours**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Chemical Analyses.**

**Unit Description**

This unit of competency covers the ability of a laboratory technologist to perform chemical analyses that includes conducting chemical sampling, preparing chemical reagents, conducting volumetric analysis and gravimetric analysis.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Conduct chemical sampling | **25** |
| 2. | Prepare chemical reagents | **25** |
| 3. | Conduct volumetric analysis | **25** |
| 4 | Conduct gravimetric analysis | **45** |
|  | **Total** | **120** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct chemical sampling | 1. Types of chemical analysis 2. Water 3. Food stuff 4. Soil 5. Blood 6. Air 7. Paints 8. Petroleum products 9. Fertilizers 10. Agrochemicals 11. Sampling tools and equipment 12. Graduated cylinders 13. Laboratory flasks 14. Droppers 15. Funnels 16. Bunsen burner 17. Analytical balances 18. Oven 19. Muffle furnace 20. Tripod stand 21. Collection of samples | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Prepare chemical reagents | * 1. chemical reagents  1. Acids 2. Bases 3. Salts 4. Indicators 5. Distilled water 6. concentration of reagents 7. apparatus and equipment 8. chemical reagents | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Conduct volumetric analysis | * 1. apparatus and equipment   2. chemical reagents   3. titration  1. Acid-base 2. Back 3. Redox 4. Complexometric    1. volumetric analysis results 5. Tabulation 6. Calculation 7. Discussion 8. Presentation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Conduct gravimetric analysis | 1. apparatus and equipment 2. chemical reagents 3. gravimetry 4. Precipitation 5. Electrogravimetry 6. Volatility 7. Particulate 8. gravimetric results 9. gravimetric results | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**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** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | 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** | | | |
| **1** | Lecture/theory room | For trainee use | 1 | 1:25 |
| **2** | Fully equipped science laboratory | For trainee use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted acids | 1L each type | 25 | 1:1 |
|  | Distilled water | For trainee use | 25 | 1:1 |
|  | Buffer solutions | pH 4, 7, 10 | 25 | 1:1 |
|  | Acetone | 1L | 25 | 1:1 |
|  | Absorption solutions | 1L | 25 | 1:1 |
|  | Assorted salts | 500g each type | 25 | 1:1 |
|  | Assorted indicators | 1L | 25 | 1:1 |
|  | Assorted acids | 1L | 25 | 1:1 |
| 1. s | Oxidizing and reducing solutions | 1L | 25 | 1:1 |
|  | Precipitating agents | 1L | 25 | 1:1 |
|  | Complexing agents | 1L | 25 | 1:1 |
|  | Precipitating solutions | 1L | 25 | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Projector |  | 1 | 1:25 |
|  | Centrifuge | Separation | 25 | 1:1 |
|  | Furnace | Decomposition | 25 | 1:1 |
|  | Balances | Measurement | 25 | 1:1 |
|  | Electrochemical cells | Analysis | 1 | 1:1 |
|  | Fume hoods |  | 1 | 1:1 |
|  | Respirators |  | 1 | 1:1 |
|  | Filtration apparatus | Filtration | 1 | 1:1 |
|  | Volumetric flasks | Measurement | 1 | 1:1 |
|  | Assorted measuring cylinders | Measurement | 1 | 1:1 |
|  | Droppers | Transferring | 1 | 1:1 |
|  | Beakers | Holding | 1 | 1:1 |
|  | Sampling canisters (SUMMA) |  | 1 | 1:1 |
|  | FT-IR | Analysis | 1 | 1:1 |
|  | Mortar and pestle | Size reduction | 1 | 1:1 |
|  | Grinder | Size reduction | 1 | 1:1 |
|  | Crucible | Size reduction | 1 | 1:1 |
|  | Spatula n and scoops | Scooping | 1 | 1:1 |
|  | Core sampler | Collection | 1 | 1:1 |
|  | Scraper and brush |  | 1 | 1:1 |
|  | Desiccators | Moisture prevention | 1 | 1:1 |
|  | Sampling bottles | Collection | 1 | 1:1 |
|  | Syringes | Collection | 1 | 1:1 |
|  | Pipettes | Measurement | 1 | 1:1 |
|  | Grab sampler | Collection | 1 | 1:1 |
|  | Dipper | Collection | 1 | 1:1 |
|  | Bailer | Collection | 1 | 1:1 |

# MODULE V UNITS OF LEARNING.

# 

# MODULE SUMMARY

The table presented below outlines the units and credit factors included in this module.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 102254116A | LABORATORY AND MANAGEMENT PRACTICE | Maintain laboratory safety | 15 |
| Manage laboratory animals | 20 |
| Prepare laboratory water | 15 |
| Manage laboratory personnel and material resources | 20 |
| Manage laboratory waste | 10 |
|  |  | **Total** | **80** |
| 0533 541 17A | PHYSICS PRINCIPLES | Apply dynamics principles | **10** |
|  | Apply principles of thermodynamics | **15** |
| Apply principles of optics | **10** |
| Apply friction principles | **10** |
| Apply pressure principles | **10** |
| Apply principles of electromagnetism | **15** |
| Apply Electrostatic And Electrical Principles | **20** |
| Apply Semiconductor Device Principles | **10** |
|  |  | **Total** | **100** |
| 1022 541 18A | LABORATORY EQUIPMENT MAINTENANCE | Perform pre-use checks on laboratory equipment | **20** |
| Perform calibration checks on laboratory equipment | **25** |
| Perform equipment cleaning | **25** |
| **Total** | **80** |
| 0511 541 19A | CYTO-HISTOLOGICAL TECHNIQUES IMMUNOLOGICAL TECHNIQUES | Carry out care and maintenance of microscopes | 30 |
| Perform cytological techniques | 25 |
| Perform histological techniques | 25 |
| Perform immunological Test | 40 |
|  |  | **Total** | **120** |
| 0533 541 20A | TEST MATERIAL PROPERTIES | Test material mechanical property | 25 |
| Test material conductivity | 25 |
| Test material magnetic property | 25 |
| Test material optical property | 25 |
|  |  | **Total** | **100** |
|  |  | **Grand Total** | **480** |

