

**REPUBLIC OF KENYA**

**COMPETENCY BASED CURRICULUM**

**FOR**

**WATER RESOURCES MANAGEMENT TECHNOLOGY**

**LEVEL 6**

|  |  |
| --- | --- |
|  |  |
| **KENYA WATER INSTITUTE**  **P.O. BOX 60013-00200**  **NAIROBI** | **TVET CDACC**  **P.O. BOX 15745-00100**  **NAIROBI** |

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# FOREWORD

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

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution and this resulted to the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, Curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows 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.

It is my conviction that this Curriculum will play a great role towards development of competent human resource for the Water Resources Management and entire Water sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**MINISTRY OF WATER & SANITATION AND IRRIGATION**

# PREFACE

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

The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, 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 Kenyan labour force.

Kenya Water Institute in conjunction with Water Sector Skills Advisory Committee (SSAC), Water Resources Authority, Jomo Kenyatta University of Agriculture and Technology (JKUAT), and South Eastern Kenya University (SEKU), with guidance from TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) has developed this Curriculum.

This curriculum has been developed following the CBET framework policy; the CBETA standards and guidelines provided by the TVET Authority and the Kenya National Qualification Framework designed by the Kenya National Qualification Authority.

The Curriculum is designed and organized with an outline of learning outcomes; suggested delivery methods, training/learning resources and methods of assessing the trainee’s achievement. The Curriculum is competency-based and allows multiple entry and exit to the course.

I am grateful to the KEWI Academic Board, Technical Committees, TVET CDACC, Water SSAC, Academia, expert workers and all those who participated in the development of this Curriculum.

**CHAIRPERSON**

**KENYA WATER INSTITUTE GOVERNING COUNCIL**

**ACKNOWLEDGEMENT**

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

I appreciate Kenya Water Institute, Water Resources Authority, Water Sector Institutions and Water Sector Skills Advisory Committee (SSAC) who enabled the development of this Curriculum.

I recognize with appreciation the role of the SSAC in ensuring that competencies required by the industry are addressed in this Curriculum. I also thank all experts in Academia and stakeholders in the Water sector for their valuable input and all those who participated in the process of developing this Curriculum.

I am convinced that this Curriculum will go a long way in ensuring that workers in the water sector in general, and water resources management in particular will acquire relevant competencies that will enable them to perform their work more efficiently.

**CEO/COUNCIL SECRETARY**

**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL**

**ABBREVIATIONS AND ACRONYMS**

|  |  |
| --- | --- |
| AC | Alternating Current |
| AP | Arithmetic Progression |
| CAD | Computer Aided Design |
| CBC | Competence Based Curriculum |
| CBET | Competence Based Education and Training |
| CDACC | Curriculum Development, Assessment and Certification Council |
| DC | Direct Current |
| DO | Dissolved oxygen |
| DI | Ductile Iron |
| DTP | Desktop Publishing |
| EMCA | Environmental Management Coordination Act |
| EMS | Environmental Management Systems |
| GHS | Globally Harmonized System |
| GI | Galvanized Iron |
| GIS | Geographical Information Systems |
| GPS | Global Positioning System |
| ICT | Information Communication Technology |
| IEE | Institute of Electrical Engineers |
| IWRM | Integrated Water Resources Management |
| KCSE | Kenya Certificate of Secondary Education |
| KEBS | Kenya Bureau of Standards |
| KEWI | Kenya Water Institute |
| KNQA | Kenya National Qualifications Authority |
| KNQF | Kenya National Qualifications Framework |
| NEMA | National Environmental Management Authority |
| OSH | Occupational Safety and Health |
| PPE | Personal Protective Equipment |
| PPR | Polypropylene |
| RC | Reinforced Concatenate |
| R-L-C | Resistor-Inductor (L) - Circuit |
| SD | Standard Deviation |
| SDG | Sustainable Development Goals |
| SSAC | Sector Skills Advisory Committee |
| TV | Television |
| TVET | Technical Vocational Education and Training |
| TVETA | Technical Vocational Education and Training Authority |
| WRA | Water Resources Authority |
| WASPA | Water Service Providers Association |
| WASREB | Water Services Regulatory Board |
| WHO | World Health Organization |
| WHSA | Water Harvesting Storage Authority |
| WRA | Water Resources Authority |
| WRUA | Water Resources Users Association |
| WSP | Water Service Providers |
| WSTF | Water Services Trust Fund |

# KEY TO UNIT CODE

**WAT/ CU/ WRMT/ BC/ 01/ 6/A**

Industry or sector

Curriculum

Occupational area

Type of Unit

Unit number

Competency Level

Version Control

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# COURSE OVERVIEW

Water Resources Management Technology Level 6 qualification consists of competencies that an individual must achieve to enable him/her to manage water resources. It comprises managing surface and ground water resources, developing groundwater resources as well as developing alternative water resources.

The units of competency comprising Water Resources Management Technology Level 6 qualification include the following:

**Basic Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factor** |
| WAT/CU/WRMT/BC/01/6/A | Communication Skills | 45 | 4.5 |
| WAT/CU/WRMT/BC/02/6/A | Digital Literacy | 60 | 6.0 |
| WAT/CU/WRMT/BC/03/6/A | Entrepreneurial Skills | 90 | 9.0 |
| WAT/CU/WRMT/BC/04/6/A | Employability Skills | 45 | 4.5 |
| WAT/CU/WRMT/BC/05/6/A | Environmental Literacy | 90 | 9.0 |
| WAT/CU/WRMT/BC/06/6/A | Occupational Safety and Health Practices | 30 | 3.0 |
| **Total** | | **360** | **36.0** |

**Common Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factor** |
| WAT/CU/WRMT/CC/01/6/A | Applied Chemistry and Biology | 180 | 18.0 |
| WAT/CU/WRMT/CC/02/6/A | Applied Mathematics | 135 | 13.5 |
| WAT/CU/WRMT/CC/03/6/A | Applied Physics | 120 | 12.0 |
| WAT/CU/WRMT/CC/04/6/A | Workshop Practice | 240 | 4.0 |
| WAT/CU/WRMT/CC/05/6/A | Technical Drawing and CAD | 105 | 10.5 |
| WAT/CU/WRMT/CC/06/6/A | Water Technology | 135 | 13.5 |
| WAT/CU/WRMT/CC/07/6/A | Water Management Principles | 210 | 21.0 |
| WAT/CU/WRMT/CC/08/6/A | Water Projects Site Survey | 45 | 4.5 |
| **Total** | | **1170** | **117.0** |

**Core Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factor** |
| WAT/CU/WRMT/CR/01/6/A | Surface Water Resources Management | 240 | 24.0 |
| WAT/CU/WRMT/CR/02/6/A | Ground Water Resources Management | 240 | 24.0 |
| WAT/CU/WRMT/CR/03/6/A | Ground Water Resources Development | 180 | 18.0 |
| WAT/CU/WRMT/CR/04/6/A | New Water Resources Development | 90 | 9.0 |
| **Total** | | **750** | **75.0** |
| **Industrial Attachment** | | **480** | **48.0** |

|  |  |  |
| --- | --- | --- |
| **Grand Total** | **2760** | **276.0** |

**Entry Requirements**

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

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

**Or**

1. Certificate Water Resources Management Craft Certificate, KNQF Level 5;

**Or**

1. Equivalent qualifications as determined by Kenya National Qualifications Authority (KNQA).

**Trainer qualification**

A trainer for this course should have a higher qualification than the level of this course.