## LABORATORY AND MANANGEMENT PRACTICES

**UNIT CODE: 1022 541 17A**

**Duration of Unit:** 80 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 a science laboratory technologist to apply laboratory and management practices. The practices include maintaining laboratory safety, manage laboratory animals, managing laboratory personnel and material resources, preparing laboratory water and managing laboratory waste.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Manage laboratory animals | 20 |
|  | Prepare laboratory water | 15 |
|  | Manage laboratory personnel and material resources | 20 |
|  | Manage laboratory waste | 10 |
|  | **Total** | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Manage laboratory animals | * 1. Introduction to laboratory animals.   2. Guinea pig   3. Albino rats   4. Rabbits   5. Frogs   6. Insects   7. Hamsters   8. Mice   9. Housing, feeding and handling of laboratory animals   10. Humane killing of laboratory animals       1. Pithing       2. Decapitation       3. Chemical suffocation       4. Neck twisting       5. Breaking of the spinal cord       6. Cervical dislocation   11. Dissection of laboratory animals   12. Diseases and pests’ control in an animal house.   13. Disposal of carcass. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Prepare laboratory water | * 1. Sources of water   2. Methods of water treatment  1. Distillation 2. Deionization 3. Filtration 4. Sedimentation 5. Reverse osmosis 6. Adsorption 7. Simple distillation 8. Fractional distillation 9. De-ionization    1. Water treatment | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Manage laboratory personnel and material resources | * 1. Definition of management   2. Principles of laboratory management      1. Delegation      2. Coordination   3. Organizational structure   4. Leadership   5. Unity of purpose   6. Functions of management   7. Management schools of thought   8. Modern theories of management   9. Laboratory inventories      1. Inventory      2. Invoice      3. Quotations      4. Catalogues      5. Local purchase order      6. Bin cards | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Manage laboratory waste | 1. Types of laboratory wastes 2. Organic 3. Halogenated 4. Aqueous 5. Solid 6. Glass ware 7. Use of antiseptics and disinfectants 8. Recycling 9. Waste disposal methods 10. Sewer line 11. Incineration 12. Burying 13. Burning 14. Soak pit 15. Evaporation | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Manage laboratory personnel and material resources | * 1. Definition of management   2. Principles of laboratory management   3. Delegation   4. Coordination   5. Organizational structure   6. Leadership   7. Unity of purpose  1. Functions of management 2. Management schools of thought 3. Modern theories of management 4. Laboratory inventories    1. Inventory    2. Invoice    3. Quotations    4. Catalogues    5. Local purchase order    6. Bin cards | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Delivery Methods**

* + Practical
  + Projects
  + Demonstrations
  + 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 |

## PHYSICS PRINCIPLES

**UNIT CODE: 0533 541 18A**

**UNIT DURATION:**  100 Hours

**Relationship to Occupational Standards**

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

**Unit Description**

This unit specifies the competencies required to apply physics principles. It involves applying: dynamics principles; principles of optics and friction principles, principles of thermodynamics; principles of electromagnetism; and principles of nuclear physics.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply dynamics principles | **20** |
|  | Apply principles of thermodynamics | **15** |
|  | Apply principles of optics | **20** |
|  | Apply friction principles | **10** |
|  | Apply pressure principles |  |
|  | Apply principles of electromagnetism | **15** |
|  | Apply Electrostatic And Electrical Principles | **20** |
|  | Apply Semiconductor Device Principles | **15** |
|  | Apply principles of nuclear physics | **10** |
|  | **Total** | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply dynamics principles | 1. Static forces 2. Newton’s laws of motion 3. Law of inertia 4. Law of momentum 5. Law of interaction 6. Equations of linear, free fall and horizontal and vertical 7. circular motion   1.4.1 Demonstration of Uniform circular motion  1.4.2Angular displacement, angular velocity, angular acceleration and centripetal force   * 1. Applications of uniform circular motion | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 2. Apply principles of thermodynamics | * 1. Heat energy   2. Heat capacity   3. Specific heat capacity   4. Latent heat   5. Latent heat of fusion   6. Latent heat of vaporization   7. Latent heat of sublimation   8. determination of Specific heat capacity using electrical and continuous flow method (solid and liquid)   9. Determination of specific Latent heats of fusion, vaporization and sublimation.   10. Adiabatic changes   11. Isothermal processes   12. Isobaric change | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 3. Apply principles of optics | * 1. Laws of refraction.   2. Refractive index, critical angle and total internal reflection.   3. Focal lengths, object distances, image distances and magnification calculation using lens formula.   4. Image formation by lenses   5. Optical instruments | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 4. Apply friction principles | * 1. Definition of friction   2. Source of friction   3. Laws of friction   4. Coefficient of friction   5. Applications of friction   6. Methods of reducing friction | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 5. Apply pressure principles | 1. Definition of pressure 2. Pressure in solids, liquids and gases 3. Transmission of pressure in liquids 4. Hydraulics 5. Measurements of pressure 6. Atmospheric pressure 7. Applications of pressure | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 6. Apply principles of electromagnetism | * 1. Magnetic flux patterns   2. Flux density   3. Electromagnets   4. cork screw rule   5. Right hand Grip rule   6. Faradays and Lenz’s laws   7. Fleming’s right hand rule and left-hand rule   8. Self-inductance   9. Mutual inductance   10. Induction due to current charge in another circuit   11. Applications of electromagnetism | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 7. Apply electrostatic and electrical principles | 1. Types of charges 2. Van de Graff generator 3. Electroscope 4. Types of capacitors 5. Factors affecting capacitance of parallel plate capacitors 6. Applications of capacitors 7. Mains Electricity sources 8. Electrical quantities 9. Electrical Circuits 10. Electrical measuring instruments 11. Ohm’s law 12. Generation of mains electricity 13. Electromagnetic induction | * Practical Assessment * Project-Based * Assessment * Portfolio of Evidence * Written Assessment |
| 7. Apply semiconductor device principles | 1. Energy band theory 2. Types of Semi-conductors 3. Doping in semi-conductor diode 4. Forward and backward biasing of semi-conductor diodes 5. Application of semi-conductor diodes -rectification 6. Types of transistors 7. Connection of transistors 8. Transistor characteristics 9. Uses of transistors | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 8. Apply principles of nuclear physics | * 1. Production of X-rays   2. Types of X-rays   3. Application of X-rays   4. Commonly available radio-active elements.   5. Types of radioactivity      1. Alpha particles      2. Beta particles      3. Gamma radiation      4. Background radiations   6. Properties of radio-active materials   7. Types of radioactive radiations   8. Half-lives of radioactive elements.   9. Uses of radioactivity   10. Hazards associated with radioactive material   11. Safety precautions on X-rays and radio-active elements. | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

* + Practical
  + Projects
  + Demonstrations
  + 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 | wifi |  | 1:25 |
|  | Whiteboard | 4 x 8 ft | 1 | 1:25 |
|  | Assorted whiteboard markers | Red, blue and black | 3 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | standard Science laboratory |  | 1 |  |
|  |  |  |  |  |
| **c** | **Tools and Equipment** | | | |
|  | Projector |  | 1 | 1:25 |
|  | Bunsen burner | 500g | 25 | 1:1 |
|  | Van de Graff generator |  | 2 | 2:25 |
|  | Transformers | 12volts |  |  |
|  | thermometers | -100c to 1000c | 25 | 1:1 |
|  | stopwatches | Digital | 25 | 1:1 |
|  | weighing balances | 0 to 2kg | 5 | 1:5 |
|  | calorimeters | Copper | 25 | 1:1 |
|  | ammeters | 0 to 2A | 25 | 1:1 |
|  | voltmeters | 0 to 5A | 25 | 1:1 |
|  | Variable Resistors | 0 to 100 ohms | 25 | 1:1 |
|  | Connecting wires | Wires with crocodile clips | 200 | 8:1 |
|  | Galvanometer | Zero centred | 25 | 1:1 |
|  | Magnets | Bar magnets | 25 | 1:1 |

# CYTO-HISTOLOGICAL AND IMMUNOLOGICAL TECHNIQUES

**UNIT CODE: 0511 541 19A**

**UNIT DURATION 120 HRS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency, cyto-histological techniques

**UNIT DESCRIPTION**

This unit specifies the competencies In Applying transport in plants and animals, analyzing communication in plants and animals, applying excretion in plants and animals, carrying out care and maintenance of microscopes, performing cytological technique, performing histological technique