**Industrial Attachment**

An individual enrolled in this course will undergo an industrial attachment for a period of 480 hours in a Water Resources Management establishment.

**Assessment**

The course will be assessed at two levels:

1. **Internal assessment**: conducted continuously by the trainer (internal assessor) who is monitored by an accredited internal verifier.
2. **External assessment:** conducted by an accredited external assessor who is monitored by an accredited external verifier.

The assessors and verifiers are registered by TVET CDACC which also coordinates external assessment.

**Certification**

An individual will be awarded a Certificate of Competency on demonstration of competence in a unit of competency. To be awarded Water Resources Technology and Management Level 6, an individual must demonstrate competence in all the units of competency in the qualification pack.

This certificate will be awarded by Kenya Water Institute.

# BASIC UNITS OF LEARNING

## COMMUNICATION SKILLS

**UNIT CODE:** WAT/CU/WRMT/BC/01/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Communication Skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit covers the competencies required to demonstrate communication skills .It involves, meeting communication needs of clients and colleagues; developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

**Summary of Learning Outcomes**

1. Meet communication needs of clients and colleagues
2. Develop communication strategies
3. Establish and maintain communication pathways
4. Promote use of communication strategies
5. Conduct interview
6. Facilitate group discussion
7. Represent the organization

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Meet communication needs of clients and colleagues | * Communication process * Modes of communication * Medium of communication * Effective communication * Barriers to communication * Flow of communication * Sources of information * Organizational policies * Organization requirements for written and electronic communication methods * Report writing * Effective questioning techniques (clarifying and probing) * Workplace etiquette * Ethical work practices in handling communication * Active listening * Feedback * Interpretation * Flexibility in communication * Types of communication strategies * Elements of communication strategy | * Interview * Written texts |
| 1. Develop communication strategies | * Dynamics of groups * Styles of group leadership * Openness and flexibility in communication * Communication skills relevant to client groups | * Interview * Written texts |
| 1. Establish and maintain communication pathways | * Types of communication pathways | * Interview * Written texts |
| 1. Promote use of communication strategies | * Application of elements of communication strategies * Effective communication techniques | * Interview * Written texts |
| 1. Conduct interview | * Types of interview * Establishing rapport * Facilitating resolution of issues * Developing action plans | * Interview * Written texts |
| 1. Facilitate group discussion | * Identification of communication needs * Dynamics of groups * Styles of group leadership * Presentation of information * Encouraging group members participation * Evaluating group communication strategies | * Interview * Written texts |
| 1. Represent the organization | * Presentation techniques * Development of a presentation * Multi-media utilization in presentation * Communication skills relevant to client groups | * Interview * Written texts |

**Suggested Methods of Instruction**

* Discussion
* Role playing
* Simulation
* Direct instruction

**Recommended Resources**

* Desktop computers/laptops
* Internet connection
* Projectors
* Telephone

## DIGITAL LITERACY

**UNIT CODE:** WAT/CU/WRMT/BC/02/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes competencies required to demonstrate digital literacy. It involves in identifying computer software and hardware, applying security measures to data, hardware, software in automated environment, computer software in solving task, internet and email in communication at workplace, desktop publishing in official assignments and preparing presentation packages.

**Summary of Learning Outcomes**

1. Identify computer software and hardware
2. Apply security measures to data, hardware, software in automated environment
3. Apply computer software in solving tasks
4. Apply internet and email in communication at workplace
5. Apply desktop publishing in official assignments
6. Prepare presentation packages

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify computer hardware and software | * Concepts of ICT * Functions of ICT * History of computers * Components of a computer * Classification of computers | * Written tests * Oral presentation |
| 1. Apply security measures to data, hardware, software in automated environment | * Data security and control * Security threats and control measures * Types of computer crimes * Detection and protection against computer crimes * Laws governing protection of ICT | * Written tests * Oral presentation * Project |
| 1. Apply computer software in solving tasks | * Operating system * Word processing * Spread sheets * Data base design and manipulation * Data manipulation, storage and retrieval | * Oral questioning * Project |
| 1. Apply internet and email in communication at workplace | * Computer networks * Network configurations * Uses of internet * Electronic mail (e-mail) concept | * Oral questioning * Written report |
| 1. Apply desktop publishing in official assignments | * Concept of desktop publishing * Opening publication window * Identifying different tools and tool bars * Determining page layout * Opening, saving and closing files * Drawing various shapes using DTP * Using colour pellets to enhance a document * Inserting text frames * Importing and exporting text * Object linking and embedding * Designing of various publications * Printing of various publications | * Oral questioning * Written report * Project |
| 1. Prepare presentation packages | * Types of presentation packages * Procedure of creating slides * Formatting slides * Presentation of slides * Procedure for editing objects | * Oral questioning * Written report * Project |

**Suggested Methods of Instruction**

* Instructor led facilitation of theory
* Demonstration by trainer
* Practical work by trainee
* Viewing of related videos
* Project
* Group discussions

**Recommended Resources**

* Computers
* Printers
* Storage devices
* Internet access

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** WAT/CU/WRMT/BC/03/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Entrepreneurial Skills

**Duration of unit:** 100 hours

**Unit Description**

This unit covers the competencies required to demonstrate understanding of entrepreneurship. It involves demonstrating understanding of an entrepreneur, entrepreneurship and self-employment. It also involves identifying entrepreneurship opportunities, creating entrepreneurial awareness, applying entrepreneurial motivation and developing business innovative strategies.

**Summary of Learning Outcomes**

* 1. Demonstrate understanding of who an entrepreneur
  2. Demonstrate knowledge of entrepreneurship and self-employment
  3. Identify entrepreneurship opportunities
  4. Create entrepreneurial awareness
  5. Apply entrepreneurial motivation
  6. Develop business innovative strategies
  7. Develop Business plan

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Demonstrate knowledge of entrepreneurship and self-employment | * Importance of self-employment * Requirements for entry into self-employment * Role of an Entrepreneur in business * Contributions of Entrepreneurs to National development * Entrepreneurship culture in Kenya * Born or made entrepreneurs | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report |
| 1. Identify entrepreneurship opportunities | * Business ideas and opportunities * Sources of business ideas * Business life cycle * Legal aspects of business * Assessment of product demand * Business environment * Factors to consider when evaluating business environment * Technology in business | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Create entrepreneurial awareness | * Forms of businesses * Sources of business finance * Factors in selecting source of business finance * Governing policies on Small Scale Enterprises (SSEs) * Problems of starting and operating SSEs | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Apply entrepreneurial motivation | * Internal and external motivation * Motivational theories * Self-assessment * Entrepreneurial orientation * Effective communications in entrepreneurship * Principles of communication * Entrepreneurial motivation | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Develop business innovative strategies | * Innovation in business * Small business Strategic Plan * Creativity in business development * Linkages with other entrepreneurs * ICT in business growth and development | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Develop Business Plan | * Business description * Marketing plan * Organizational/Management * plan * Production/operation plan * Financial plan * Executive summary * Presentation of Business Plan | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |

**Suggested Methods of Instruction**

* Direct instruction
* Project
* Case studies
* Field trips
* Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training

**Recommended Resources**

* Case studies
* Business plan templates
* Computers
* Overhead projectors
* Internet
* Mobile phone
* Video clips
* Films
* Newspapers and Handouts
* Business Journals
* Writing materials

## EMPLOYABILITY SKILLS

**UNIT CODE:** WAT/CU/WRMT/BC/04/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Employability Skills

**Duration of Unit:** 80 hours

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves conducting self-management, demonstrating interpersonal communication, critical safe work habits, leading a workplace team, planning and organizing work, maintaining professional growth and development, demonstrating workplace learning, problem solving skills and managing ethical performance.

**Summary of Learning Outcomes**

1. Conduct self-management
2. Demonstrate interpersonal communication
3. Demonstrate critical safe work habits
4. Lead a workplace team
5. Plan and organize work
6. Maintain professional growth and development
7. Demonstrate workplace learning
8. Demonstrate problem solving skills
9. Manage ethical performance

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct self-management | * Self-awareness * Formulating personal vision, mission and goals * Strategies for overcoming life challenges * Managing emotions * Emotional intelligence * Assertiveness versus aggressiveness * Expressing personal thoughts, feelings and beliefs * Developing and maintaining high self-esteem * Developing and maintaining positive self-image * Setting performance targets * Monitoring and evaluating performance * Articulating ideas and aspirations * Accountability and responsibility * Good work habits * Self-awareness * Values and beliefs * Self-development * Financial literacy * Healthy lifestyle practices * Adopting safety practices | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate interpersonal communication | * Meaning of interpersonal communication * Listening skills * Types of audience * Public speaking * Writing skills * Negotiation skills * Reading skills * Meaning of empathy * Understanding customers’ needs * Establishing communication networks * Assertiveness * Sharing information | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate critical safe work habits | * Stress and stress management * Time concept * Punctuality and time consciousness * Leisure * Integratingpersonal objectives into organizational objectives * Resources mobilization * Resources utilization * Setting work priorities * Developing healthy relationships * HIV and AIDS * Drug and substance abuse * Managing emerging issues | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Lead a workplace team | * Leadership qualities * Power and authority * Team building * Determination of team roles and objectives * Team parameters and relationships * Individual responsibilities in a team * Forms of communication * Complementing team activities * Gender and gender mainstreaming * Human rights * Developing healthy relationships * Maintaining relationships * Conflicts and conflict resolution * Coaching and mentoring skills | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Plan and organize work | * Functions of management * Planning * Organizing * Time management * Decision making concept * Task allocation * Developing work plans * Developing work goals/objectives and deliverables * Monitoring work activities * Evaluating work activities * Resource mobilization * Resource allocation * Resource utilization * Proactive planning * Risk evaluation * Problem solving * Collecting, analysing and organising information * Negotiation | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Maintain professional growth and development | * Avenues for professional growth * Training and career opportunities * Assessing training needs * Mobilizing training resources * Licenses and certifications for professional growth and development * Pursuing personal and organizational goals * Managing work priorities and commitments * Recognizing career advancement | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate workplace learning | * Managing own learning * Mentoring * Coaching * Contributing to the learning community at the workplace * Cultural aspects of work * Networking * Variety of learning context * Application of learning * Safe use of technology * Taking initiative/proactivity * Flexibility * Identifying opportunities * Generating new ideas * Workplace innovation * Performance improvement * Managing emerging issues * Future trends and concerns in learning | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate problem solving skills | * Critical thinking process * Data analysis tools * Decision making * Creative thinking * Development of creative, innovative and practical solutions * Independence in identifying and solving problems * Solving problems in teams * Application of problem-solving strategies * Testing assumptions * Resolving customer concerns | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Manage ethical performance | * Meaning of ethics * Ethical perspectives * Principles of ethics * Ethical standards * Organization code of ethics * Common ethical dilemmas * Organization culture * Corruption, bribery and conflict of interest * Privacy and data protection * Diversity, harassment and mutual respect * Financial responsibility/accountability * Etiquette * Personal and professional integrity * Commitment to jurisdictional laws * Emerging issues in ethics | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |

**Suggested Methods of Instruction**

* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Assignments
* Q&A

**Recommended Resources**

* Computers
* Stationery
* Charts
* Video clips
* Audio tapes
* Radio sets
* TV sets
* LCD projectors

## ENVIRONMENTAL LITERACY

**UNIT CODE**:WAT/CU/WRMT/BC/06/6/A

**Relationship to Occupational Standards**:

This unit addresses the Unit of Competency: Demonstrate Environmental Literacy

**Duration of Unit:** 40 hours

**Unit Description**

This unit describes the competencies required demonstrate environmental literacy.it involves controlling environmental hazard, controlling environmental pollution, complying with workplace sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs, monitoring activities on environmental protection/programs, analysing resource use and developing resource conservation plans.

**Summary of Learning Outcomes**

1. Control environmental hazard
2. Control environmental Pollution
3. Demonstrate sustainable resource use
4. Evaluate current practices in relation to resource usage
5. Identify Environmental legislations/conventions for environmental concerns
6. Implement specific environmental programs
7. Monitor activities on Environmental protection/Programs
8. Analyze resource use
9. Develop resource conservation plans

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Control environmental hazard | * Purposes and content of Environmental Management and Coordination Act 1999 * Storage methods for environmentally hazardous materials * Disposal methods of hazardous wastes * Types and uses of PPE in line with environmental regulations * Occupational Safety and Health Standards (OSHS) | * Written questions * Oral questions |
| 1. Control environmental Pollution control | * Types of pollution * Environmental pollution control measures * Types of solid wastes * Procedures for solid waste management * Different types of noise pollution * Methods for minimizing noise pollution | * Written questions * Oral questions * Role play |
| 1. Demonstrate sustainable resource use | * Types of resources * Techniques in measuring current usage of resources * Calculating current usage of resources * Methods for minimizing wastage * Waste management procedures * Principles of 3Rs (Reduce, Reuse, Recycle) * Methods for economizing or reducing resource consumption | * Written questions * Oral questions * Role play |
| 1. Evaluate current practices in relation to resource usage | * Collection of information on environmental and resource efficiency systems and procedures, * Measurement and recording of current resource usage * Analysis and recording of current purchasing strategies. * Analysis of current work processes to access information and data * Identification of areas for improvement | * Written questions * Oral questions * Role play |
| 1. Identify Environmental legislations/conventions for environmental concerns | * Environmental issues/concerns * Environmental legislations /conventions and local ordinances * Industrial standard /environmental practices * International Environmental Protocols (Montreal, Kyoto) * Features of an environmental strategy | * Written questions * Oral questions |
| 1. Implement specific environmental programs | * Community needs and expectations * Resource availability * 5s of good housekeeping * Identification of programs/Activities * Setting of individual roles /responsibilities * Resolving problems /constraints encountered * Consultation with stakeholders | * Written questions * Oral questions * Role play |
| 1. Monitor activities on Environmental protection/Programs | * Periodic monitoring and Evaluation of activities * Gathering feedback from stakeholders * Analyzing data gathered * Documentation of recommendations and submission * Setting of management support systems to sustain and enhance the program * Monitoring and reporting of environmental incidents to concerned /proper authorities | * Oral questions * Written tests * Practical test |
| 1. Analyze resource use | * Identification of resource consuming processes * Determination of quantity and nature of resource consumed * Analysis of resource flow through different parts of the process. * Classification of wastes for possible source of resources. | * Written tests * Oral questions * Practical test |
| 1. Develop resource Conservation plans | * Determination of efficiency of use/conversion of resources * Causes of low efficiency of use of resources * Plans for increasing the efficiency of resource use | * Written tests * Oral questions * Practical test |