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Carry out care and maintenance of microscopes | **30** |
|  | Perform cytological techniques | **25** |
|  | Perform histological techniques | **25** |
|  | Perform immunological Test | **40** |
|  | **Total** | **120** |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Learning Outcome** | **Content** | | **Suggested Assessment Methods** | | |
| 1. Carry out care and maintenance of microscopes | | 1. Terminologies used in microscopy 2. Types of microscopes 3. Bright field 4. Darkfield 5. Fluorescent 6. Digital 7. Electron microscope    1. Ocular parts of a microscope 8. Eyepiece lens 9. Drawtube 10. Objective lenses 11. Mechanical stage 12. Adjustment knobs 13. Base     1. Image formation     2. Use of oil immersion     3. Lens defects and corrections     4. Calibration of a microscope 14. Use of ruler 15. Eyepiece graticule 16. Stage graticule     1. Care and maintenance of a microscope 17. Dusting and cleaning 18. Lubrication     1. Storage     2. Handling of microscopes     3. Calibration of microscope | | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Perform cytological technique | * 1. Identification of cells and simple tissues.   2. Isolation and staining of Plant and animal cells.      1. Plant cells      2. Blood      3. Urine      4. Saliva      5. Faecal sample   3. Movement of substances in and out of the cell   4. Preparation of solutions of various concentrations and biological materials for diffusion.   5. Preparation of solutions of various concentrations and biological materials for osmosis.   6. Experimental apparatus for osmosis and diffusion | | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment | | |
| 1. Perform Histological technique | * 1. Definition of histology   2. Plant tissues   3. Animal tissues   4. Histological procedures      1. Squash preparation      2. Smear preparation      3. Microtomy procedure | | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment | | |
| 1. Perform immunological Test | 4.1 Types of immunity   1. Specific 2. Non specific    1. Lymphoid organs 3. Bone marrow 4. Spleen 5. Lymph nodes 6. Thymus gland    1. Lymphoid tissue    2. Secondary    3. Immune cells 7. Monocytes 8. Lymphocytes    1. Mast cells    2. Immunoglobulins    3. Structure of antibody    4. Complement system    5. Complement fixation test    6. Histocompatibility complex    7. Hypersensitivity reactions 9. Type I 10. Type II 11. Type III     1. Tissue transplant     2. Agglutination 12. Agglutination inhibition 13. Precipitation     1. Polymerase Change Reaction (PCR)     2. Enzyme linked immuno-sorbent Assay (ELISA)   Immunoelectrophoretic   * 1. Types of vaccines  1. Live 2. Live attenuated 3. Recombinant 4. Toxoids    1. Routes of administration   Role of immunization | | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment | | |

## TEST MATERIAL PROPERTIES

**Unit Code:** 0533 541 20A

**Unit Duration:**  120 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Test material properties

**Unit Description**

This unit of competency covers the ability of a laboratory technologist to test the characteristics and behavior of substances such as metals, ceramics, or plastics under various conditions. It involves testing material mechanical properties, test material electrical properties, test material conductivity, test material magnetic properties and test material optical properties of materials

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Test material mechanical property | 25 |
|  | Test material conductivity | 25 |
|  | Test material magnetic property | 25 |
|  | Test material optical property | 25 |
|  | **Total** | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Test material mechanical property | 1. Metals: 2. Characteristics:   Conductivity, Toughness, Ductility   1. Testing methods:   Tensile, Compression, Hardness,  Fatigue impact tests   1. Applications of testing methods 2. Polymers (Plastics) 3. Characteristics:   High flexibility, Viscoelastic behaviour.  Low density,   1. Testing methods   Tensile, Flexural, Impact test.   1. Applications of testing methods 2. Ceramics and Glasses 3. Characteristics   High hardness, Brittle, Resistant to wear.   1. Testing methods   Hardness, fracture toughness, Compressive strength tests.   1. Applications of testing methods 2. Report writing on testing material mechanical property practicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Test material conductivity | 1. Thermal conductivity 2. Metals 3. Non-metals 4. Electrical conductivity 5. Conductors 6. Semiconductors 7. Insulators 8. Ionic conductivity 9. Electrolysis 10. Report writing on testing material conductivity practical | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Test material magnetic property | 1. Magnetic test samples 2. Ferromagnetic materials 3. Particle Magnetic Testing  * Wet * Dry  1. Report writing on testing magnetic property practical | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Test material optical property | 1. Optical Properties 2. Transmission 3. Reflection 4. Refraction 5. Luminous intensity 6. Scattering (diffraction) 7. Material Composition: 8. Glass 9. Plastic 10. Crystals 11. Physical Properties: 12. Durability 13. Weight 14. Thermal Stability 15. Application: 16. Optical Lenses 17. Filters 18. Mirrors 19. Optical measuring instruments 20. Diffraction grating 21. Refractometer 22. Optical power meter 23. Polarizer 24. Report writing on testing optical property practical | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

* + Practical
  + Projects
  + Demonstrations
  + Field trips
  + Direct instruction
  + Group discussion

**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 | wifi |  | 1:25 |
|  | Whiteboard | 4 x 8 ft | 1 | 1:25 |
|  | Assorted colours of whiteboard markers | Red, blue and black | 3 | 1:25 |
|  | Metals | Steel | 1 bar | 1:25 |
|  | Polymers | Plastics | 25 | 1:1 |
|  | Ceramics | Tiles | 25 | 1:1 |
|  | Glass | Silicon | 25 | 1:1 |
|  | Magnets | Bar | 25 | 1:1 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| **10** | Standard Science laboratory |  | 1 |  |
| **C** | **Tools and Equipment** | | | |
|  | Mirror | Plain and curved | 25 | 1:1 |
|  | Projector |  | 1 | 1:25 |
|  | Lenses | Perspex | 25 | 1:1 |
|  | Glass block | Rectangular | 25 | 1:1 |
|  | Optical pins | 2 inches | 100 | 4:1 |

# MODULE VI UNITS OF LEARNING.

# MODULE SUMMARY

The table presented below outlines the units and credit factors included in this module.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **UNIT NAME** | **ELEMENTS** | **DURATION (HOURS)** |
| 0511 541 21A | BIOLOGY PRINCIPLES | Analyse communication in plants and animals | **10** |
| Apply nutrition in plants and animals | **10** |
| Apply transport in plants and animals | **20** |
| Analyse support and locomotion in animals | **20** |
| Analyse reproduction in plants and animals | **20** |
| Apply excretion in plants and animals | **20** |
|  |  | **Total** | **100** |
| 0511 541 22A | IMMUNOLOGICAL AND MICROBIOLOGICAL  TECHNIQUES | Perform Immunological Tests | **20** |
| Culture microbial specimen | **20** |
| Carry out anti biotic sensitivity tests | **20** |
| Apply industrial microbiological techniques | **20** |
| Carry out parasitic tests | **20** |
|  |  | **Total** | **100** |
| 0531 541 23A | CHEMISTRY INSTRUMENTATION TECHNOIQUES | Carry out chromatographic techniques | **25** |
| Carry out spectroscopic techniques | **25** |
| Carry out electroanalytical techniques | **25** |
| Carry out colorimetric techniques | **25** |
| **Total** | **100** |
| 0533 541 24A | PHYSICAL QUANTITY MEASUREMENT | To measure fundamental quantity | **10** |
| To measure electrical quantity | **20** |
| To measure material flow | **20** |
| To measure and control thermometric quantity | **20** |
| To measure optical property | **20** |
| To measure sound and acoustic | **10** |
| **Total** | **100** |
| **GRAND TOTAL** | **400** |

# BIOLOGY PRINCIPLES

**UNIT CODE: 0511 541 21A**

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply biology principles

**Duration of Unit: 100 Hours**

**Unit Description**

This unit of competence specifies the knowledge and competences required to apply biological principles. It involves analyzing: communication, nutrition, transport, reproduction, excretion in plants and animals, applying support and locomotion in animals and plants and analyzing genes and Chromosomes structures

Summary of Learning Outcomes

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Analyse communication in plants and animals | **10** |
|  | Apply nutrition in plants and animals | **10** |
|  | Apply transport in plants and animals | **20** |
|  | Analyse support and locomotion in animals | **20** |
|  | Analyse reproduction in plants and animals | **20** |
|  | Apply excretion in plants and animals | **20** |
|  | **Total** | **100** |

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

|  |  |  |
| --- | --- | --- |
| Learning Outcome | Content | Suggested Assessment Methods |
| 1. Analyze communication in plants and animals | 1. Neurons 2. Transmission of nervous impulse 3. Central nervous system (CNS) 4. Peripheral nervous system (PNS) 5. Structure and functions of sensory organs: 6. Eye 7. Ear 8. Nose 9. Tongue 10. Skin 11. Endocrine system:     1. Pituitary gland     2. Hypothalamus     3. Pineal gland     4. Thyroid gland     5. Parathyroid gland     6. Pancreas     7. Adrenal gland     8. Thymus     9. Plant growth curves     10. Primary and secondary growth 12. Tropic and tactic growth responses | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply nutrition in plants and animals | 1. Types of nutrition: 2. Autotrophic nutrition 3. Heterotrophic nutrition. 4. Holozoic 5. Parasitic 6. Saprophytic 7. Process of digestion, absorption, assimilation, and egestion. 8. Nutritional deficiency diseases 9. Morphology and functions of the leaf 10. Process of photosynthesis     1. Light stage     2. Dark stage     3. C4 pathways     4. C3 pathways | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply transport in plants and animals | 1. Types of circulatory systems 2. Open circulatory system 3. Closed circulatory system 4. Components of the circulatory systems 5. Blood 6. Blood vessels 7. Heart 8. Lymphatic system 9. Gaseous exchange surfaces in animals 10. The skin 11. The lungs 12. The gills 13. Buccal cavity 14. Mechanisms of breathing in mammals. 15. Gaseous exchange in fish 16. Vascular tissues in plants 17. Water and mineral uptake in plants 18. Transpiration in plants 19. Cuticular transpiration 20. Lenticular transpiration 21. Stomatal transpiration 22. Translocation 23. Mechanisms of opening and closing of stomata | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Analyze support and locomotion in animals | 1. Types of muscles 2. Skeletal muscles 3. Smooth 4. Cardiac 5. Striated 6. Mechanism of muscle action 7. Types of skeletons 8. Endoskeleton 9. Exoskeleton 10. Bone formation 11. Intramembranous ossification 12. Endochondral ossification 13. Bones of axial skeleton 14. Bones of endoskeleton 15. Joints | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Analyse reproduction in plants and animals | 1. Reproductive system in plants 2. Vegetative propagation 3. Flower structure and functions 4. Pollination 5. Fertilization 6. Seeds and fruits dispersal 7. Reproductive system in animals 8. Gametogenesis 9. Ovulation cycle 10. Menstrual cycle 11. Birth control methods | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply excretion in plants and animals | 1. Plant excretory products 2. Excretory system in mammals 3. Kidney structure and functions 4. Homeostasis 5. Positive feedback mechanism 6. Negative feedback mechanism | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

Suggested Methods of Delivery:

* + Practical
  + Projects
  + Demonstrations
  + Direct instruction
  + Group discussion