**Suggested Methods of Instruction**

* Instructor led facilitation of theory
* Practical demonstration of tasks by trainer
* Practice by trainees
* Observations and comments and corrections by trainers

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Environmental Management and Coordination Act 1999
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE)
* ISO standards
* Company environmental management systems (EMS)
* Montreal Protocol
* Kyoto Protocol

## OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** WAT/CU/WRMT/BC/06/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate Occupational Safety and Health Practices

**Duration of Unit:** 40 hours

**Unit Description**

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risk, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

**Summary of Learning Outcomes**

1. Identify workplace hazards and risk
2. Control OSH hazards
3. Implement OSH programs

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify workplace hazards and risks | * Identification of hazards in the workplace and/or the indicators of their presence * Evaluation and/or work environment measurements of OSH hazards/risk existing in the workplace * Gathering of OSH issues and/or concerns | * Oral questions * Written tests * Portfolio of evidence * Third party report |
| 1. Control OSH hazards | * Prevention and control measures e.g. use of PPE * Risk assessment * Contingency measures | * Oral questions * Written tests * Portfolio of evidence * Third party report |
| 1. Implement OSH   programs | * Company OSH program, evaluation and review * Implementation of OSH programs * Training of team members and advice on OSH standards and procedures * Implementation of procedures for maintaining OSH-related records | * Oral questions * Written tests * Portfolio of evidence * Third party report |

**Suggested Methods of instruction**

* Assigments
* Discussion
* Q&A
* Role play
* Viewing of related videos

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE) e.g.
* Mask
* Face mask/shield
* Safety boots
* Safety harness
* Arm/Hand guard, gloves
* Eye protection (goggles, shield)
* Hearing protection (ear muffs, ear plugs)
* Hair Net/cap/bonnet
* Hard hat
* Face protection (mask, shield)
* Apron/Gown/coverall/jump suit
* Anti-static suits
* High-visibility reflective vest

# COMMON UNITS OF LEARNING

## APPLIED CHEMISTRY AND BIOLOGY

**UNIT CODE:** WAT/CU/WRMT/CC/01/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Chemistry and Biology Principles

**Duration of Unit:** 255 HOURS

**Unit Description**

This unit covers the competencies required to apply chemistry and biology principles. It involves applying inorganic chemistry principles, organic chemistry principles, physical chemistry principles, water chemistry principles and chemical water quality principles. It also entails applying biology and microbial water quality principles.

**Summary of Learning Outcomes**

1. Apply inorganic chemistry principles
2. Apply organic chemistry principles
3. Apply physical chemistry principles
4. Apply water chemistry principles
5. Apply chemical water quality principles
6. Apply biology principles
7. Apply microbiological water quality principles

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** | |
| * 1. Apply Inorganic Chemistry Principles | * Atomic structure and the periodic table * Electronic configuration of the first 30 elements of the periodic table * Groups, periods and blocks in the periodic table * Trends in physical and chemical properties of main group elements * Chemical bonding and structures * Properties of metallic, covalent and Ionic bonds * Nomenclature and chemical formulae of inorganic compounds * Dissolution and hydrolysis of ionic compounds of period 3 elements * The mole concept and aqueous solutions * Stoichiometry of chemical reactions * Chemical reagents and solution preparation * GHS of classification and labelling of chemicals * Storage, packaging, transportation, handling and disposal of hazardous chemical wastes * Personal safety and chemical accidents prevention | * Practical Tests * Interviewing * Oral questioning * Third party report * Written tests | |
| 2. Apply organic chemistry principles | * Classification of organic compounds * Structure and nomenclature of organic compounds * Physical and chemical properties of alkanes * Physical and chemical properties of alkenes and alkynes * Physical and chemical properties of alcohols * Physical and chemical properties of carboxylic acids * Natural and synthetic polymers * Aerobic and anaerobic processes * Eutrophication | * Practical Test * Interviewing * Oral questioning * Third party report * Written tests | |
| 3. Apply physical chemistry principles | * Electrochemical series and reactivity series * Corrosion * Displacement reactions * Solubility rules * Chemical reactions in electrochemical cells * Kinetic theory and gas laws * Reversible reactions and chemical equilibria * Chemical kinetics * Thermochemistry and thermodynamics * Rate law applications in aqueous medium * Colloidal suspensions | * Practical Test * Interviewing * Oral questioning * Third party report * Written tests | |
| 4.Apply water chemistry principles | * Structure and chemical composition of water * Acid-base phenomena * Properties of water * Solubility of fluids in water * Chemical equilibria in the carbonate system * Auto-ionization and levelling effect of water * Implications of unique chemistry of water | * Practical Test * Interviewing * Oral questioning * Third party report * Written tests | |
| 5. Apply chemical water quality principles | | * Water quality and effluent discharge standards and guidelines * Irrigation water quality regulations * Water and wastewater sampling techniques for chemical testing * Protocols for physical and chemical analysis * Physical and chemical water quality analysis principles, and applications * Physical and chemical tests for drinking water, irrigation water and waste water. * Data collection, recording, interpretation and reporting * Safety considerations in a chemical water and wastewater quality testing laboratory | | * Practical Test * Interviewing * Oral questioning * Third party report * Written tests | |
| 1. Apply Biology principles | * Concepts and terms of Biology * Characteristics of living things * Organization of life forms * The five-kingdom classification system * Viruses * Prokaryotes and eukaryotes * Unicellular and multicellular organisms * Classification of aquatic organisms * Principles of aquatic ecology * Application of aquatic ecology in water quality monitoring * Classification of pathogenic microorganisms and their vectors * General laboratory biosafety rules | | * Practical Test * Interviewing * Oral questioning * Third party report * Written tests |
| 1. Apply microbial water quality principles | * Water sampling for microbial analysis * Microbial water quality analysis principles and application * Microbiological water quality testing | | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |

**Suggested Methods of Instruction:**

* Direct instruction
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

|  |  |
| --- | --- |
| * Analytical balances * UV-Vis spectrophotometers * Colour comparator discs * pH meter * Conductivity meter * Meters with ISE e.g. fluoride, nitrate * Turbidimeter * Conductivity meters * Dissolved oxygen meter * BOD oxitop bottles * Oven * Incubator * Muffle furnace (up to 500oC) * Refrigerator * Cooler boxes * jar test kit * Membrane filtration units * Thermometers * Distillers * filtration units * Autoclaves * Microscope * Quant tray sealer * Desiccators * Hotplates * Magnetic stirrers * Computers * Vacuum Pumps |  |

## APPLIED MATHEMATICS

**UNIT CODE:** WAT/CU/WRMT/CC/02/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Mathematical Skills

**Duration of Unit:** 195 Hours

**Unit Description**

This unit describes the competencies required to apply mathematical skills. It entails applying functions of a scientific calculator, arithmetic operations, algebraic expressions, ratios rates and proportions, calculus principles as well probability and statistics principles.

This applies to water sector.

**Summary of Learning Outcomes**

1. Use functions of a scientific calculator
2. Apply arithmetic operations
3. Apply algebraic expressions
4. Apply ratios, rates and proportions to solve problems
5. Apply calculus principles
6. Apply probability and statistics principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Use functions of a scientific calculator | * Function keys and their usage. * Applying order of operations and use of brackets to solve multi-step calculations. * Switching between various modes on the calculator. * Working with integers * Working with secondary functions using the shift key. * Interpreting the display and recording the result. | * Oral tests * Written tests * Practical test |
| 1. Apply Arithmetic operations | * Integers * Arithmetic operations * Surds * Decimal places, significant figures, standard form * Indices * Logarithms * Logarithmic equations | * Written tests * Assignments * Supervised exercises |
| 1. Apply algebraic expressions | * Algebraic expressions and equations * Transposition of formulae * Solution of linear and quadratic equations * The equation of a straight line * Applications of linear graphs. * Graphs of quadratic functions * interpolation and extrapolation * Simultaneous equations in two unknowns * Sequences and series: Arithmetic and geometric * Coordinate geometry | * Oral questioning * Written test * Practical exercises |
| 1. Apply ratios, rates and proportions to solve problems | * Ratios: simple ratios * Proportions: direct and inverse proportions * Rates | * Oral questioning * Written tests * Practical exercises |
| 1. Apply Calculus Principles | * Differentiation from first principles. * Standard derivatives. * Differentiation of trigonometric, logarithmic and exponential functions. * Logarithmic differentiation * Applications of differentiation: Rates of change, Small changes * Integration * Indefinite and definite integrals * Application of integration: Area and volumes | * Oral questioning * Written tests * Practical exercises |
| 1. Apply Probability and statistics principles | * Concepts and definition of terms * Laws of probability * Types of events * Probability distributions: discrete and continuous * Interpretation of probability distribution data * Measures of central tendency * Linear correlation * Linear regression * Statistical tests: t-test, f-test, Q-test, ANOVA | * Oral questioning * Written tests * Practical exercises |

**Suggested Delivery Methods**

* Direct instruction
* Group discussions
* Demonstration by trainer
* Field study
* Case study

**Recommended Resources**

* Scientific Calculators
* Computers
* Charts with presentations of data
* Graph books
* Dice

## APPLIED PHYSICS

**UNIT CODE:** WAT/CU/WRMT/CC/03/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Physics Principles

**Duration of unit:** 120 Hours

**Unit Description**

This unit describes the competence required to apply principles. It involves performing measurements of physical quantities, applying principles of forces, applying principles of classical mechanics, heat transfer, waves and oscillations, as well as density and pressure principle. It also entails applying electromagnetic induction principles

**Summary of Learning Outcomes**

1. Perform measurements of physical quantities
2. Apply principles of forces
3. Apply principles of classical mechanics
4. Apply principles of heat transfer
5. Apply principles of waves and oscillations
6. Apply density, pressure and fluid flow principles
7. Apply principles of electromagnetic induction

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Measurements of physical quantities | * Basic physical quantities and SI units * Derived units * Measurement of the physical quantities * Unit Interconversion | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Apply principles of forces | * Types of forces and their effects * Resolving forces * Friction and viscosity * Centre of gravity * Moments of force * Solving problems | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Apply Principles of classical Mechanics | * Concepts and terms in classical mechanics * Linear Motion * Projectile motion * Newton’s laws of motion * Conservation of linear momentum * Potential energy * Kinetic energy * Conservation of energy * Solving problems | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Apply principles of heat Transfer | * Concepts and terms in heat transfer * Modes of heat transfer * Change of physical state * Temperature change * Latent heat * Specific heat capacity * Quantity of heat * Kinetic theory | * Practical Test * Oral questioning * Practical tests * Written tests |
| 1. Apply principles of waves and oscillations | * Principles and terms in waves and oscillation * Types of waves * Wave equation * Electromagnetic spectrum * Dual nature of light * Rectilinear propagation of light * Optical properties of light * Simple harmonic oscillations * Vibration * Solving problems | * Practical Test * Oral questioning * Practical tests * Written tests |
| 1. Apply density, pressure and fluid flow principles | * Density in fluids and solids * Pressure in fluids and solids * Bernoulli’s Principle * Equation of continuity * Hydraulic machines * Suction pumps * Application of pressure in hydraulic machines | * Practical Test * Oral questioning * Practical tests * Written tests |
| 1. Apply principles of electromagnetic induction | * Concepts and terminology in electromagnetic induction * Magnetic parameters * Magnetic properties of materials * induced e.m.f. and current * Faraday’s laws of electromagnetic induction * Lenz’s law * Applications of electromagnetic induction | * Practical Test * Oral questioning * Practical * Written tests |

**Suggested Methods of Instruction**

* Direct instruction
* Demonstration by trainer
* Practice by the trainee
* Discussions

**Recommended Resources**

* Stop watches
* Metre rules
* Micrometer screw gauges
* Vernier caliper
* Electric meters
* Voltmeters
* Electronics kit
* PPE
* Assorted cables and wires
* Measuring rules
* Optical bench
* Mirrors
* Lenses

## WORKSHOP PRACTICE

**UNIT CODE:** WAT/CU/WRMT/CC/04/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Workshop Practices

**Duration of Unit:** 240 Hours

**Unit Description**

This unit describes the competence required to apply workshop practice. It involves applying workshop safety measures, identifying engineering materials, performing masonry tasks, carpentry tasks, plumbing tasks, as well as general electrical tasks, welding tasks and mechanical tasks. It also involves managing workshop wastes.

**Summary of Learning Outcomes**

1. Apply workshop safety measures
2. Identify engineering materials
3. Perform masonry tasks
4. Perform carpentry tasks
5. Perform electrical tasks
6. Perform plumbing tasks
7. Perform general welding tasks
8. Perform mechanical tasks
9. Manage workshop wastes

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply workshop safety measures | * Safety requirements in the workshop * Workshop rules and regulations * Electrical, mechanical, chemical and fire hazards * Workshop risk assessment * First aid * Safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Identify engineering materials | * Classification of engineering materials * Crystalline structure of materials * Properties of materials * Construction material: types, standard processing and applications | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Perform masonry tasks | * Masonry tools and machinery * Masonry works supplies and materials * Tasks in masonry work * Troubleshoot, care and maintenance of masonry tools * Safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Perform carpentry tasks | * Carpentry tools and machinery * Carpentry works supplies and materials * Carpentry work * Troubleshoot, care and maintenance of carpentry tools * Safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Perform electrical tasks | * Concepts and terminology in electricity and electronics * Electric charges and current * Electric and electronic circuits * Electrical and electronic instruments * Electrical and electronic measurements * Errors in electrical measurement * Ohms law * Kirchhoff’s laws * AC and DC circuits in electronic systems * Electrical and electronic installation * R-L-C circuits * Semi-conductor devices:   + Diodes   + Transistors * Electrical tools and machinery * Electrical works supplies and materials * Alternative sources of electricity * Wiring * Troubleshoot, care and maintenance of electrical systems * Safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Perform plumbing tasks | * Plumbing tools and machinery * Plumbing works supplies and materials * Pipes, fittings and appurtenances * Installation of piping system * Troubleshoot, care and maintenance of piping system * Safety and hygiene | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Perform General welding tasks | * Welding hand tools and machinery * Welding works supplies and materials * Welding methods * Troubleshoot, care and maintenance of welding tools * Safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Perform mechanical tasks | * Use of mechanical hand tools and machinery * Lifting equipment * Types of lifting equipment: manual, mechanized, hydraulic and pneumatic * Operation principles: pre-requisite checks, operation procedures, equipment safety. * Troubleshoot, care and maintenance of mechanical tools * Routine maintenance: cleaning, servicing and trouble shooting * Mechanical works supplies and materials * Tasks in mechanical work * Types of pumps * Working principles of pumps * Pump selection criteria * Pump performance parameters * Fluid pumping calculations * Pumping plant operation and maintenance * Safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Manage workshop wastes | * Environmental management laws and regulations * Work station cleaning * Waste management and disposal * Storage products and supplies * Waste management methods * Waste disposal methods * Safety and health | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Discussion
* Direct instruction