Recommended Resources for 25 Trainees

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No. | Category/Item | Description/ Specifications | Quantity | Recommended Ratio  (Item: Trainee) |
| A | Learning Materials | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Computer | For trainer’s use | 1 | 1:25 |
|  | 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 |
| 1. e | Human Heart model | For trainer’s use | 1 | 1:25 |
| 1. n | Human Brain model | For trainer’s use | 1 | 1:25 |
| 1. h | Human skeleton model | 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 |
|  | Masks | For trainee use | 25 | 1:1 |
|  | laboratory animals (rats) | For trainee use | 5 | 1:5 |
|  | Dissecting kit | For trainee use | 5 | 1:5 |
|  | Dissecting board | For trainee use | 5 | 1:5 |
|  | Covers slips | For trainee use | 5 | 1:5 |
|  | Glass slides | For trainee use | 5 | 1:5 |
| D | Tools and Equipment | | | |
|  | Compound light microscope | For trainee use | 5 | 1:5 |

## IMMUNOLOGICAL AND MICROBIOLOGICAL TECHNIQUES

**UNIT CODE:** 0511 541 22A

**Duration of Unit:** 100 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct microbiological analysis and immunological techniques

**Unit Description**

This unit specifies the competencies required to carry out microbiological techniques. It involves Culturing microbial specimen, carrying out antibiotic sensitivity test, and applying industrial microbiological techniques. Carrying out parasitic tests, and performing immunological test

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Culture Microbial Specimen | **20** |
|  | Carry Out Anti Biotic Sensitivity Tests | **20** |
|  | Apply Industrial Microbiological Techniques | **20** |
|  | Carry Out Parasitic Tests | **20** |
|  | **Total** | **100** |

**Learning Outcomes, Content and suggested methods of assessment**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **suggested methods of assessment** |
| 1. Culture microbial specimen | 1. Culture equipment 2. Autoclave 3. Wire loop 4. Source of heat 5. Oven 6. Aluminium foil 7. Sterility indicator 8. Petri plate 9. Incubator 10. Culture reagents 11. Agar 12. Distilled water 13. 70% Alcohol 14. Culture Inoculation 15. Streaking 16. Pour plate 17. Stabbing 18. Spread plating 19. Microbial cultures 20. Types of specimens 21. Water 22. Milk 23. Food 24. Microbes 25. Types of culture media 26. Nutrient agar 27. Broth 28. Semi solid | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out antibiotic sensitivity test | * 1. Classes of antibiotics   2. Mode of action of antibiotics   3. Antibiotic samples   4. Antibiotic resistance   5. Sensitivity testing   6. Dilution method   7. Disc diffusion method   8. Bacterial enumeration | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Apply industrial microbiological techniques | 1. Industrial microorganisms 2. Beer making 3. Antibiotic production 4. Biodegradation 5. Biogas production | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out parasitic test | 1. Bacterial identification 2. Staining 3. Parasitic tests 4. Biochemical tests 5. Laboratory diagnosis 6. Water sampling | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of instruction**

* + Practical
  + Projects
  + Demonstrations
  + Group discussions
  + 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 |
|  | Computer | 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 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | **Lecture/theory room** |  |  |  |
| **1.** | Fully equipped science laboratory | For trainee use | **1** | 1:25 |
| **2.** | 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 |
|  | Masks | For trainee use | **25** | 1:1 |
|  | Covers slips | For trainee use | **5** | 1:5 |
|  | Glass slides | For trainee use | **5** | 1:5 |
| **D** | **Tools and Equipment** | | | |
| 1. **.** | Compound light microscope | For trainee use | **5** | 1:5 |
| 1. **.** | First aid kit | For trainee use | **1** | 1:25 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Fridge | For trainee use | **1** | 1:25 |
| 1. **4.** | Autoclave | For trainee use | **1** | 1:12 |
| 1. **5.** | Water bath | For trainee use | **5** | 1:5 |
| 1. **6.** | Centrifuge | For trainee use | **2** | 1:12 |
| 1. **7.** | Incubator | For trainee use | **1** | 1:25 |
| 1. **8.** | Bunsen burner | For trainee use | **5** | 1:5 |

## CHEMISTRY INSTRUMENTATION TECHNOIQUES

**UNIT CODE: 0531 541 23A**

**UNIT DURATION: 100 hours**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Perform Chemistry Instrumentation Techniques.**