**Recommended Resources**

* Mason’s trowel
* Adjustable wrench
* Anvil
* Arc welding shields
* Chain pipe wrench
* Die stock and die sets
* Draw in wire
* Hacksaw
* Hand drill
* Pullers
* Solder gun
* Spirit level
* Vernier callipers
* Welding goggles
* Aggregates
* Assorted pipe joints
* Brushes
* Cement
* Nails
* Pipe cleaner
* Timber
* Trunking
* Saws
* Concrete mixers
* Grinders

## TECHNICAL DRAWING AND COMPUTER AIDED DRAWING

**UNIT CODE:** WAT/CU/WRMT/CC/05/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Technical Drawing and Computer Aided Drawing Design Principles

**Duration of Unit:** 105 Hours

**Unit Description**

This unit covers the competencies required to apply technical drawing and computer aided design principles. It involves identifying, using and maintaining drawing equipment and materials, producing plane geometry drawings, solid geometry drawings, 3D drawings, and working drawings It also involves applying CAD packages in producing working drawings

**Summary of Learning Outcomes**

1. Use and maintain drawing equipment and materials
2. Produce plane geometry drawings
3. Produce solid geometry drawings
4. Produce 3D drawings
5. Produce working drawings
6. Apply CAD packages

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Use and maintain drawing equipment and materials | * Drawing office set up * Drawing tools, materials and equipment | * Written tests * Oral questioning * Interviewing * Practical Test * Third party reports |
| 1. Produce plane geometry drawings | * Drawing lines * Lettering and numbering * Drawing scales * Construction of angles, lines and tangents * Geometric forms | * Written tests * Oral questioning * Interviewing * Practical Test * Third party reports |
| 1. Produce solid geometry drawings | * Drawing patterns * Surface developments * True shapes, plans and elevations * Free hand sketching | * Written tests * Oral questioning * Interviewing * Practical Test * Third party reports |
| 1. Produce 3D drawings | * Pictorial projections * Orthographic projections | * Written tests * Oral questioning * Interviewing * Practical Test * Third party reports |
| 1. Produce working drawings | * Construction plans, elevation and sections * Irrigation and drainage structures | * Written tests * Oral questioning * Interviewing * Practical Test * Third party reports |
| 1. Apply CAD packages | * Introduction to CAD * 2D drawing * 3D drawing * Page Layout and Printing | * Written tests * Oral questioning * Interviewing * Practical Test * Third party reports |

**Suggested Delivery Methods**

* Direct instruction
* Practice by trainee
* Demonstration by trainer
* Group discussion

**Recommended Resources**

* Drawing boards
* Drawing paper
* Drawing pencils
* CAD software
* Computers
* Internet

## WATER TECHNOLOGY

**UNIT CODE:** WAT/CU/WRMT/CC/06/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Water Technology Principles

**Duration of Unit:** 135 Hours

**Unit Description**

This unit describes the competence required to apply water technology principles. It involves applying basic water supply principles, wastewater collection and treatment as well as basic irrigation and drainage principles.

**Summary of Learning Outcomes**

1. Apply basic water supply principles
2. Apply principles of wastewater collection and treatment
3. Apply basic irrigation and drainage principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply basic water supply principles | * Water demand * Sources of water * Water abstraction * Water treatment * Safe water storage and handling * Water pipes and appurtenances * Distribution system | * Practical Test * Oral questioning * Written tests * Third party reports |
| 1. Apply principles of wastewater collection and treatment | * Sources of waste water * Characteristics of wastewater   + Domestic   + Industrial * Effluent discharge and containment regulations * Sewerage system layouts * Sewer pipes and appurtenances * Wastewater treatment and disposal processes * Industrial waste treatment processes * Onsite wastewater treatment systems * Sludge treatment * Feacal sludge management * Wastewater recycling and re-use * Sludge recycling and re-use | * Practical Test * Oral questioning * Written tests * Third party reports |
| 1. Apply basic irrigation and drainage principles | * Soil, plant-water relationship * Land preparation * Sources of water for irrigation * Irrigation farm layout * Quality of irrigation water * Irrigation methods * Methods of drainage | * Practical Test * Oral questioning * Written tests * Third party reports |

**Suggested Methods of Instruction**

* Direct instruction
* Demonstration by trainer
* Practice by the trainee
* Discussion

**Recommended Resources**

* National water and sanitation policy documents
* National standards manuals
* Basic engineering workshops
* Basic soil laboratory equipment and supplies
* Basic water quality laboratory equipment and supplies
* Water supply demonstration platforms
* Wastewater and sanitation demonstration platforms
* Demonstration farms
* Computers
* Internet connectivity

## WATER MANAGEMENT

**UNIT CODE:** WAT/CU/WRMT/CC/07/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Water Management Principles.

**Duration of Unit:** 210 Hours

**Unit Description**

This unit describes the competencies required to apply water management principles. It involves applying hydrology, hydrogeology as well as soil and water conservation, remote sensing and GIS principles. It also entails applying water policy and legislation as well integrated water resources management principles.

**Summary of Learning Outcomes**

1. Apply hydrology principles
2. Apply hydrogeology principles
3. Apply water and sanitation policy and legislation
4. Apply soil and water conservation principles
5. Apply integrated water resources management principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply hydrology principles | * Principles Concepts of hydrology * Hydrological cycle * Hydrological processes and applications * Basic hydrological measurements * Precipitation * Evaporation * Safety in hydrometry | * Written tests * Practical Test * Oral questioning * Third party report |
| 1. Apply hydrogeology principles | * Basic geochemistry and geophysics principles * Internal structure of the earth * Earth processes * Geologic structures * Minerals and rocks * Aquifers * Groundwater recharge basics * Groundwater characteristics * Spring and well protection | * Written tests * Interviewing * Practical Test * Oral questions * Third party report |
| 1. Apply soil and water conservation principles | * Land degradation * Soil conservation principles and applications * Water conservation principles and applications * Catchment protection | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Apply remote sensing and GIS principles | * Concepts and basic principles of remote sensing and GIS * Remote sensing and GIS instrumentation basics * Remote sensing and GIS tools and equipment for water management * Remote sensing and GIS data collection * Remote sensing and GIS data interpretation | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Apply water policy and legislation | * Water resources management policy and legal framework * Water services policy and legal framework * Sanitation services policy and legal framework * Water abstraction permitting and licensing * Wastewater and sludge disposal permitting and licensing * Law of contract * Law of tort * Regional and international perspectives in water management * Water use conflict and dispute resolution * Ethical practices in water management | * Written tests * Practical Test * Interviewing * Oral questioning * Third party reports |
| 1. Apply integrated water resources management principles | * Concepts of IWRM * Principles of IWRM * Applications of IWRM in local and national context | * Written tests * Practical Test * Oral questioning * Third party reports |