**Unit Description**

This unit of competency covers the ability of a laboratory technician to use chemical analytical instruments to analyze samples and it will include to carry out chromatographic technique, carry out spectroscopic technique, carry out electroanalytical technique and carry out colorimetric techniques.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | Carry Out Chromatographic Techniques | **25** |
|  | Carry Out Spectroscopic Techniques | **25** |
|  | Carry Out Electroanalytical Techniques | **25** |
|  | Carry Out Colorimetric Techniques | **25** |
|  | **Total** | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out chromatographic techniques | 1. chromatographic test 2. chromatographic apparatus and equipment 3. Syringe 4. Volumetric flasks 5. Analytical balances 6. Crucibles 7. Graduated glassware 8. Cuvettes 9. High Performance Liquid Chromatography (HPLC) 10. Gas Chromatography (GC) 11. Ion Exchange Chromatography (IEC) 12. Thin Layer Chromatography (TLC) 13. Gel Electrophoresis (GE) 14. High Performance Liquid Chromatography (HPLC) 15. Gas Chromatography (GC) 16. Ion Exchange Chromatography (IEC) 17. Thin Layer Chromatography (TLC) 18. Gel Electrophoresis (GE) 19. Prepare standards and samples 20. Carry out analysis 21. Optimizing laboratory instrument 22. Calibration 23. Troubleshooting 24. Physical checks 25. Process results 26. Tabulation 27. Calculation 28. Interpretation 29. Discussion | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out spectroscopic techniques | * 1. Spectroscopic apparatus and equipment  1. Flame Atomic Emission Spectrometer    * 1. (FAES) 2. Atomic Absorption Spectrophotometer (AAS) 3. Mass Spectrometer (MS) 4. Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES)    1. Optimize spectroscopic equipment 5. Calibration 6. Troubleshooting 7. Physical checks 8. Prepare standards and samples 9. Carry out analysis 10. Process results 11. Tabulation 12. Calculation 13. Interpretation 14. Discussion | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out electroanalytical techniques | * 1. Identify tests to be performed   2. Identify electroanalytical apparatus and equipment  1. Potentiometer 2. Ampere meter 3. Conductometer 4. Electro gravimeter 5. Voltameter    1. Optimize electroanalytical equipment 6. Calibration 7. Troubleshooting 8. Physical checks    1. Prepare standards and samples    2. Carry out analysis    3. Process results 9. Tabulation 10. Calculation 11. Interpretation 12. Discussion | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Carry out colorimetric techniques | * 1. Identify tests to be performed   2. Identify colorimetric apparatus and equipment  1. Lovibond color comparator 2. colorimeter 3. UV-Vis spectrophotometer    1. Optimize colorimetric equipment 4. Calibration 5. Troubleshooting 6. Physical checks    1. Prepare standards and samples    2. Carry out analysis 7. Process results 8. Tabulation 9. Calculation 10. Interpretation 11. Discussion | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**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** | | | |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
|  | Desktop computers/laptops | For trainer’s use | 1 | 1:25 |
|  | Internet connection | 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** | | | |
| **1** | Lecture/theory room | For trainer’s use | 1 | 1:25 |
| **2** | Fully equipped chemistry laboratory | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Silica gel | 500g | 25 | 1:1 |
|  | Acetone | 1L | 25 | 1:1 |
|  | Ethanol | 1L | 25 | 1:1 |
|  | n-butanol | 1L | 25 | 1:1 |
|  | diethyl ether | 1L | 25 | 1:1 |
|  | petroleum ether | 1L | 25 | 1:1 |
|  | chloroform | 1L | 25 | 1:1 |
|  | methanol | 1L | 25 | 1:1 |
|  | standards | 1L | 25 | 1:1 |
| 1. s | assorted samples | 1L | 25 | 1:1 |
|  | helium gas | 1L | 25 | 1:1 |
|  | Standards | 1L | 25 | 1:1 |
|  | Buffers solutions | 1L | 25 | 1:1 |
|  | Distilled water | 1L | 25 | 1:1 |
|  | Standards | 1L | 25 | 1:1 |
|  | Assorted samples | 1L | 25 | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Projector |  | 1 | 1:25 |
|  | Paper chromatography | Separation | 25 | 1:1 |
|  | TLC plates | Separation | 25 | 1:1 |
|  | UV light | analysis | 25 | 1:1 |
|  | Gas chromatography | Separation | 1 | 1:25 |
|  | HPLC | Separation | 1 | 1:25 |
|  | Gel Electrophoresis | Separation | 12 | 1:2 |
|  | Cuvettes | Holding | 25 | 1:1 |
|  | Measuring cylinders | Measuring | 25 | 1:1 |
|  | Flame Atomic Emission Spectrometer |  | 1 | 1:25 |
|  | Atomic Absorption Spectrophotometer |  | 1 | 1:25 |
|  | Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES) |  | 1 | 1:25 |
|  | Beakers | Holding | 25 | 1:1 |
|  | Measuring cylinders | Measuring | 25 | 1:1 |
|  | Volumetric flasks | Measuring | 25 | 1:1 |
|  | pH meters | Measuring | 25 | 1:1 |
|  | Potentiometer | Measuring | 12 | 1:2 |
|  | Ampere meter | Measuring | 12 | 1:2 |
|  | Conductometer | Measuring | 12 | 1:2 |
|  | Electro gravimetal | Analysis | 5 | 1:5 |
|  | Voltameter | Analysis | 25 | 1:1 |
|  | Electrochemical cells | Analysis | 25 | 1:1 |
|  | Fume hoods | Analysis | 2 | 1:12 |
|  | Lovibond color comparator |  | 12 | 1:12 |
|  | Colorimeter | Measuring | 1 | 1:25 |
|  | UV-Vis spectrophotometer | Analysis | 1 | 1:25 |
|  | Bailer | Collection | 1 | 1:25 |

## PHYSICAL QUANTITIES MEASUREMENT

**UNIT CODE:** 0533 541 24A

**UNIT DURATION:**  100 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: measure physical quantities

**Unit Description**

This unit of competency focuses on equipping laboratory technologists with the skills to accurately measure a wide range of physical quantities using appropriate measuring instruments. It encompasses the measurement of fundamental physical quantities, electrical parameters, material flow, temperature (thermometric quantities), optical properties, as well as sound and acoustic characteristics.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcomes** | **Duration (Hours)** |
|  | To measure fundamental quantity | **10** |
|  | To measure electrical quantity | **20** |
|  | To measure material flow | **20** |
|  | To measure and control thermometric quantity | **20** |
|  | To measure optical property | **20** |
|  | To measure sound and acoustic | **10** |
|  | **Total** | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Measure fundamental quantity. | * 1. Basic and Derived quantities.   2. SI units   3. Measurement of physical quantities  1. mass 2. length 3. time    1. Measuring instruments       1. meter rule       2. Vernier caliper       3. Micrometer screw gauge       4. Stopwatch       5. Beam balance    2. Conversion of units    3. Writing report on measuring fundamental practical | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Measure electrical quantity | 1. Electrical quantities 2. Volt 3. Current 4. Ohm 5. Electrical Circuits 6. Electrical measuring instruments 7. Voltmeter 8. Ammeter 9. Ohmmeter 10. Multimeter 11. Factors affecting resistance 12. Resistor networks 13. Conversion of Moving coil galvanometer into ammeter or voltmeter 14. Capacitance 15. Inductance 16. Report writing on measure electrical quantity practicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Measure material flow | 1. Sample material 2. Types of flows 3. Flow rate 4. Flow measuring instruments 5. Variable flow meter 6. Mechanical flow meter 7. Venturi meter   3.5. Report writing on measure material flow practicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 1. Measure and control thermometric quantity | 1. Heat and temperature 2. Temperature measuring instruments    1. Change of states       1. Melting       2. Vaporisation       3. Sublimation/deposition    2. Determination of specific and latent heats of fusion, vaporization.    3. Thermometric quantities    4. Thermal pollution    5. Report writing on measure and control of thermometric quantity practicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 5. Measure optical property | 1. Propagation of light 2. Properties of light 3. Laws of reflection. 4. Focal lengths, object distances, image distances and magnification calculation using mirror formula. 5. Image formation by lenses 6. Laws of refraction. 7. Focal lengths, object distances, image distances and magnification calculation using lens formula. 8. Refractive index, critical angle and total internal reflection. 9. Optical quantities:   5.9.1 Luminous flux   * + 1. Luminous intensity   5.10 Report writing on measure optical properties’ practicals | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |
| 6. Measure sound and acoustic. | 1. Definition of sound 2. Introduction to sound measurement    * 1. Properties of sound (refraction, reflection, interference, absorption)      2. Role of sound measurement      3. Factors that influence sound measure    1. Qualities of sound (loudness, pitch and timbre)    2. Measurement of the speed of sound    3. Sound pressure level meters       1. Sound level meter       2. Dosimeter       3. Vibration meters       4. Octave band analyser    4. Sound levels       1. Sound exposure level       2. Sound power level       3. Sound pressure level       4. Sound intensity level       5. Sound veracity level    5. Noise pollution    6. Report writing on measure of sound and acoustic practical | * Practical Assessment * Project-Based Assessment * Portfolio of Evidence * Written Assessment |

**Suggested Methods of Instruction**

* + Practical
  + Projects
  + Demonstrations
  + Direct instruction
  + Group discussion

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. 1 | Desktop computer/laptop | For trainer’s use | 1 | 1:25 |
|  | Internet connection | wifi |  | 1:25 |
|  | Whiteboard | 4 x 8 ft | 1 | 1:25 |
|  | Assorted whiteboard markers | Red, blue and black | 3 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| **1** | standard Science laboratory |  | 1 |  |
| **c** | **Tools and Equipment** | | | |
|  | Projector |  | 1 | 1:25 |
|  | Vernier calipers | Half division | 25 | 1:1 |
|  | Micrometer screw gauge | Accuracy of 0.01mm | 25 | 1:1 |
|  | Tape measure | 5m | 25 | 1:1 |
|  | variable flow meter |  | 5 | 1:5 |
|  | mechanical flow meter |  | 5 | 1:5 |
|  | Bunsen burner | 500g | 25 | 1:1 |
|  | Capacitors | paper | 25 | 1:1 |
|  | Meter rule | Wooden | 25 | 1:1 |
|  | venturi meter |  | 25 | 1:1 |
|  | Cell holder | Double | 25 | 1:1 |
|  | Electroscope | Gold leaf | 25 | 1:1 |
|  | Van de Graff generator |  | 2 | 2:25 |
|  | Mirror | Plain and curved | 25 | 1:1 |
|  | Lenses | Perspex | 25 | 1:1 |
|  | Glass block | Rectangular | 25 | 1:1 |
|  | Optical pins | 2 inchs | 100 | 4:1 |
|  | Transformers | 12volts | 25 | 1:1 |
|  | thermometers | -100c to 1000c | 25 | 1:1 |
|  | stopwatches | Digital | 25 | 1:1 |
|  | weighing balances | 0 to 2kg | 5 | 1:5 |
|  | calorimeters | Copper | 25 | 1:1 |
|  | ammeters | 0 to 2A | 25 | 1:1 |
|  | voltmeters | 0 to 5A | 25 | 1:1 |
|  | Variable Resistors | 0 to 100 ohms | 25 | 1:1 |
|  | Connecting wires | Wires with crocodile clips | 200 | 8:1 |
|  | Dry cells | D size | 50 | 2:1 |
|  | Galvanometer | Zero centred | 25 | 1:1 |
|  | Tuning fork | 2 harmonics | 25 | 1:1 |
|  | sound level meters | Digital LCD | 5 | 1:5 |
|  | vibration meters | Digital | 5 | 1:5 |
|  | octave band analyzers |  | 5 | 1:5 |