**Suggested Methods of Instruction:**

* Direct instruction
* Project
* Case studies
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

* Computers
* Stationery
* Class A evaporation pan
* Model weather station
* Wading suit
* Tape measure
* Staff gauge
* Hand lens
* Clinometer
* GPS receiver
* Maps
* Steel file
* Steel knife
* Rock samples
* Minerals
* PPE
* CoK, 2010
* Water Act, 2016
* EMCA, 2015
* WRA regulations
* Local government regulations
* International Protocols

## WATER PROJECT SITE SURVEY

**UNIT CODE:** WAT/CU/WRMT/CC/08/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Survey Water Project Sites

**Duration of Unit:** 45Hours

**Unit Description**

This unit covers the competencies required to survey water project sites. It involves conducting reconnaissance surveys, mapping water project site and plotting site profiles and cross sections.

**Summary of Learning Outcomes**

This unit covers the competencies required to Survey project site**.** It involves:

1. Conduct reconnaissance surveys
2. Map water project sites
3. Plot site profiles and cross section

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Conduct reconnaissance surveys | * Desk study * Reconnaissance survey procedures * Reconnaissance survey reporting and interpretation | * Practical Test * Oral questioning * Written tests   Third party reports |
| 1. Map water project sites | * Methods used in project site survey * Tape and offset survey * Levelling * Tacheometry * Traversing * Operation and maintenance of survey equipment * Site survey data collection and analysis * Conducting site survey using various methods and techniques | * Practical Test * Oral questioning * Written tests * Third party reports |
| 1. Plot site profiles and cross sections | * Plotting of Contour maps * Drawing of profiles * Drawing of cross sections * Development of terrestrial maps | * Practical Test * Oral questioning * Written tests * Third party reports |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Discussions
* Observation
* Discussion

**Recommended Resources**

* Tape measures
* Arrows
* Ranging rods
* Prismatic compasses
* Optical squares
* Dumpy levels
* Automatic levels
* Digital levels
* Levelling staffs
* Tripod stands
* Odometers
* Electromagnetic distance measurement equipment
* Theodolites
* Total stations

# CORE UNITS OF LEARNING

## SURFACE WATER RESOURCES MANAGEMENT

**UNIT CODE:** WAT/CU/WRMT/CR/01/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Manage Surface Water Resources

**Duration of Unit:** 240 Hours

**Unit Description**

This unit covers the competencies required to manage surface water resources. It involves siting hydro-meteorological monitoring stations, collecting and analysing hydro-meteorological data, monitoring surface water resources quality and maintaining surface water monitoring equipment. It also entails preparing hydrological reports as well as managing surface water resources customer service.

**Summary of Learning Outcomes**

1. Site hydro-meteorological monitoring stations
2. Collect hydro-meteorological data
3. Analyse hydro-meteorological data
4. Prepare hydrological reports
5. Monitor surface water resources quality
6. Maintain surface water monitoring equipment
7. Prepare hydrological reports
8. Manage surface water resources customer service

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Site hydro-meteorological monitoring stations | * Principles and concepts in hydrological monitoring * Instrumentation for hydrological monitoring * Factors in hydrological monitoring station siting * Meteorological parameters:   + Wind speed   + Wind direction   + Humidity   + Temperature * Hydrological parameters:   + Evaporation   + Precipitation   + Infiltration   + Surface run-off   + Percolation   + Stream flow   + Sediment discharge * Installation of hydro-meteorological monitoring tools and equipment | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Collect hydro-meteorological data | * Concepts and terminology hydro-meteorology * Objectives of water resources monitoring * Hydro-meteorological data collection methods * Hydro-meteorological measurements * Data logging * Personal safety and health | * Written tests * Interviewing * Oral questioning * Third party report |
| 1. Analyse hydro-meteorological data | * Statistical tools for hydro-meteorological data * Double mass analysis * Estimation of missing hydrological data * Flow duration and mass curve * Envelope curves * Hydrological frequency analysis * Hydrograph analysis * Applications of hydro-metereological data in event forecasting and climate change preparedness | * Written tests * Interviewing * Oral questions * Third party reports |
| 1. Prepare hydrological reports | * Hydrological report format * Hydrological report preparation * Hydrological report interpretation | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Monitor surface water resources quality | * Concepts and principles of water resources quality monitoring * Characteristics of surface water by source * Surface water resources quality indicators:   + Physical   + Chemical   + Microbiological   + Macrobiological * Tools and equipment for surface water resources quality monitoring:   + Field   + Laboratory   + Remote sensing * Surface water quality monitoring protocol * Surface water quality sampling, monitoring and reporting * Water quality report interpretation * Personal safety in surface water quality monitoring | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Prepare surface water management plans | * Concepts and principles in surface water resources management: * Water catchment * Water sheds * Wetlands * Surface water bodies * Surface water quantity challenges and issues * Surface water quality challenges and issues * Surface water management planning and reporting * Community participation in surface water resources management | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Maintain surface water monitoring equipment | * Routine maintenance of surface water monitoring station tools and equipment * Diagnosis and trouble shooting * Faults and repair procedures * Equipment servicing scheduling * Documentation of equipment maintenance, diagnosis and servicing | * Written tests * Interviewing * Oral questioning * Third party report |
| 1. Manage surface water resources customer service | * Concepts and principles of citizens’ water rights in devolved system of Government * Mapping of surface water resource users * Registration of surface WRUAs * Surface water abstraction permit procedures * Surface water abstraction costing and billing * Surface water resource use conflict management | * Written tests * Interviewing * Oral questioning * Third party report |

**Suggested Methods of Instruction:**

* Direct instruction
* Case studies
* Field trips
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

* Computers
* Surveying equipment
* Water samplers
* Drenchers
* Water level recorders
* Staff gauges
* ADCP
* ADP
* ADV
* Current meters
* Portable weir boards
* PPE
* GPS receiver
* Rain gauges
* Wind vanes
* Windsocks
* Hygrometers
* Maximum and minimum thermometers
* Evaporation pans
* Planimeter
* Stevenson screen

## GROUNDWATER RESOURCES MANAGEMENT

**UNIT CODE:** WAT/CU/WRMT/CR/02/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Manage Groundwater Resources

**Duration of Unit:** 240 Hours

**Unit Description**

This unit covers the competencies required to manage ground water resources. It involves siting hydrogeological monitoring stations, monitoring groundwater quality and levels, conducting hydrogeological surveys and preparing hydrogeological survey reports. It also entails maintaining groundwater monitoring equipment, preparing groundwater resource management plans as well as groundwater resources customer service.

**Summary of Learning Outcomes**

1. Site hydrogeological monitoring stations
2. Monitor groundwater levels
3. Conduct hydrogeological surveys
4. Prepare hydrogeological survey reports
5. Monitor groundwater quality
6. Maintain groundwater monitoring equipment
7. Prepare groundwater resource management plans
8. Manage groundwater resources customer service

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

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Site hydrogeological monitoring stations | * Principles and concepts in hydrogeological monitoring:   + Hydraulic characteristics of aquifers   + Darcy’s law   + Groundwater flow   + Groundwater recharge potential   + Groundwater resources mapping * Instrumentation for hydrogeological monitoring * Factors in hydrogeological monitoring station siting * Hydrogeological monitoring parameters * Installation of hydrogeological monitoring tools and equipment | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Monitor groundwater levels | * Tools and equipment for monitoring groundwater levels * Groundwater level measurement techniques * Data logging * Groundwater level data analysis, reporting and interpretation * Groundwater level fluctuations * Groundwater hydrograph | * Written tests * Interviewing * Oral questioning * Third party report |
| 1. Conduct hydrogeological surveys | * Concepts of groundwater exploration and exploitation * Hydrogeological survey methods: * Electrical resistivity * Seismic refraction and reflection * Gravity method * Magnetic method * Well logging * Hydrogeological survey tools and equipment * Hydrogeological data collection * Hydrogeological survey data analysis | * Written tests * Practical Test * Interviewing * Oral questioning * Third party report |
| 1. Prepare hydrogeological survey reports | * Hydrogeological report format * Hydrogeological report preparation * Hydrogeological report interpretation | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Monitor groundwater resources quality | * Concepts and principles of groundwater resources quality monitoring * Characteristics of groundwater * Groundwater resources quality indicators:   + Physical   + Chemical   + Microbiological * Tools and equipment for groundwater resources quality monitoring:   + Field   + Laboratory * Groundwater quality monitoring protocol * Groundwater quality sampling, monitoring and reporting * Groundwater quality report interpretation * Personal safety in groundwater quality monitoring | * Written tests * Interviewing * Oral questioning * Third party reports |
| 1. Maintain groundwater resources monitoring equipment | * Routine maintenance of groundwater monitoring station tools and equipment * Diagnosis and trouble shooting * Faults and repair procedures * Equipment servicing scheduling * Documentation of equipment maintenance, diagnosis and servicing | * Written tests * Interviewing * Oral questioning * Third party report |
| 1. Prepare groundwater management plans | * Concepts and principles in groundwater resources management: * Spring protection * groundwater recharge * Groundwater quantity challenges and issues * Surface water quality challenges and issues * Surface water management planning and reporting * Community participation in surface water resources management | * Written tests * Interviewing * Oral questioning * Third party report |
| 1. Manage ground water resources customer service | * Concepts and principles of groundwater resources exploitation in devolved system of government * Mapping of ground water resource users * Registration of ground WRUAs * Groundwater abstraction permit procedures * Groundwater abstraction costing and billing * Groundwater use resource use conflict management | * Written tests * Interviewing * Oral questioning * Third party report |

**Suggested Methods of Instruction:**

* Direct instruction
* Project
* Case studies
* Field trips
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

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| * Terrameters * Seismic meters * GPS receivers * Maps * Water pumps * Water samplers * PPE * Water quality portable test kits * Water meters |

## GROUNDWATER RESOURCES DEVELOPMENT

**UNIT CODE:** WAT/CU/WRMT/CR/03/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Develop Groundwater Resources

**Duration of Unit:** 180 Hours

**Unit Description**

This unit covers the competencies required to develop groundwater resources. It involves establishing boreholes, hand dug wells and artificial ground water recharge structures.

**Summary of Learning Outcomes**

1. Establish boreholes
2. Establish hand dug wells
3. Establish artificial ground water recharge structures

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Establish boreholes | * Well design criteria * Borehole drilling methods:   + Rotary   + Percussion * Tools and equipment for drilling * Drilling fluids * Drilling problems and solution * Legal requirements for establishment of boreholes: * Licenses * Permits * Mobilization and logistics for drilling exercise * Well completion: * Well development methods * Well casing and screens * Gravel pack and grouting * Pumping test: * Aquifer tests and well tests * Data collection and analysis * Well efficiency * Pump selection criteria * Pump drives systems * Pump installation * Borehole commissioning protocols * Borehole operation and maintenance * Costing of water from boreholes * Health and safety | * Written tests * Interviewing * Practical Test * Oral questioning * Third party report |
| 1. Establish hand dug wells | * Siting hand dug wells * Tools and equipment for digging wells * Construction of hand dug wells * Protection of hand dug wells * Operation and maintenance of hand dug wells * Health and safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party report |
| 1. Establish artificial ground water recharge structures | * Concepts of groundwater recharge * Groundwater recharge siting * Groundwater recharge methods * Tools and equipment for construction of artificial groundwater recharge structures * Work scheduling for groundwater recharge * Ground water recharge works * Health and safety | * Written tests * Practical Test * Interviewing * Oral questioning * Third party report |

**Suggested Methods of Instruction:**

* Direct instruction
* Project
* Case studies
* Field trips
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

* Computers
* Stationery
* Terrameter
* Seismic meters
* Magnetometers
* gravimeters
* geoelectric
* borehole geophysical logger
* gps receiver
* Video camera
* Sofware: gewin, QGIS, Suffer, ArcGIS
* Mud pumps
* Drill pipes
* Drilling rigs
* Drill collars
* Hand digging tools :Mattock,Hoes,Shovels,Chisels,Hammers
* Construction materials: gravel, clay, ballast, sand, cement, barbed wire
* Fencing materials: chain link, poles, nails
* Dump proof course
* Pipes and fittings

## NEW WATER RESOURCES DEVELOPMENT

**UNIT CODE:** WAT/CU/WRMT/CR/04/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Develop New Water Resources

**Duration of Unit:** 90 Hours

**Unit Description**

This unit covers the competencies required to develop new water resources. It involves promoting water recycling and reuse, desalinating water as well as harvesting and storing atmospheric water.

This standard applies in the Water sector

**Summary of Learning Outcomes**

1. Promote water recycle and reuse

2. Desalinate water

3. Harvest atmospheric water

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

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Promote water recycling and reuse | * Concepts of new water resources * Sources of water for recycling and re-use * National policies and regulations on water recycling and re-use * Technologies for water recycling and re-use * Community participation in water recycling and reuse | * Written tests * Practical Test * Interviewing * Oral questioning * Third party report |
| 1. Desalinate water | * Principles and concepts in water desalination * Water salinity classifications * In situ and ex-situ applications for each water desalination technology: * Solar distillation * Membrane filtration * Ion exchange * Reverse osmosis * Costing of water desalination | * Written tests * Interviewing * Practical Test * Oral questions * Third party report |
| 1. Harvest and store atmospheric water | * Principles and concepts of atmospheric water harvesting and storage * Characteristics of each atmospheric water source: * Rainwater * Fog * Dew * Rainwater harvesting and storage * Fog and dew harvesting technologies * Tools and equipment for atmospheric water harvesting * Community sensitization on atmospheric water harvesting * Cost implications atmospheric water harvesting and storage | * Written tests * Practical Test * Interviewing * Oral questioning * Third party report |

**Suggested Methods of Instruction:**

* Direct instruction
* Case studies
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

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| * Computers * Stationery * Data storage devices * Drones * Membrane filters * Reverse osmosis |